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Pest categorisation of *Platypus apicalis*

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Abstract

The EFSA Panel on Plant Health performed a pest categorisation of *Platypus apicalis* (Coleoptera: Curculionidae: Platypodinae), an ambrosia beetle, also known as a pinhole borer, for the EU territory. *P. apicalis* is a polyphagous pest native to New Zealand. The majority of its life cycle is spent inside tree wood, but it does not directly feed on plant tissue, instead larvae and adults feed on a symbiotic fungus (*Sporothrix nothofagi* which is pathogenic to *Nothofagus* spp.) vectored by adults and introduced when they bore tunnels into the host. *P. apicalis* feeds within a wide range of live, often stressed trees, in dead or dying hardwood and softwood trees, and fallen or felled trees. Successful reproduction can occur inside a number of living tree species including *Castanea sativa, Pinus* spp. and *Ulmus* spp. *P. apicalis* is not known to have established outside of New Zealand although findings have been reported in Australia. Whilst there are no records of interceptions of this species in the EU, platypodines are intercepted with solid wood packing material (SWPM) and *Platypus* species, but not *P. apicalis*, have been intercepted with wooden logs in Japan. Host plants for planting also provide a potential pathway. Hosts are grown widely across the EU in areas with climates comparable to those in New Zealand where the pest occurs suggesting that conditions in the EU are suitable for its establishment. If introduced into the EU, adults could disperse naturally by flight, perhaps tens or hundreds of metres. The movement of infested wood and host plants for planting within the EU could facilitate spread. Economic impacts in forestry and timber industries would result from the galleries created by *P. apicalis* and from wood staining caused by the symbiotic fungus. Phytosanitary measures are available to inhibit the entry of *P. apicalis*. *P. apicalis* satisfies the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.

Keywords: Ambrosia beetle, pest risk, pinhole borer, plant health, plant pest

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1. Introduction

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

1.1.1. Background

The new Plant Health Regulation (EU) 2016/2031, on the protective measures against pests of plants, is applying from 14 December 2019. Conditions are laid down in this legislation in order for pests to qualify for listing as Union quarantine pests, protected zone quarantine pests or Union regulated non-quarantine pests. The lists of the EU regulated pests together with the associated import or internal movement requirements of commodities are included in Commission Implementing Regulation (EU) 2019/2072. Additionally, as stipulated in the Commission Implementing Regulation 2018/2019, certain commodities are provisionally prohibited to enter in the EU (high risk plants, HRP). EFSA is performing the risk assessment of the dossiers submitted by exporting to the EU countries of the HRP commodities, as stipulated in Commission Implementing Regulation 2018/2018. Furthermore, EFSA has evaluated a number of requests from exporting to the EU countries for derogations from specific EU import requirements.

In line with the principles of the new plant health law, the European Commission with the Member States are discussing monthly the reports of the interceptions and the outbreaks of pests notified by the Member States. Notifications of an imminent danger from pests that may fulfil the conditions for inclusion in the list of the Union quarantine pest are included. Furthermore, EFSA has been performing horizon scanning of media and literature.

As a follow-up of the above-mentioned activities (reporting of interceptions and outbreaks, HRP, derogation requests and horizon scanning), a number of pests of concern have been identified. EFSA is requested to provide scientific opinions for these pests, in view of their potential inclusion by the risk manager in the lists of Commission Implementing Regulation (EU) 2019/2072 and the inclusion of specific import requirements for relevant host commodities, when deemed necessary by the risk manager.

1.1.2. Terms of reference

EFSA is requested, pursuant to Article 29(1) of Regulation (EC) No 178/2002, to provide scientific opinions in the field of plant health.

EFSA is requested to deliver 53 pest categorisations for the pests listed in Annex 1A, 1B, 1D and 1E (for more details see mandate M-2021-00027 on the Open.EFSA portal). Additionally, EFSA is requested to perform pest categorisations for the pests so far not regulated in the EU, identified as pests potentially associated with a commodity in the commodity risk assessments of the HRP dossiers (Annex 1C; for more details see mandate M-2021-00027 on the Open.EFSA portal). Such pest categorisations are needed in the case where there are not available risk assessments for the EU.

When the pests of Annex 1A are qualifying as potential Union quarantine pests, EFSA should proceed to phase 2 risk assessment. The opinions should address entry pathways, spread, establishment, impact and include a risk reduction options analysis.

Additionally, EFSA is requested to develop further the quantitative methodology currently followed for risk assessment, in order to have the possibility to deliver an express risk assessment methodology. Such methodological development should take into account the EFSA Plant Health Panel Guidance on quantitative pest risk assessment and the experience obtained during its implementation for the Union candidate priority pests and for the likelihood of pest freedom at entry for the commodity risk assessment of High Risk Plants.

1.2. Interpretation of the Terms of Reference

Platypus apicalis is one of a number of pests listed in Annex 1B to the Terms of Reference (ToR) to be subject to pest categorisation to determine whether it fulfils the criteria of a potential Union quarantine pest for the area of the EU excluding Ceuta, Melilla and the outermost regions of Member States referred to in Article 355(1) of the Treaty on the Functioning of the European Union (TFEU), other than Madeira and the Azores, and so inform EU decision-making as to its appropriateness for potential inclusion in the lists of pests of Commission Implementing Regulation (EU) 2019/ 2072. If a pest fulfils the criteria to be potentially listed as a Union quarantine pest, risk reduction options will be identified.

1.3. Additional information

This pest categorisation was initiated following the commodity risk assessment of *Acer* spp. plants for planting from New Zealand performed by EFSA (EFSA PLH Panel, 2020), in which *P. apicalis* was identified as a relevant non-regulated EU pest which could potentially enter the EU on *Acer spp*.

2. Data and methodologies

2.1. Data

2.1.1. Literature search

A literature search on *P. apicalis* 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. Papers relevant for the pest categorisation 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, online), the CABI databases and scientific literature databases as referred above in Section 2.1.1.

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

The Europhyt and TRACES databases were 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 as a subproject of PHYSAN (Phyto-Sanitary Controls) specifically concerned with plant health information. TRACES is the European Commission's multilingual online platform for sanitary and phytosanitary certification required for the importation of animals, animal products, food and feed of non-animal origin and plants into the European Union, and the intra-EU trade and EU exports of animals and certain animal products. Up until May 2020, the Europhyt database managed notifications of interceptions of plants or plant products that do not comply with EU legislation, as well as notifications of plant pests detected in the territory of the Member States and the phytosanitary measures taken to eradicate or avoid their spread. The recording of interceptions switched from Europhyt to TRACES in May 2020.

GenBank was searched to determine whether it contained any nucleotide sequences for *P. apicalis* which could be used as reference material for molecular diagnosis. GenBank® (www.ncbi.nlm.nih.gov/genbank/) is a comprehensive publicly available database that as of August 2019 (release version 227) contained over 6.25 trillion base pairs from over 1.6 billion nucleotide sequences for 450,000 formally described species (Sayers et al., 2020).

2.2. Methodologies

The Panel performed the pest categorisation for *P. apicalis*, following guiding principles and steps presented in the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018), the EFSA guidance on the use of the weight of evidence approach in scientific assessments (EFSA Scientific Committee, 2017) and the International Standards for Phytosanitary Measures No. 11 (FAO, 2013).

The criteria to be considered when categorising a pest as a potential Union quarantine pest (QP) are given in Regulation (EU) 2016/2031 Article 3 and Annex I, Section 1 of the Regulation. Table 1 presents the Regulation (EU) 2016/2031 pest categorisation criteria on which the Panel bases its conclusions. In judging whether a criterion is met the Panel uses its best professional judgement (EFSA Scientific Committee, 2017) by integrating a range of evidence from a variety of sources (as presented above in Section 2.1) to reach an informed conclusion as to whether or not a criterion is satisfied.

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, deemed to be a risk management decision, the Panel will present a summary of the observed impacts in the areas where the pest occurs, and make a judgement about potential likely impacts in the EU. Whilst the Panel may quote impacts reported from areas where the pest occurs in monetary terms, the Panel will seek to express potential EU impacts in terms of yield and quality losses and not in monetary terms, in agreement with the EFSA guidance on quantitative pest risk assessment (EFSA PLH Panel, 2018). Article 3 (d) of Regulation (EU) 2016/2031 refers to unacceptable social impact as a criterion for quarantine pest status. Assessing social impact is outside the remit of the Panel.

Table 1: Pest categorisation criteria under evaluation, as derived from 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 (article 3)
Identity of the pest (Section 3.1)	Is the identity of the pest clearly defined, 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 in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.
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 for entry and spread.
Potential for consequences in the EU territory (Section 3.5)	Would the pests' introduction have an economic or environmental impact on the EU territory?
Available measures (Section 3.6)	Are there measures available to prevent pest entry, establishment, spread or impacts?
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.

3. Pest categorisation

3.1. Identity and biology of the pest

3.1.1. Identity and taxonomy

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

Yes. The identity of the species is established and *Platypus apicalis* White is the accepted scientific name and authority.

Platypus apicalis White, 1846, is an insect within the order Coleoptera, family Curculionidae, subfamily Platypodinae. Synonyms of the species are *Crossotarsus apicalis* White, 1846, *Platypus douei* Chapuis, 1865 and *Platypus castaneus* Broun, 1880 (EFSA PLH Panel, 2020). Members of the Platypodinae are known as pinhole borers, although the same name has also been applied to some Scolytinae (e.g. *Xyleborinus saxesenii*, the fruit-tree pinhole borer). Platypodinae, together with Scolytinae whose larvae also feed on symbiotic 'ambrosia fungi' are known as ambrosia beetles. Pinhole borers had been considered as a distinct family, the Platypodidae. However, more recently, their taxonomic status has been changed to subfamily (Platypodinae) within the Curculionidae although there is still some debate on this issue (Kirkendall et al., 2015). For the purposes of this pest categorisation, *P. apicalis* is considered as within the Platypodinae.

The EPPO code[1] (Griessinger and Roy, 2015; EPPO, 2019) for this species is PLTPAP (EPPO, online).

[1] An EPPO code, formerly known as a Bayer code, is a unique identifier linked to the name of a plant or plant pest important in agriculture and plant protection. Codes are based on genus and species names. However, if a scientific name is changed, the EPPO code remains the same. This provides a harmonised system to facilitate the management of plant and pest names in computerised databases, as well as data exchange between IT systems (Griessinger and Roy, 2015; EPPO, 2019).

3.1.2. Biology of the pest

P. apicalis is an ambrosia beetle; ambrosia beetles live inside tree wood and do not directly feed on plant tissue, instead both larvae and adults feed on symbiotic fungi (Batra, 1966) which are carried in particular organs (mycangia) and introduced by adults when they bore tunnels into the host (Farrell et al., 2001). In the case of *P. apicalis,* the fungus is *Sporothrix nothofagi* Gadgil and Dick, 2004 (Ophiostomataceae) known only from New Zealand. S. *nothofagi* is pathogenic to *Nothofagus* trees. Faulds (1977) artificially inoculated red beech (*N. fusca*) of various sizes (diameter at breast height 31–45 cm) with a mycelial suspension of *S. nothofagi;* all inoculated trees wilted and died within 4–40 months whilst uninoculated control trees with similar diameters remained healthy.

The life cycle of *P. apicalis* consists of egg, five larval instars, pupa and adult. Individuals spend almost their entire life inside the host, either a living tree or a felled or fallen tree. However, each adult generation emerges from the host where they are born and fly in search of suitable host trees for colonisation, mating and reproduction (Scion, 2009). Newly emerged males detect fallen, freshly felled or stressed live trees using volatile chemicals released from stressed tissue. When an adult male reaches a host, it releases an aggregation pheromone to attract other adults (males and females) to the site. When attacking living trees, males bore into the lower parts of the stem, often where the diameter is between 6 cm and 15 cm. However, *P. apicalis* can also attack larger diameter trees which are stressed (EPPO, 2020). The males bore tunnels 2 mm in diameter which reach into the sapwood and extend into the boundary between sapwood and heartwood. Males and females mate at the entrance of a tunnel and eggs are laid in small batches of four to seven eggs at the end of a tunnel. Additional batches of eggs can be laid in other branches of the tunnel or gallery system, also called a nest (Scion, 2009). Larvae at all stages move freely throughout the nest and feed on the introduced fungus. Larvae create tunnels approximately 8 mm long, which are used as pupal chambers (Scion, 2009). Adults typically take 2 years to develop from eggs and emerge in spring and summer although up to 40% may take more than 2 years to complete development (Scion, 2009). Up to 425 adults have been recorded from a single nest but usually the number is much lower (Scion, 2009).

3.1.3. Host range/Species affected

P. apicalis can attack a wide range of live, dead or dying hardwood and softwood trees (Ytsma, 1988). Successful reproduction can occur inside a number of living tree species. Feeding and successful breeding in dead or dying trees and recently felled wood has been reported whilst wood of some species can be attacked although there is no successful reproduction (Table 2). Alma and Van Boven (1976) note that large numbers of *P. apicalis* are reported to attack felled Douglas fir logs within a few days of felling although live trees are not attacked.

Table 2: Living tree species that are attacked by *Platypus apicalis* and in which successful reproduction takes place together with dead or dying species which are attacked, and in which reproduction may or may not be possible[1, 2, 3, 4, 5]

Binomial name	Common name	State of plants in which *Platypus apicalis* tunnels and note on ability for *P. apicalis* reproduction			
		Living tree, reproduction occurs	Dead or dying tree, reproduction occurs	Dead or dying tree, unknown reproduction	Dead or dying tree, no reproduction
Acacia melanoxylon	Australian blackwood				✓
Acacia dealbata	Acacia bernier			✓	
Acer pseudoplatanus	Sycamore		✓		
Agathis australis	kauri		✓		
Aristotelia *serrata*	Wineberry				✓
Betula pendula	silver birch			✓	
Brachyglottis huntii	Rautini	✓			

Binomial name	Common name	State of plants in which *Platypus apicalis* tunnels and note on ability for *P. apicalis* reproduction			
		Living tree, reproduction occurs	**Dead or dying tree, reproduction occurs**	**Dead or dying tree, unknown reproduction**	**Dead or dying tree, no reproduction**
Castanea sativa	sweet chestnut	✔			
Cordyline australis	cabbage tree	✔			
Dacrycarpus dacrydioides	Kahikatea		✔		
Dacrydium cupressinum	Rimu		✔		
Diospyros kaki	persimmon			✔	
Dysoxylum spectabile	Kohekohe			✔	
Eucalyptus spp.	eucalyptus				✔
Ginkgo biloba	ginkgo			✔	
Nothofagus spp.	beech		✔		
Nothofagus fusca	red beech	✔			
N. menziesii	silver beech	✔			
N. solandri	black beech	✔			
N. truncata	hard beech	✔			
Picea abies	Norway spruce			✔	
Pinus spp.	pine		✔		
Populus trichocarpa	black cottonwood				✔
Pseudotsuga menziesii	Douglas-fir		✔		
Quercus robur	common oak				✔
Rhus spp.	sumac			✔	
Salix fragilis	crack willow			✔	
Sequoia sempervirens	coast redwood				✔
Ulmus spp.	elms		✔		
Weinmannia racemosa	Maori	✔	✔		

References for Table 2: [1] Alma and Van Boven (1976); [2] Brockerhoff et al. (2003); [3] EPPO (2020); [4] Ridley et al. (2000); [5] Scion (2009).

3.1.4. Intraspecific diversity

There is no intraspecific diversity found in literature.

3.1.5. Detection and identification of the pest

Are detection and identification methods available for the pest?

Yes, detection and identification methods are available. Infested trees and logs show symptoms of attack although these are not diagnostic; specimens can be identified using morphological keys or molecular methods.

Symptoms

Trees attacked by *P. apicalis* show dieback from the tips of branches and twigs, entry holes into galleries (2 mm in diameter) may be visible and there can be general decline (Scion, 2009). Frass and fine-shredded material from the boring of the entrance tunnel can be seen when it collects in heaps at the base of the tree or lodges in the crevices of bark, and is a characteristic feature of attack (Clark, 1932; Scion, 2009). Frass is more abundant and conspicuous on trunks of dead or fallen trees than on living trees (Mark et al., 1977). Infested logs would also show entry holes into galleries.

Identification

P. apicalis is included within a morphological key to Australian Platypodinae which is available online (Bickerstaff et al., 2019). Adults are dark brown, the basal segment of the antennae, metathorax and upper parts of legs are yellow (Chapuis, 1865).

Molecular methods are available to identify *P. apicalis*. Reay et al. (2012) provided a partial sequence of 28S ribosomal RNA to Genbank.

3.2. Pest distribution

3.2.1. Pest distribution outside the EU

P. apicalis is indigenous to New Zealand (Brockerhoff et al., 2003) and can be found throughout the North Island, the South Island and Chatham Islands (NZ, about 800 km east of South Island), although not in the drier eastern forests of NZ (Scion, 2009). Clark (1932) stated that the species was more plentiful in the North Island.

Brockerhoff et al. (2003) were uncertain as to whether *P. apicalis* occurred in Australia. Bickerstaff et al. (2020) noted that findings of *P. apicalis* in Australia had only been collected at or near ports of entry and suggested that they should be regarded as intercepted specimens rather than established populations. EPPO (2020) reports that *P. apicalis* is not known to have been introduced to new areas.

Figure 1: Global distribution of *Platypus apicalis* (Data Source: CABI, online accessed on 8 February 2022.)

3.2.2. Pest distribution in the EU

Is the pest present in the EU territory? If present, is the pest in a limited part of the EU or is it scarce, irregular, isolated or present infrequently? If so, the pest is considered to be not widely distributed.   **No**, *P. apicalis* is not known to occur in the EU.

3.3. Regulatory status

3.3.1. Commission Implementing Regulation 2019/2072

P. apicalis is not listed in Annex II of Commission Implementing Regulation (EU) 2019/2072, or its amendments, such as (EU) 2021/2285.

High-risk plant regulations

Following the publication of a scientific opinion regarding high-risk plants, specifically the commodity risk assessment of *Acer* spp. plants for planting from New Zealand (EFSA PLH Panel, 2020), *P. apicalis* was included in Commission Implementing Regulation (EU) 2020/1361 which notes that with appropriate mitigation measures applied, the phytosanitary risk is reduced to an acceptable level and the *Acer* species from New Zealand should no longer be considered high-risk plants.

3.3.2. Hosts or species affected that are prohibited from entering the Union from third countries

Table 3: List of plants, plant products and other objects that are *Platypus apicalis* hosts whose introduction into the Union from certain third countries is prohibited (Source: Commission Implementing Regulation (EU) 2019/2072, Annex VI)

List of plants, plant products and other objects whose introduction into the Union from certain third countries is prohibited			
	Description	**CN Code**	**Third country, group of third countries or specific area of third country**
1.	Plants of [...] *Picea* A. Dietr., *Pinus* L., *Pseudotsuga* Carr. and [...] other than fruit and seeds	ex 0602 20 20 ex 0602 20 80 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 47 ex 0602 90 50 ex 0602 90 70 ex 0602 90 99 ex 0604 20 20 ex 0604 20 40	Third countries other than: Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Turkey, Ukraine and United Kingdom
2.	Plants of *Castanea* Mill. and *Quercus* L., with leaves, other than fruit and seed	ex 0602 10 90 ex 0602 20 20 ex 0602 20 80 ex 0602 90 41 ex 0602 90 45 ex 0602 90 46 ex 0602 90 48 ex 0602 90 50 ex 0602 90 70 ex 0602 90 99 ex 0604 20 90 ex 1404 90 00	Third countries other than Albania, Andorra, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Canary Islands, Faeroe Islands, Georgia, Iceland, Liechtenstein, Moldova, Monaco, Montenegro, North Macedonia, Norway, Russia (only the following parts: Central Federal District (Tsentralny federalny okrug), Northwestern Federal District (Severo-Zapadny federalny okrug), Southern Federal District (Yuzhny federalny okrug), North Caucasian Federal District (Severo-Kavkazsky federalny okrug) and Volga Federal District (Privolzhsky federalny okrug)), San Marino, Serbia, Switzerland, Turkey, Ukraine and United Kingdom

Pending risk assessment, high-risk plant regulation EC 2018/2019 includes temporary prohibition of plants for planting of *Castanea* and *Ulmus,* plants in which *P. apicalis* can feed and reproduce.

3.3.3. Legislation addressing the organisms vectored by *Platypus apicalis* (Commission Implementing Regulation 2019/2072)

The pathogen *S. nothofagi,* which is vectored by *P. apicalis*, is not regulated by EU phytosanitary legislation.

3.4. Entry, establishment and spread in the EU

3.4.1. Entry

Is the pest able to enter into the EU territory? If yes, identify and list the pathways.
Yes, *P. apicalis* could potentially enter the EU within plants for planting, wood and solid wood packaging material.
Comment on plants for planting as a pathway.
Plants for planting could provide a pathway.

Haack et al. (2014) reported Platypodinae were intercepted with solid wood packing material (SWPM) in USA. Of 13,768 bark and wood-infesting insects intercepted on SWPM entering US ports from 1984 to 2008, ~ 1% (141 of 13,768) were Platypodinae.

During a 2-year survey of SWPM entering the EU (April 2013 to March 2015), no Platypodinae that were detected were identified to species or genus (Eyre et al., 2018). The studies by Haack et al. (2014) and Eyre et al. (2018) indicate that Platypodinae can be associated with SWPM, which could therefore provide a pathway for entry into the EU.

Platypus species, but not *P. apicalis*, have been intercepted with wooden logs in Japan (e.g. Browne, 1985, 1986) indicating that members of the genus can be transported via international trade.

The EFSA PLH Panel (2020) commodity risk assessment for *Acer* spp. plants for planting from New Zealand, indicated with 95% certainty, that between 99.29% and 99.97% of 1- to 3-year-old bare-rooted plants produced using specified mitigation measures would be free of *P. apicalis*, giving an overall evaluation of 'pest free with some exceptional cases'; this led to certain species of *Acer* plants for planting from New Zealand being removed from the EU list of high-risk plants ((EU) 2020/1361).

Potential pathways for *P. apicalis* to enter the EU are shown in Table 4.

Table 4: Potential pathways for *Platypus apicalis* to enter into the EU 27

Pathways (Description e.g. host/intended use/ source)	**Life stage**	**Relevant mitigations** [e.g. prohibitions (Annex VI), special requirements (Annex VII) or phytosanitary certificates (Annex XI) within Implementing Regulation 2019/2072]
Solid wood packaging material	Eggs, larvae, pupae, adults	ISPM 15; Implementing Regulation 2019/2072
Woody host plants for planting (excluding seeds), with a diameter > 6 cm	Eggs, larvae, pupae, adults	EU 2018/2019 (High risk plants prohibition), phytosanitary certificate
Cut branches with diameter > 6cm	Eggs, larvae, pupae, adults	Implementing Regulation 2019/2072, Annex XI, part A e.g. cut branches of conifers from third countries require a phytosanitary certificate
Round wood with bark	Eggs, larvae, pupae, adults	Implementing Regulation 2019/2072, Annex VII, e.g. point 80

Notifications of interceptions of harmful organisms began to be compiled in Europhyt in May 1994 and in TRACES in May 2020. As at 8 February 2022, there were no records of interception of *P. apicalis* in the Europhyt and TRACES databases.

The HS system for classifying commodities for customs purposes identifies some wood in the rough to the trees from which the wood comes. Wood chips and particles are not identified to the trees from which they derive. For the 5-year period 2017–2021, there are no records of EU imports from New Zealand of selected wood in the rough or wood chips (Table 5).

Table 5: Potential commodity pathways for *Platypus apicalis* into the EU

Potential commodity pathway	HS code	2017	2018	2019	2020	2021
Wood in the rough: *Pinus* < 15 cm diameter	4403 22	No import data from New Zealand				
Poplar or Aspen	4403 97	"				
Eucalyptus spp.	4403 98	"				
beech	4403 94	"				
oak	4403 91	"				

SWPM is a known pathway for Platypodinae. A substantial proportion of pallets and SWPM are made with coniferous wood (Powell, 2002), including *Pinus,* which can be *P. apicalis* hosts (Table 3). Given the lack of imports of wood and wood chips (Table 5), entry via SWPM appears as the most reasonable possible potential pathway.

3.4.2. Establishment

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

Yes, *P. apicalis* could become established in the EU. Host plants are available within the EU and host distribution overlaps with suitable climatic conditions to support long term survival of *P. apicalis* within the EU.

Exotic species of bark beetles and pinhole borers have established in Europe (e.g. Kirkendall and Faccoli, 2010; Marini et al., 2011) indicating that transfer to suitable hosts following entry is possible at least for some species. Given the similarity in the biology of platypodines, we assume that transfer is possible for *P. apicalis*.

Climatic mapping is the principal method for identifying areas that could provide suitable conditions for the establishment of a pest taking key abiotic factors into account (Baker, 2002). Availability of hosts is considered in Section 3.4.2.1. Climatic factors are considered in Section 3.4.2.2.

3.4.2.1. EU distribution of main host plants

P. apicalis is a polyphagous species, and trees in which it is known to be able to reproduce are found across the EU, e.g. *Acer pseudoplatanus*, *Castanea sativa*, *Nothofagus* spp., *Picea* spp., *Pinus* spp., *Pseudotsuga menziesii* and *Ulmus* spp. A relative probability map produced by the Joint Research Centre (JRC) for EFSA showing *Acer* is provided below (Figure 2). Appendix C provides maps for other hosts.

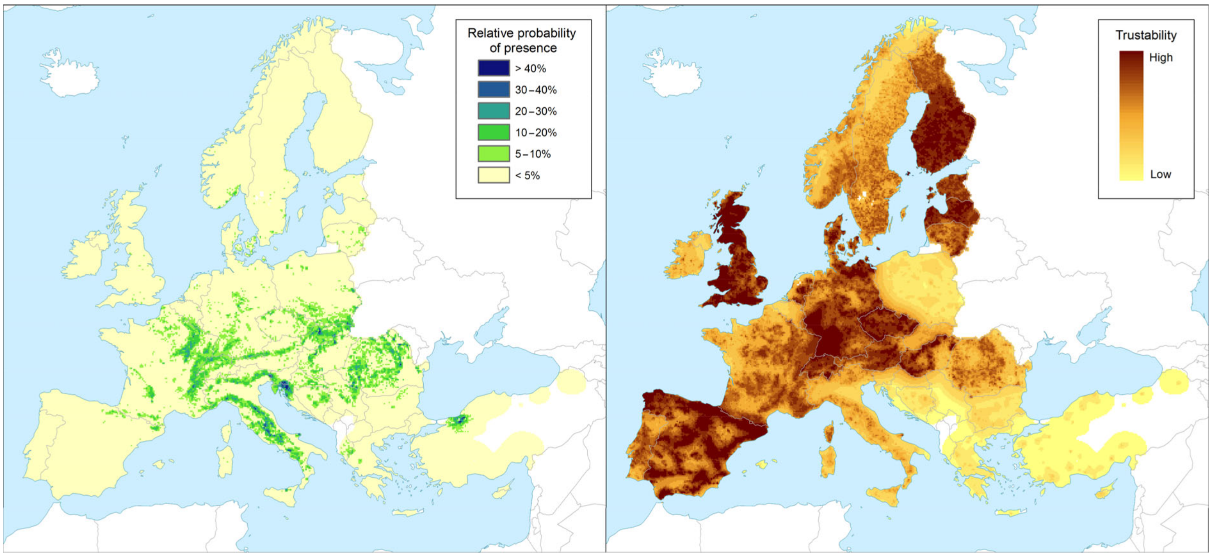

Figure 2: Left panel: Relative probability of the presence (RPP) of the genus *Acer* in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Appendix C (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 on methodology, see Appendix C)

3.4.2.2. Climatic conditions affecting establishment

The global Köppen–Geiger climate zones (Kottek et al., 2006) describe terrestrial climate in terms of average minimum winter temperatures and summer maxima, amount of precipitation and seasonality (rainfall pattern). Climatic zones in New Zealand are comparable to climatic zones within the EU. In New Zealand, *P. apicalis* occurs in zone Cfb (temperate oceanic). This climate zone also occurs in the EU and is found widely in central and northern EU countries and is represented in ~ 46% of EU 27 five arcmin grid cells (MacLeod and Korycinska, 2019) (Figure 3) .

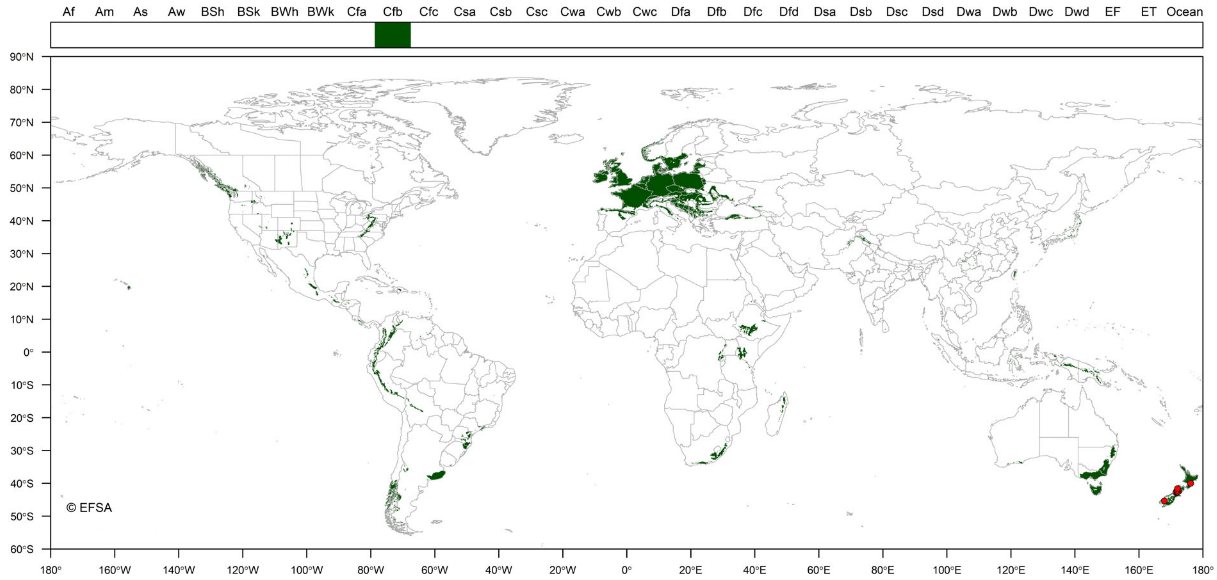

Figure 3: Distribution of Köppen–Geiger climate type Cfb that occurs in the EU and in New Zealand where *Platypus apicalis* has been reported

3.4.3. Spread

Describe how the pest would be able to spread within the EU territory following establishment?

Adults can fly and could spread locally, perhaps several tens of meters within stands of trees but potentially up to a few km as observed with another closely related species. Longer distance spread could occur via movement of infested trees (as plants for planting) or wood.

Comment on plants for planting as a mechanism of spread.

Infested host plants for planting with stems between 6 cm and 15 cm in diameter could facilitate spread carrying all life stages within the galleries.

Adult males and females can fly. Scion (2009) reports *P. apicalis* adults flew up to 800 m to reach rapidly growing eucalyptus trees. Pham (2020) conducted flight mill experiments on a related species, *Platypus quercivorus* Murayama, in Japan, and noted that 95% of flights lasted less than 20 min and the mean distance flown by males was 3.00 km (range: 80 m to 24.7 km), whereas the mean distance for females was 3.75 km (range: 40 m to 28.8 km). However, flight mill studies often overestimate dispersal distances seen in nature (Robinet et al., 2019). Studying *Platypus koryoensis* (Murayama) in the field using mark, release and recapture techniques, Lee et al. (2019) reported 85% of captured adults were caught within 25 m of the release point and 100% within 50 m.

3.5. Impacts

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

Yes, the introduction of *P. apicalis* into the EU could cause economic impacts in forestry and timber industries.

P. apicalis attacks dead, weakened and healthy trees, usually stems of 6–15 cm in diameter, and in the lower part of the living tree (Grehan and Nixon, 1978). When boring their tunnels, the beetles inoculate the highly pathogenic fungus *Sporothrix nothofagi* into the wood. The fungus impedes sapflow in the host causing wilt, dieback or death. The likelihood of tree mortality increases where the tree was already under stress, e.g. due to insufficient moisture (Payton, 1989; Scion, 2009). Large-scale mortality, particularly involving *Nothofagus* spp., can result from mass attacks as a result of the aggregation pheromone attracting many individuals to live trees (Milligan, 1979; Milligan and Ytsma, 1988). In New Zealand, *P. apicalis* has great economic impact in *Nothofagus* and *Eucalyptus* forests (Scion, 2009). *P. apicalis* emerging from felled or fallen *Weinmannia* trees are likely to attack and kill or damage nearby healthy *Weinmannia* (Payton, 1989).

Recently felled trees, especially conifers are susceptible to attack by *P. apicalis* (Ytsma, 1988). Large numbers of *P. apicalis* can be found on logs of *Pseudotsuga menziesii* (Douglas fir) a few days after felling although the beetles are not attracted to feed and develop within stumps of *P. menziesii* (Alma and Van Boven, 1976). *P. apicalis* is economically important because the galleries the species create in recently felled timber reduce the value and quality of commercial wood (Ytsma, 1988). The associated symbiotic ambrosia fungus causes staining of the wood around the galleries, further lowering and downgrading timber quality. Tunnelling to create galleries reduces the strength of structural timbers and spoil veneers as does staining by the fungus. Such staining increases the cost of pulping when making paper because greater amounts of bleaching agents are necessary (Scion, 2009).

As noted by EPPO (2020), the potential impact of *P. apicalis* on *C. sativa* is difficult to assess because *C. sativa* is only grown as an ornamental in New Zealand and no studies reporting damage were found although the literature indicates that *C. sativa* is susceptible to *S. nothofagi* (Scion, 2009); in the EU *C. sativa* is an important amenity tree and is commercially grown for production of sweet chestnuts, especially in Spain.

3.6. Available measures and their limitations

Are there measures available to prevent pest entry, establishment, spread or impacts such that the risk becomes mitigated?

Yes, some host plants are prohibited, and wood imports and SWPM require phytosanitary treatments.

3.6.1. Identification of potential additional measures

Phytosanitary measures (prohibitions) are currently applied to some host plants for planting (see Section 3.3.2).

Additional potential risk reduction options and supporting measures are shown in Sections 3.6.1.1 and 3.6.1.2.

3.6.1.1. Additional potential risk reduction options

Potential additional control measures are listed in Table 6.

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

Control measure/risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/spread/impact)
Require pest freedom	Pest-free production site, area, place or production	Entry/Spread
Biological control and behavioural manipulation	Entomopathogenic fungi (*Beauveria bassiana*, *B. brongniartii* and *Metarhizium anisopliae* have been shown to kill *P. apicalis* (Glare et al., 2002) and have potential for localised control of *Platypus* spp.	Spread, Impact
Chemical treatments on consignments or during processing	Phosphine or sulfuryl fluoride fumigation could be used to treat wood (Leal et al., 2010; Pawson et al., 2014)	Entry/Spread
Waste management	Treatment of the waste (deep burial, composting, incineration, chipping, production of bio-energy…) in authorised facilities and official restriction on the movement of waste.	Establishment/Spread

Control measure/risk reduction option (Blue underline = Zenodo doc, Blue = WIP)	RRO summary	Risk element targeted (entry/establishment/ spread/impact)
Heat and cold treatments	Host wood is heat treated to achieve a minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of the wood. Host wood is kiln dried to below 20% moisture; (Pawson et al., 2014) SWPM has been treated according to ISPM 15	Entry/Spread

3.6.1.2. Additional supporting measures

Potential additional supporting measures are listed in Table 7.

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

Supporting measure (Blue underline = Zenodo doc, Blue = WIP)	Summary	Risk element targeted (entry/ establishment/ spread/impact)
Inspection and trapping	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/ Establishment/ Spread
Laboratory testing	Examination, other than visual, to determine if pests are present using official diagnostic protocols. Diagnostic protocols describe the minimum requirements for reliable diagnosis of regulated pests.	Entry/Spread
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/ Spread
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/ Spread
Delimitation of Buffer zones	ISPM 5 defines a buffer zone as 'an area surrounding or adjacent to an area officially delimited for phytosanitary purposes in order to minimise the probability of spread of the target pest into or out of the delimited area, and subject to phytosanitary or other control measures, if appropriate' (ISPM 5). The objectives for delimiting a buffer zone can be to prevent spread from the outbreak area and to maintain a pest-free production place (PFPP), site (PFPS) or area (PFA).	Spread/Impact
Surveillance	Surveillance to guarantee that plants and produce originate from a pest-free area could be an option.	Spread/Impact

3.6.1.3. Biological or technical factors limiting the effectiveness of measures

- The effect of fumigation on wood is short-lived. For example, if the moisture content of fumigated wood remains high, ambrosia beetles, may colonise treated wood at a later date (Leal et al., 2010).
- If introduced, little can be done to control pinhole borers once trees have been infested. Due to difficulties of accessing larvae and adults in tunnels chemical control within a forest situation is not effective (Glare et al., 2002).

3.7. Uncertainty

There is no key uncertainty that would cast doubt on the conclusions of this opinion.

4. Conclusions

P. apicalis satisfies all the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest. Table 8 provides a summary of the PLH Panel conclusions.

Table 8: The Panel's conclusions on the pest categorisation criteria defined in Regulation (EU) 2016/2031 on protective measures against pests of plants (the number of the relevant sections of the pest categorisation is shown in brackets in the first column)

Criterion of pest categorisation	Panel's conclusions against criterion in Regulation (EU) 2016/2031 regarding Union quarantine pest	Key uncertainties
Identity of the pest (Section 3.1)	The identity of the species is established and *Platypus apicalis* is the accepted name.	None
Absence/presence of the pest in the EU (Section 3.2)	*P. apicalis* is not known to occur in the EU.	None
Pest potential for entry, establishment and spread in the EU (Section 3.4)	*P. apicalis* could potentially enter the EU within plants for planting, wood and solid wood packaging material. *P. apicalis* could become established in the EU. Host plants are available within the EU and host distribution overlaps with suitable climatic conditions to support long-term survival of *P. apicalis* within the EU. Adults can fly and could spread locally, perhaps several tens of meters within stands of trees but potential up to a few km. Longer distance spread could occur via movement of infested trees (as plants for planting) or wood.	None
Potential for consequences in the EU (Section 3.5)	The introduction of *P. apicalis* into the EU could cause economic impacts in forestry and timber industries.	None
Available measures (Section 3.6)	Some host plants are prohibited, and wood imports and SWPM require phytosanitary treatments	None
Conclusion (Section 4)	*P. apicalis* satisfies all of the criteria that are within the remit of EFSA to assess for it to be regarded as a potential Union quarantine pest.	None
Aspects of assessment to focus on/scenarios to address in future if appropriate:	Future studies on the pathogenic nature of *S. nothofagi* and its hosts.	

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Abbreviations

EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
MS	Member State
PLH	EFSA Panel on Plant Health
PZ	Protected Zone
SWPM	Solid wood packaging material
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, 2018a,b)
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO, 2018a,b)
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, 2018a,b)
Eradication (of a pest)	Application of phytosanitary measures to eliminate a pest from an area (FAO, 2018a,b)
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO, 2018a,b)
Greenhouse	A walk-in, static, closed place of crop production with a usually translucent outer shell, which allows controlled exchange of material and energy with the surroundings and prevents release of plant protection products (PPPs) into the environment.
Hitchhiker	An organism sheltering or transported accidentally via inanimate pathways including with machinery, shipping containers and vehicles; such organisms are also known as contaminating pests or stowaways (Toy and Newfield, 2010).

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, 2018a,b)
Pathway	Any means that allows the entry or spread of a pest (FAO, 2018a,b)
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, 2018a,b)
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, 2018a,b)
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, 2018a,b)

Appendix A – *Platypus apicalis* host plants/species affected

Host name	Plant family	Common name	Reference
Acacia dealbata	Fabaceae	Acacia bernier	EFSA PLH Panel (2020)
Acacia melanoxylon	Fabaceae	Australian blackwood	EFSA PLH Panel (2020)
Acer pseudoplatanus	Sapindaceae	Sycamore maple	EFSA PLH Panel (2020)
Agathis australis	Araucariaceae	Kauri	EFSA PLH Panel (2020)
Aristotelia serrata	Elaeocarpaceae	Wineberry	EFSA PLH Panel (2020)
Betula pendula	Betulaceae	Common silver birch	EFSA PLH Panel (2020)
Brachyglottis huntii	Asteraceae	Rautini	EFSA PLH Panel (2020)
Castanea sativa	Fagaceae	Sweet chestnut	EFSA PLH Panel (2020)
Cordyline australis	Asparagaceae	Cabbage tree	Grehan and Nixon (1978)
Coprosma chathamica	Rubiaceae		Milligan (1979)*
Corynocarpus laevigata	Corynocarpaceae	Karaka	Milligan (1979)*
Dacrydium cupressinum	Podocarpaceae	Rimu	EFSA PLH Panel (2020)
Dacrycarpus dacrydioides	Podocarpaceae	Kahikatea	EFSA PLH Panel (2020)
Diospyros kaki	Ebenaceae	Persimmon	EFSA PLH Panel (2020)
Dysoxylum spectabile	Meliaceae	Kohekohe	EFSA PLH Panel (2020)
Eucalyptus spp.	Myrtaceae	Eucalyptus	EFSA PLH Panel (2020)
Ginkgo biloba	Ginkgoaceae	Ginkgo	EFSA PLH Panel (2020)
Melicytus chathamicus (=*Hymenanthera chatamica*)	Violaceaea		Milligan (1979)*
Myrsine chathamica	Primulaceae		Milligan (1979)*
Nothofagus	Nothofagaceae	Beech	CABI (online)
Nothofagus fusca	Nothofagaceae	Red beech	EFSA PLH Panel (2020)
Nothofagus menziesii	Nothofagaceae	Silver beech	EFSA PLH Panel (2020)
Nothofagus solandri	Nothofagaceae	Black beech	EFSA PLH Panel (2020)
Nothofagus truncata	Nothofagaceae	Hard beech	EFSA PLH Panel (2020)
Picea abies	Pinaceae	Norway spruce	EFSA PLH Panel (2020)
Pinus spp.	Pinaceae	Pine	EFSA PLH Panel (2020)
Pinus muricata	Pinaceae	Muricata pine	Milligan (1979)
Pinus nigra	Pinaceae	Corsican pine	Milligan (1979)
Pinus ponderosa	Pinaceae		Milligan (1979)
Pinus radiata	Pinaceae	Radiata pine	Milligan (1979)
Pinus taeda	Pinaceae	Loblolly pine	Milligan (1979)
Plagianthus betulinus	Malvaceae	Ribbonwood	Milligan (1979)*
Populus trichocarpa	Salicaceae	Black cottonwood	EFSA PLH Panel (2020)
Pseudotsuga menziesii	Pinaceae	Douglas-fir	EFSA PLH Panel (2020)
Pseudopanax chathamica	Araliaceae	Hoho	Milligan (1979)*
Quercus robur	Fagaceae	Common oak	EFSA PLH Panel (2020)
Rhus spp.	Anacardiaceae	Sumac	EFSA PLH Panel (2020)
Salix fragilis	Salicaceae	Crack willow	EFSA PLH Panel (2020)
Salix babylonica	Salicaceae	Weeping willow	Milligan (1979)
Senecio huntii	Asteraceae		Milligan (1979)*
Sequoia sempervirens	Cupressaceae	Coast redwood	EFSA PLH Panel (2020)
Ulmus spp.	Ulmaceae	Elm	Ridley et al. (2000)
Weinmannia racemose	Cunoniaceae	Maori	EFSA PLH Panel (2020)

*: It is not clear whether living trees or felled or damaged trees are attacked.

Appendix B – Distribution of *Platypus apicalis*

Distribution records based on CABI (online).

Region	Country	Sub-national (e.g. State)	Status
Oceania	New Zealand	–	Present
	Australia	–	Absent (intercepted only) (Bickerstaff et al., 2019)

Appendix C – Maps and methodological notes

C.1. *Pinus* in Europe

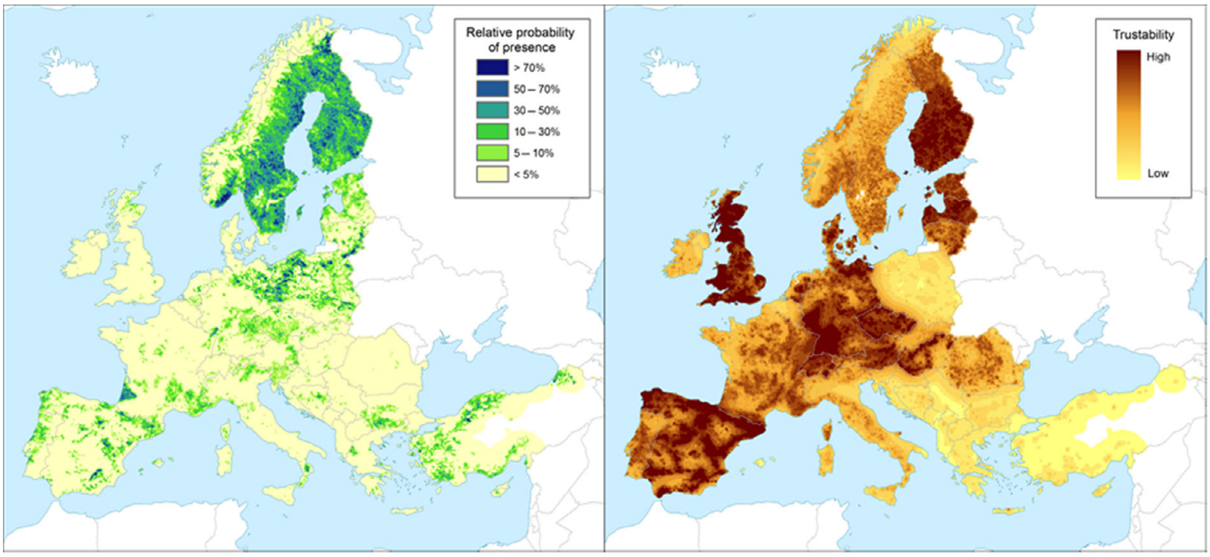

Figure C.1: Left panel: Relative probability of the presence (RPP) of the genus *Pinus* in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Section C.3 of Appendix C (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 Section C.3 of Appendix C)

C.2. *Picea* in Europe

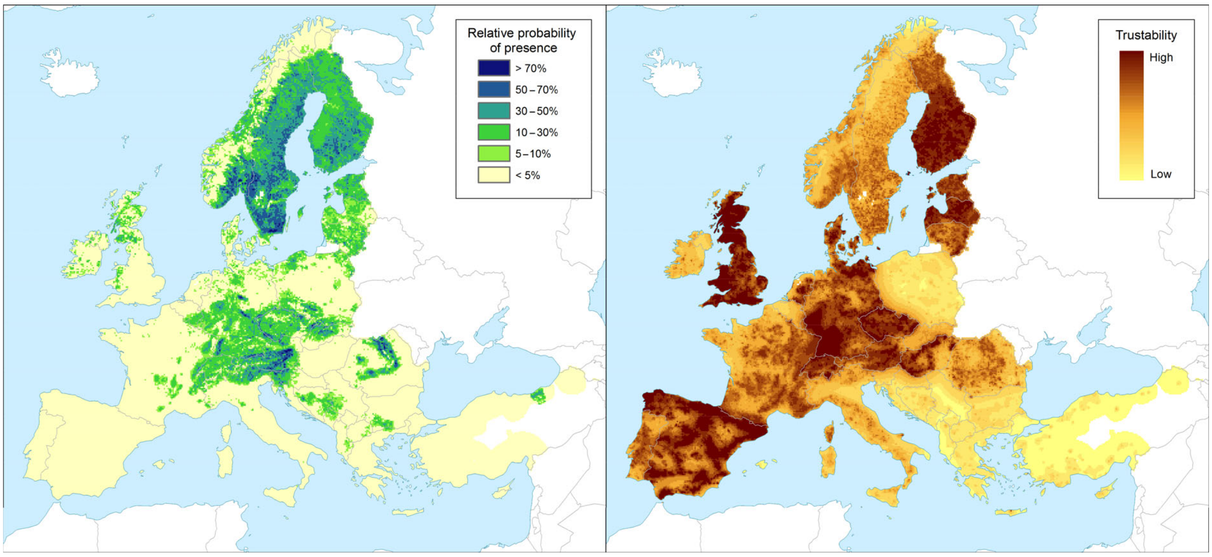

Figure C.2: Left panel: Relative probability of the presence (RPP) of the genus *Picea* in Europe, mapped at 100 km^2 resolution. The underlying data are from European-wide forest monitoring data sets and from national forestry inventories based on standard observation plots measuring in the order of hundreds m^2. RPP represents the probability of finding at least one individual of the taxon in a standard plot placed randomly within the grid cell. For details, see Section C.3 of Appendix C (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 Section C.3 of Appendix C)

C.3. Methodological notes on Figures C.1 and C.2

The relative probability of presence (RPP) reported here and in the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz et al., 2016) is the probability of a species, and sometimes a genus, occurring in a given spatial unit (de Rigo et al., 2017). The maps of RPP are produced by spatial multiscale frequency analysis (C-SMFA) (de Rigo et al., 2014, 2016) of species presence data reported in geolocated plots by different forest inventories.

Geolocated plot databases

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

The harmonisation of these data sets was performed as activity within the research project at the origin of the European Atlas of Forest Tree Species (de Rigo et al., 2016; San-Miguel-Ayanz et al., 2016; San-Miguel-Ayanz, 2016). All data sets were harmonised to an INSPIRE compliant geospatial grid, with a spatial resolution of 1 km^2 pixel size, using the ETRS89 Lambert Azimuthal Equal-Area as geospatial projection (EPSG: 3035, https://spatialreference.org/ref/epsg/etrs89-etrs-laea/).

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

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[2]. 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.

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

European Information System on Forest Genetic Resources (EUFGIS) is a smaller geodatabase that provides information on tree species composition in over 3,200 forest plots in 34 European countries. The plots are part of a network of forest stands managed for the genetic conservation of one or more target tree species. Hence, the plots represent the natural environment to which the target tree species are adapted (EUFGIS, online).

Georeferenced Data on Genetic Diversity (GD^2) is a smaller geo-database as well. It provides information about a 63 species that are of interest for genetic conservation. It counts 6,254 forest plots that are located in stands of natural populations that are traditionally analysed in genetic surveys. While this database covers fewer species than the others, it does covers 66 countries in Europe, North Africa and the Middle East, making it the data set with the largest geographic extent (INRA, online).

Modelling methodology

For modelling, the data were harmonised in order to have the same spatial resolution (1 km^2) and filtered to a study area that comprises 36 countries in the European continent. The density of field observations varies greatly throughout the study area and large areas are poorly covered by the plot databases. A low density of field plots is particularly problematic in heterogenous 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.

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

The probability to find a single species in a 1-km^2 grid cell cannot be higher than the probability of the presence of all the broadleaved (or coniferous) species combined, because all sample plots are localised inside forested areas. Thus, to improve the accuracy of the maps, the preliminary RPP values were constrained to not exceed the local forest-type cover fraction (de Rigo et al., 2014). The latter was estimated from the 'Broadleaved forest', 'Coniferous forest' and 'Mixed forest' classes of the Corine Land Cover (CLC) maps (Bossard et al., 2000; Büttner et al., 2012), with 'Mixed forest' cover assumed to be equally split between broadleaved and coniferous.

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

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 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 it (de Rigo et al., 2014, 2016).

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

C.4. *Ulmus minor* in Europe

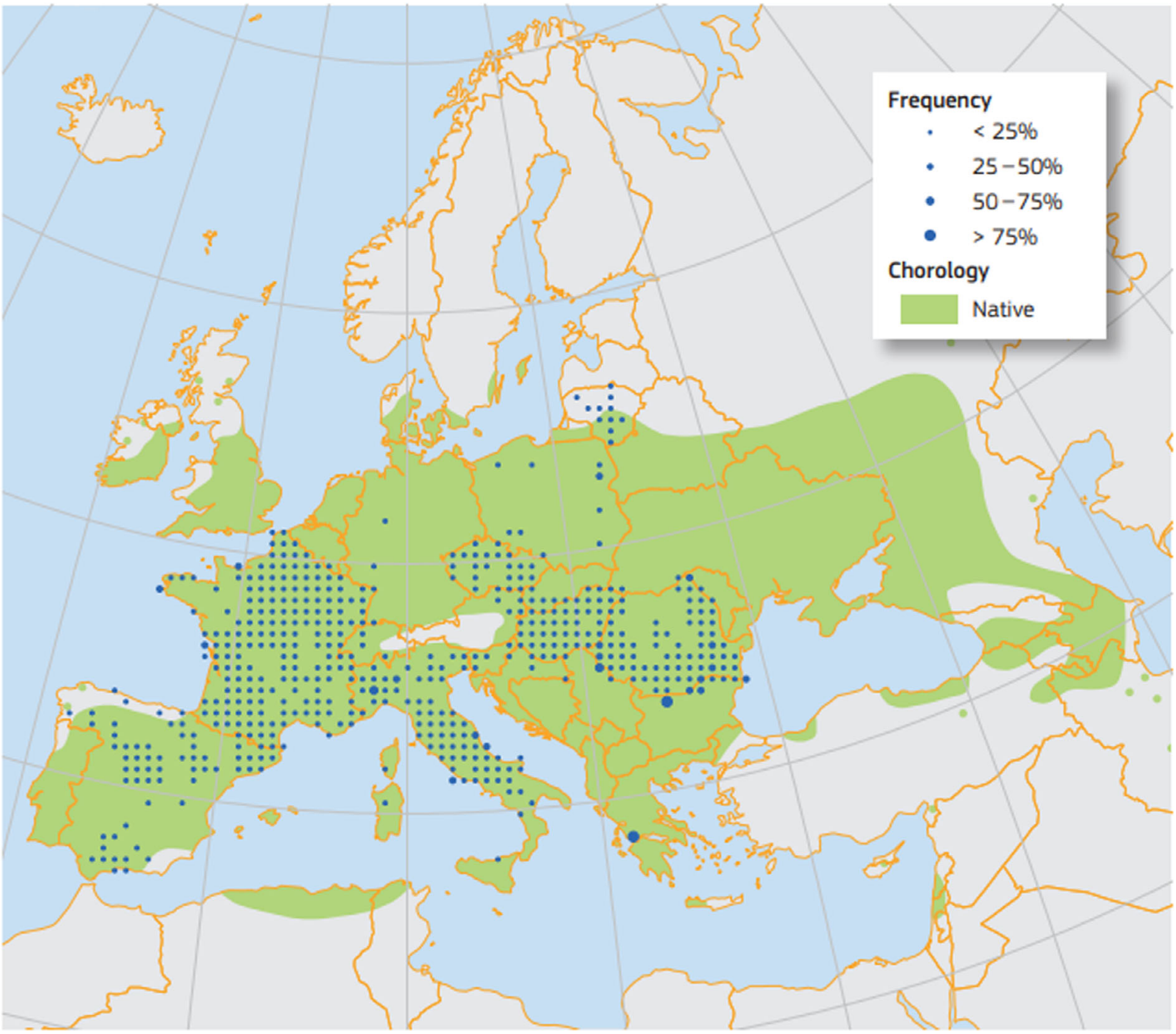

Figure C.3: Plot distribution and simplified chorology map for *Ulmus minor*. Frequency of *U*. *minor* occurrences within the field observations as reported by the National Forest Inventories. Source: Caudullo G and de Rigo D, 2016. *Ulmus* - elms in Europe: distribution, habitat, usage and threats. In: San-Miguel-Ayanz J, de Rigo D, Caudullo G, Houston Durrant T and Mauri A (eds.), European Atlas of Forest Tree Species. Publ. Off. EU, Luxembourg, pp. e01bd40+

C.5. *Castanea sativa* in Europe

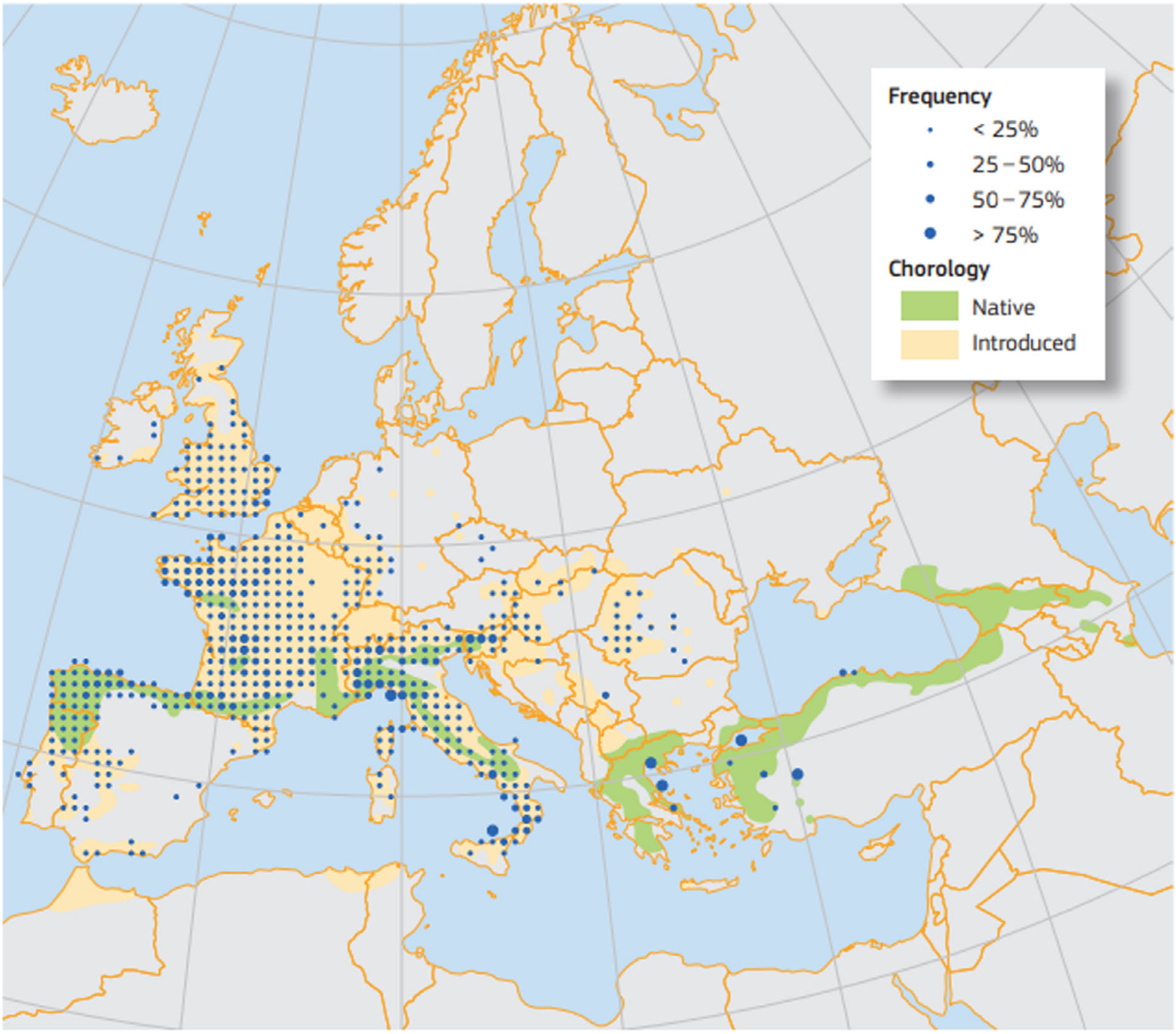

Figure C.4: Plot distribution and simplified chorology map for *Castanea sativa*. Frequency of *C. sativa* occurrences within the field observations as reported by the National Forest Inventories. Source: Caudullo G and de Rigo D, 2016. *Castanea sativa* in Europe: distribution, habitat, usage and threats. In: San-Miguel-Ayanz J, de Rigo D, Caudullo G, Houston Durrant T and Mauri A (eds.), European Atlas of Forest Tree Species. Publ. Off. EU, Luxembourg, pp. e01bd40+