EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES

21-26634

This PRA document was modified in 2021 in relation to the recommended distance for the establishment of a pest free area, and to clarify the phytosanitary measures recommended.

Pest Risk Analysis for

Heterobasidion irregulare

September 2015

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This risk assessment follows the EPPO Standard PM PM 5/5(1) *Decision-Support Scheme for an Express Pest Risk Analysis* (available at http://archives.eppo.int/EPPOStandards/pra.htm) and uses the terminology defined in ISPM 5 *Glossary of Phytosanitary Terms* (available at https://www.ippc.int/index.php).
This document was first elaborated by an Expert Working Group and then reviewed by the Panel on Phytosanitary Measures and if relevant other EPPO bodies.

Cite this document as:
EPPO (2015) *Pest risk analysis for Heterobasidion irregulare*. EPPO, Paris.
Available at http://www.eppo.int/QUARANTINE/Pest_Risk_Analysis/PRA_intro.htm
Photo: *Heterobasidion irregulare*.Courtesy: Paolo Gonthier (University of Torino, IT) and Matteo Garbelotto (University of California, Berkeley, US)

21- 26634 (21-26448, 20-25973, 15-21059, 15-20692, 15-20465, 15-20336, 14-20209, 14-20169, 14-20096)

Pest Risk Analysis for *Heterobasidion irregulare*

This PRA follows EPPO Standard PM 5/5 *Decision-Support Scheme for an Express Pest Risk Analysis*.

PRA area: *EPPO region*
Prepared by: EWG on *Heterobasidion irregulare*
Date: 2014-12-01/04

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The PRA was further reviewed by core members (Guillaume Fried, José Maria Guitian Castrillon, Salla Hannunen, Petr Kapitola, Arild Sletten, Nursten Üstün) between 2015-01-27 and 2015-02-20, and by the Panel on Phytosanitary Measures and the Panel on Quarantine Pests for Forestry on 2015-03-11/13.

Summary of the Pest Risk Analysis for *H. irregulare*
PRA area: *EPPO region*
Describe the endangered area: *H. irregulare* has the potential to establish throughout the EPPO region where *Pinus* occurs, possibly up to the northern distribution border of *H. annosum* s.s. (62°N in Sweden). It is likely to be damaging on *P. pinea* throughout the Mediterranean and to add to the impact by *H. annosum* s.s. on other hosts throughout the PRA area.
Main conclusions *Overall assessment of risk: H. irregulare* presents the case of an unusual pathway of introduction in the EPPO region, but this PRA shows that trade pathways also exist. The probability of entry is considered as moderate-high for natural spread from the infested area in Italy and untreated wood packaging material. Entry on wood of conifer host species (with the higher likelihood of association) and particle wood of conifers and waste wood (from countries where the pest occurs) was rated as moderate/low. Although plants for planting were assessed with a low risk, they may be traded as large ornamental, which would present an increased risk. Entry on other pathways is less likely. Natural spread from the infested area in Italy is currently constrained by a lack of suitable presence of hosts around the outbreak area. Entry into another EPPO country through natural spread may happen in the order

of one to few decades in the absence of efficient containment measures.

Although similar to *H. annosum* s.s. in its life cycle, *H. irregulare* has comparative advantages that would influence impact (much higher fruiting and saprobic ability resulting in a much higher transmission potential; higher spore production, resulting in higher rates of primary infection; saprobic ability, leading to a higher inoculum potential in the secondary spread of the disease, thus possibly a higher rate of spread through root contacts). In addition, hybridization occurs between *H. irregulare* and *H. annosum* s.s. and there is a risk for increased virulence and different host range (possibly of the two species) in the long-term. All pine trees of the EPPO region may be at risk in the long term. Damage in the long-term could be substantial throughout the EPPO region, and significantly increased compared to that of European *Heterobasidion* species.

The EWG supported that entry of *H. irregulare* into the EPPO region should be prevented and its spread contained. It also considered important to prevent further introductions of *H. irregulare* from different areas in North America. In particular, preventing introduction from Western North America would also reduce the risk of introduction of the other North American species *H. occidentale*, which has a similar biology with partially overlapping hosts.

Phytosanitary Measures: Risk management options were identified for conifer wood, for conifer particle wood and waste wood, and for plants for planting. Wood packaging material should be treated according to ISPM 15. Measures for bark, Christmas trees and wood of *Quercus*, *Prunus serotina*, *Arbutus menziesii* and *Artostaphylos* spp. were not studied in details, but similar measures could be used as for particle wood, plants for planting and conifer wood.

The EWG recommended that measures for wood be applied to all coniferous hosts of *H. irregulare*, considering the remaining uncertainties on the importance of hosts. In addition, covering all hosts of *H. irregulare* would allow targeting some major hosts of *H. occidentale* including *Pseudotsuga menziensi*.

Containment measures were described, that could be applied to the infested area in Italy (see 16.2).

Phytosanitary risk for the *endangered area* (*Individual ratings for likelihood of entry and establishment, and for magnitude of spread and impact are provided in the document*)	**High x**	Moderate ☐	Low ☐
Level of uncertainty of assessment (*see Q 17 for the justification of the rating. Individual ratings of uncertainty of entry, establishment, spread and impact are provided in the document*)	High ☐	**Moderate x**	Low ☐

Other recommendations:

The EWG recommended that containment measures should be taken in Italy. Italy is the only country where the pathogen is present in the EPPO region. The pathogen is present in a limited area, which is favourable for containment because there is not a continuum of suitable forest. It is still possible to slow down and possibly even stop the spread of this pathogen and avoid its introduction into other EPPO countries. The EWG noted that, in the long term, any further spread of the pathogen would potentially have significant impact on European forests and trees.

Finally, although uncertainty is low regarding the potential for establishment and economic impact in other parts of the EPPO region, there are still gaps in knowledge for this pest. Research is needed on the following aspects: susceptibility of the main conifer and oak species to *H. irregulare* and hybrids between *H. irregulare* and *H. annosum* s.s.; presence and ecology of *H. irregulare* on oak stands; effectiveness of urea and/or other treatments against *Heterobasidion* on oak stumps; saprobic ability of *H. irregulare* and hybrids between *H. irregulare* and *H. annosum* s.s. on wood of the main European conifer and oak species; use of mild heat treatments to kill *H. irregulare* on plants for planting; spore dispersal; rapid diagnostic methods.

Content

Stage 1. Initiation

Reason for performing the PRA: *Heterobasidion irregulare* has recently been described as a new species belonging to the *H. annosum* complex and originating from North America. *H. irregulare* was introduced into Italy (Lazio), probably during World War II, and has spread. It is causing mortality on *Pinus pinea* and has also been found on *P. halepensis* and *Erica arborea*. The Panel on Phytosanitary Measures suggested *H. irregulare* as a priority for PRA, which was confirmed by the Working Party on Phytosanitary Measures in June 2014.

This PRA focuses on *H. irregulare*, but also mentions in the pest risk management section the second North American species, *H. occidentale*, described as a new species belonging to the *H. annosum* complex at the same time as *H. irregulare*.

The EPPO standard PM 5/5 *Decision-Support Scheme for an Express Pest Risk Analysis* was used, as recommended by the Panel on Phytosanitary Measures. Pest risk management was conducted according to the EPPO Decision-support scheme for quarantine pests PM 5/3(5) (detailed in Annex 8).

Note to PRA core members and Panels.
A draft data sheet is available, with details especially on biology, detection and identification (under development at 27-01-2015).

Time was saved by referring to existing comprehensive reviews of knowledge (in particular Woodward et al., 1998 for *H. annosum* s.l. and Garbelotto and Gonthier, 2013 for *H. irregulare*), without always consulting/referring to the original sources. This was considered necessary for this "express PRA" to save resources. Original references considered essential by the EWG were added.

PRA area: EPPO region (map at www.eppo.org).

Note: To be consistent with some previous PRAs, 5 rating levels are used for the likelihood of entry on individual pathways (very low, low, moderate, high, very high) even if PM 5/5(1) uses only 3 levels. The levels of uncertainty in PM 5/5(1) are used throughout the text (low, moderate, high).

Stage 2. Pest risk assessment

1. Taxonomy

Taxonomic classification. Fungi; Basidiomycota; Russulales; Bondarzewiaceae; *Heterobasidion irregulare* (Underw.) Garbelotto & Otrosina (MB 515278 - Otrosina and Garbelotto, 2010).

Common names of the disease. Maladie du rond des pins (Québec), Annosus root and butt rot (USA).

Synonym (Otrosina and Garbelotto, 2010; Farr and Rossman, 2014). *Polyporus irregularis* Underwood, Torrey Bot Club. Bull. 24:85, 1897.
The names "North American *H. annosum* P ISG"; *Fomes annosus, Fomitopsis annosa, Polyporus annosus* are also mentioned in the literature.

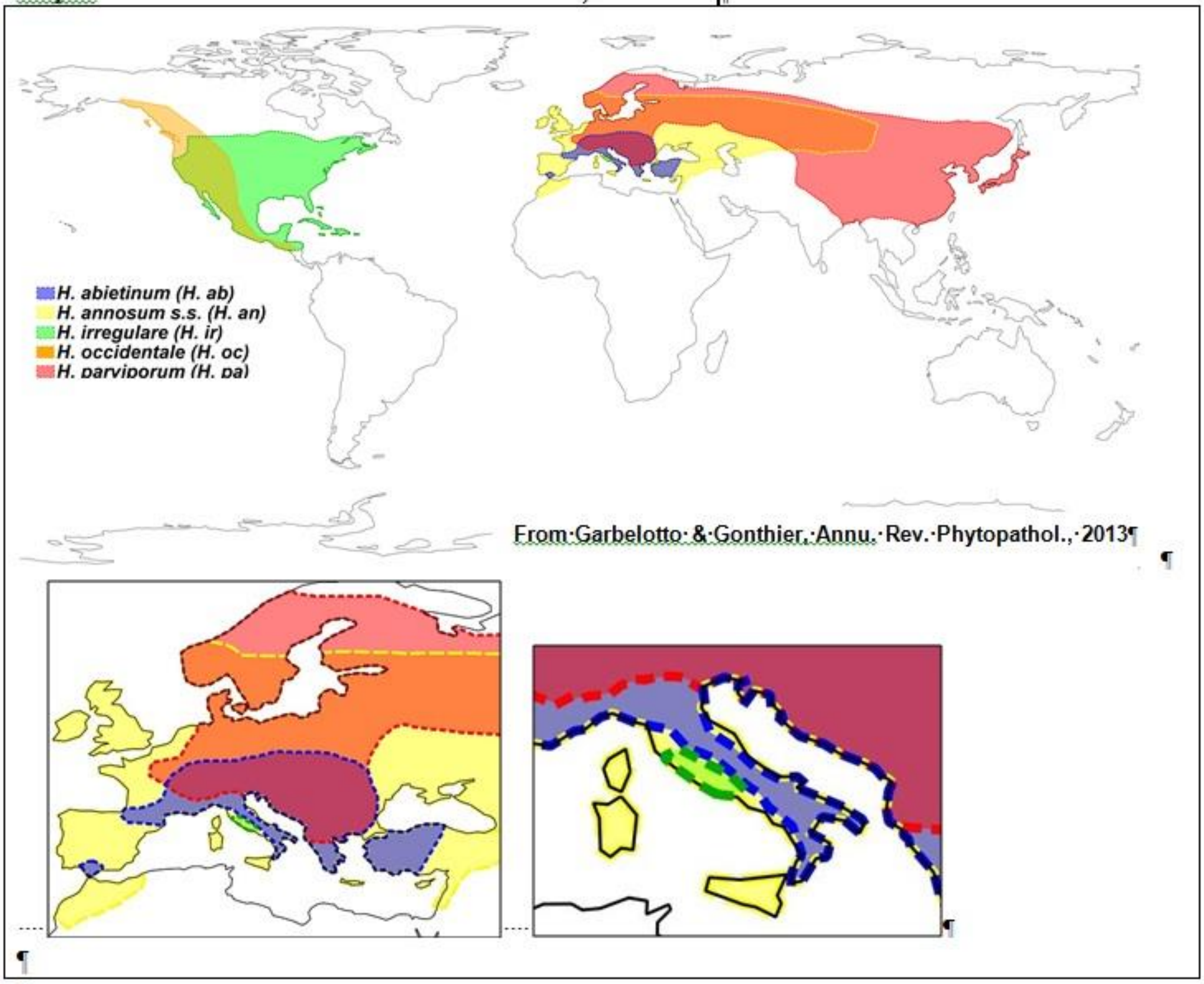
Background on the taxonomy
H. irregulare is part of the *H. annosum* complex (*H. annosum* sensu lato, [s.l.]). It was recognized as a distinct species by Otrosina and Garbelotto (2010). The taxonomic history is important to understand the current situation of *H. irregulare*. The *H. annosum* complex consists of 5 species:
- 2 from North America: *H. irregulare* and *H. occidentale* (only North America is generally referred to, although there are some records in other parts of the Americas, most of them with some uncertainty).
- 3 from Eurasia: *H. annosum* sensu stricto (s.s.), *H. parviporum* and *H. abietinum*.

The 5 species were previously considered as 5 intersterility groups (ISGs) of *H. annosum*, with different host preferences (although their host ranges are all broader than only the main host genera and overlap to a certain extent). The concept of ISG for *H. annosum* was first used by Korhonen (1978). The 5 ISGs were referred to as the European "F" ISG, European and North American "S" ISGs and the European and North American "P" ISGs. The North American ISGs were described by Chase and Ulrich, 1990.

- The European F ISG (mostly on *Abies*) and S ISG (mostly on *Picea*, also *Abies sibirica*) were the first ISG groups to be named as distinct species, respectively as *H. abietinum* and *H. parviporum*.
- The North American S ISG (mostly on *Abies*, *Picea*, *Pseudotsuga*, *Tsuga, Sequoiadendron*) was named as *H. occidentale* (Otrosina and Garbelotto, 2010).
- The European and North American P ISGs (mostly on *Pinus*, but also several other genera) were shown to have nearly complete interfertility, phenotypic similarities, close levels of genetic relatedness and similar host range and infection biology, but to be two clear sister taxa with no evidence of recent gene flow (Stenlid and Karlsson, 1991; Otrosina et al., 1993; Linzer et al., 2008). The North American P ISG was described as *H. irregulare* (Otrosina and Garbelotto, 2010), while the European P ISG is now *H. annosum* s.s.

EPPO (2013) provides a summary of hosts and distribution for the 5 species. The map below (from Garbelotto and Gonthier, 2013) illustrates their known distribution.

Map 1. Worldwide distribution of *H. annosum* s.l., and zooms



It is not always possible to conclude which *Heterobasidion* species is dealt with in the North American literature that pre-dates their division. In North America, only *H. irregulare* and *H. occidentale* (and some hybrids) are known to occur. Old publications on *H. annosum* relating to North America may relate to either *H. irregulare* or *H. occidentale*. In addition, intersterility groups were already known in the 1980s for the USA. They are sometimes mentioned in publications and this allows reliable species designation. Where only *H. annosum* is mentioned, the hosts indicated cannot always be used to conclude which *Heterobasidion* species is dealt with because of the overlap in their host range. However, only *H. irregulare* is known to occur in Eastern USA. Consequently, if records refer strictly to Western USA, they may relate to both, but if they refer to Eastern USA, they are likely to relate to *H. irregulare*. Records on angiosperms, also in Western USA, are also likely to relate to *H. irregulare* (M. Garbelotto, University of California, 2014-12, personal communication).

There is a strong genetic differentiation between the Western and Eastern (incl. Midwest) populations of *H. irregulare* (Linzer et al., 2008; Dalman et al., 2010). There are some indications that both populations may be present in Mexico, and the introduction in Italy is from the Eastern populations.

Although the 5 species belong to different intersterility groups, there is a certain level of sexual compatibility between some of them. Hybrids of *H. irregulare* were found, formed with:

- *H. occidentale* in Western USA (Garbelotto et al., 1996; Lockman et al., 2014);
- *H. annosum* s.s. in Italy (Gonthier et al., 2007; Gonthier and Garbelotto, 2011).

2. Pest overview

H. annosum s.l. is a well-known pathogen, causing one of the most damaging diseases of conifers worldwide. Its biology was extensively studied in the 20th century. The morphology, biology and life cycle are similar for the species in the *H. annosum* complex, with some variations. The morphology, biology and life cycle of *H. irregulare* are detailed in the EPPO data sheet (in preparation).

H. irregulare was shown to have a comparable pathogenicity to that of *H. annosum* s.s. in experiments, on *P. pinea* and *P. halepensis* (Scirè et al., 2008, 2011; Garbelotto et al., 2010), on seedlings or cuttings of *P. pinea*, *P. sylvestris* and *P. taeda* (Gonthier et al., 2014a, citing others), and *P. pinaster* (Lung-Escarmant et al., 2012). However, some important differences have been observed, that would influence the establishment, spread and impact of *H. irregulare*. The following competitive advantages over *H. annosum* s.s. are identified in the literature:

- higher production of fruiting bodies. Giordano et al. (2014) showed that *H. irregulare* produces higher numbers of fruiting bodies with a larger mean surface of hymenophores (approximately 13 times).
- higher production of basidiospores (Scirè et al., 2011)
- in the Mediterranean environment, *H. irregulare* was shown to develop in both dry and wet forest stands. Basidiospore production occurs throughout the year, while that of *H. annosum* s.s. is limited during the summer (Garbelotto et al., 2010, Gonthier et al. 2007; Gonthier et al., 2012).
- Higher infectivity. Scirè et al. (2011), in inoculation trials on 6-months seedlings of *P. pinea* in pots showed that *H. annosum* s.s. has a lower capacity to penetrate infect the roots, and also grows slower than *H. irregulare*
- higher ability to saprophytically colonize wood. In inoculation experiments on *P. sylvestris*, *H. irregulare* colonized larger volumes of wood, on average 5 times larger, than *H. annosum* (Giordano et al., 2014). This ability leads to higher inoculum potential for secondary infection.
- possibly a different host range and a broader ecological amplitude than *H. annosum* s.s. (Gonthier et al., 2012). *H. annosum* s.s. is not recorded on *P. halepensis* (Motta et al., 2011). *H. irregulare* spores were trapped in pure oak stands where spores of *H. annosum* s.s. were not found (Gonthier et al., 2012).

In experiments in laboratory conditions (Lung-Escarmant et al., 2012), one isolate of *H. irregulare* from Italy showed an overall better growth and sporulation (in vitro) than a selection of 12 French and Italian isolates of *H. annosum* s.s.

Finally, interspecific hybridization between *H. irregulare* and *H. annosum* s.s. is very common in Italy (approximately 25% of isolates from the area where *H.irregulare* has been introduced have gene content from both species) (Gonthier and Garbelotto, 2011). Hybridization has been shown as a major cause of emerging aggressive pathogens (Brasier, 2001). The effects of hybridization on the disease are not known. Hybridization may influence the fitness and virulence of both *H. irregulare* and *H. annosum* s.s., as well as adaptation and pathogenicity (Gonthier et al., 2014a). Because *H. irregulare* mates freely with *H. annosum* s.s., it is not likely that the presence of *H. annosum* s.s. will prevent the establishment of *H. irregulare*.

3. Is the pest a vector? **Yes** ☐ **No** ✓

4. Is a vector needed for pest entry or spread? **Yes** ☐ **No** ✓

5. Regulatory status of the pest

H. irregulare is not listed as a quarantine pest by EPPO countries according to the EPPO collection of phytosanitary regulations and summaries (www.eppo.int); it was added to the EPPO Alert List in 2013.

"*H. annosum*" (probably *H. annosum* s.l., i.e. also covering *H. irregulare* and *H. occidentale*) is a regulated pest for Brazil, Uruguay, India, New Zealand (lists of regulated pests on www.ippc.int). India also regulates separately *H. parviporum* (Eurasian species) and *H. araucariae* (Oceanian species).

Currently there are no official control measures in Italy. Possible measures to contain *H. irregulare* are described in Gonthier et al. (2014a).

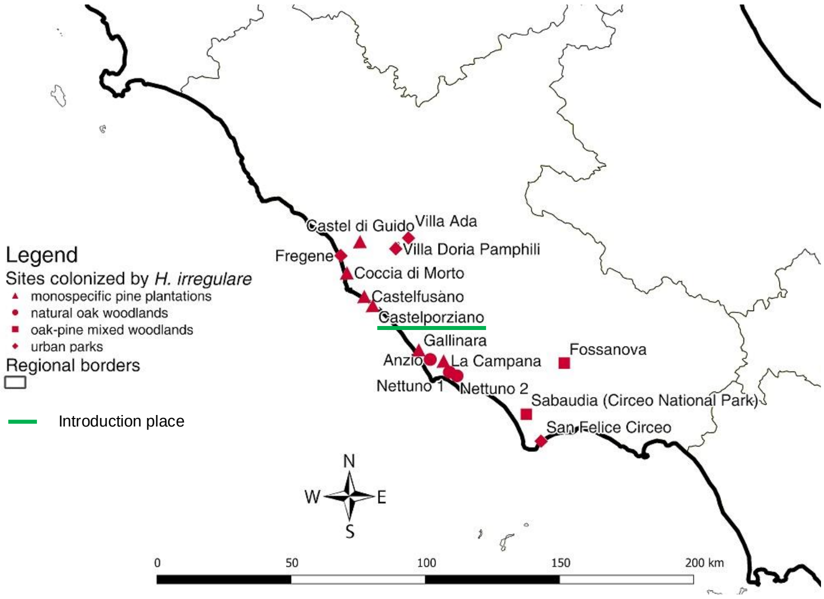
6. Distribution of *Heterobasidion irregulare*

Continent	Distribution	Details and comments	References
Americas	**Present in North America**		
	Canada	Ontario (detected 1955, probably present as early as 1929)	Laflamme, 2011
		Québec (detected 1989)	Laflamme, 2011
		British Columbia	Hammett et al., 2014
	Mexico	Hidalgo, Michoacan, Mexico (Central Mexico)	Linzer et al., 2008
	USA	Alabama	Garbelotto et al., 2010; Otrosina and Garbelotto, 2010
		Arizona	Worrall et al., 2010 (as North American *H. annosum* s.s.)
		California	Gonthier et al., 2007; Linzer et al., 2008; Otrosina and Garbelotto, 2010
		Colorado	Worrall et al., 2010 (as North American *H. annosum* s.s.)
		Florida	US ForestService, 2011
		Georgia	Georgia Forestry Commission, 2013
		Illinois	Juzwik (ND – map for North Eastern USA only)
		Indiana	Juzwik (ND – map for North Eastern USA only), also a record in Farr and Rossman (2014) for *H. annosum*.
		Iowa	Juzwik (ND – map for North Eastern USA only), also a record in Farr and Rossman (2014) for *H. annosum*.
		Louisiana	Gonthier et al., 2007; Garbelotto et al., 2010
		Maine	Juzwik (ND – map for North Eastern USA only), Maine Forest Service, 2008 (as *H. annosum*)
		Massachusetts	Juzwik (ND – map for North Eastern USA only)
		Michigan	Michigan Department of Natural Resources, 2012; Michigan State University, 2013
		Minnesota	Blanchette et al. (2015?, under publication)
		Mississippi	Gonthier et al., 2007; Garbelotto et al., 2010
		Missouri	Gonthier et al., 2007; Linzer et al., 2008
		Montana	Dalman et al., 2010; Lockman, 2006
		Nebraska	Worrall et al., 2010 (as North American *H. annosum* s.s.)
		New Hampshire	Juzwik (ND – map for North Eastern USA only), also a record in Farr and Rossman (2014) for *H. annosum*.
		New Mexico	Worrall et al., 2010 (as North American *H. annosum* s.s.)
		New York	Juzwik (ND – map for North Eastern USA only)
		North Carolina	US Forest Service, 2010;
		Ohio	Juzwik (ND – map for North Eastern USA only), also a record in Farr and Rossman (2014) for *H. annosum*.
		Oregon	Gonthier et al., 2007; Dalman et al., 2010
		South Carolina	Gonthier et al., 2007; Garbelotto et al., 2010
		Texas	Ostry and Juzwik, 2008
		Vermont	Dalman et al., 2010
		Washington	Gonthier et al., 2007; Linzer et al., 2008
		Wisconsin (first detected 1993)	Linzer et al., 2008
Caribbean	Cuba		Otrosina and Garbelotto, 2010
	Dominican Republic		Otrosina and Garbelotto, 2010

Continent	*Distribution*	*Details and comments*	*References*
Europe	Italy	Lazio	
Central America	Absent	See uncertainties below	
South America	Absent	See uncertainties below	
Africa, Asia, Oceania: Absent			

Origin. The natural range of *H. irregulare* is generally considered to cover North America, South to Mexico, and there are uncertainties in relation to the Caribbean and Central America. The distribution of *H. irregulare* is best documented for USA and Canada (see *Uncertainties* below). In the USA, although *H. irregulare* is considered to be widespread, it occurs predominantly in the Eastern and Western parts of the country (and not as much in the Central part). There is a strong genetic differentiation between the Western and Eastern (including Midwest) populations of *H. irregulare* (see under 1). In North America, *H. irregulare* seems to have caused more problems in recent years, due to management practices (thinning) favouring new infestations. For example it is spreading in Wisconsin (first found in 1993, and by 2013 had reached 23 counties; Wisconsin DNR 2014) and Canada (Laflamme, 2011). In Canada, until recently, it was known to occur only in the Eastern part of the country.

Details on the distribution in Italy. The Italian population of *H. irregulare* was shown to originate from Eastern USA (Linzer et al., 2008). *H. irregulare* was first detected in the Presidential Estate of Castelporziano, Lazio region (Gonthier et al., 2004) (possible pathways are given in section 8). Until recently, some authors supported that there had been two separate introductions (both during WWII), in Castelporziano and in the Circeo National Park (D'Amico et al., 2007, Motta et al., 2011). However, Garbelotto et al. (2013), using population genetics conclude that the Italian outbreak is due to a single introduction at Castelporziano, followed by spread. A map of the current distribution in Italy is given below.



H. irregulare is present in the Lazio region along the Tyrrhenian Coast (from Fregene Monumental Pinewood in the north to San Felice Circeo in the south). It extends 9 km inland at Castel di Guido in the North and 18 km at Fossanova in the South. It was also found in the gardens of several historical villas in Rome (Ada, Doria Pamphili, Borghese - D'Amico et al., 2007; Scirè et al., 2008, 2009). D'Amico et al. (2007) report surveys conducted 130 km north-west and 150 km south-east of Rome; the pathogen was not found in plantings situated 120 km in the north-west of Rome, and 115 km in the south-east of Rome.

Uncertainties. Data available lead to some uncertainties regarding the distribution of *H. irregulare,* which are important in the framework of this PRA.

- **USA.** Publications pre-dating the description of *H. irregulare* and *H. occidentalis* refer to *H. annosum*. In the Western part of North America, *H. irregulare* and *H. occidentale* have an overlapping distribution, while in the East, only *H. irregulare* is known to occur. In addition to the positive records in the table above, the following records for *H. annosum* in Eastern USA are likely to relate to *H. irregulare*.

- CABI (2014) contains records of *H. annosum* s.l. for Kentucky, Tennessee, Arkansas.
- Juzwik (ND), in a map of the distribution for Northeastern USA, mentions that *H. irregulare* is reported or expected but not confirmed in Delaware, Rhode Island, Minnesota.
- Farr and Rossman (2014) indicate records of *H. annosum* for certain Eastern States (East of a line from Minnesota to Louisiana) in Arkansas, Connecticut, Delaware, Maryland, Pennsylvania, Rhode Island, Tennessee, Virginia; and for Oklahoma in the Centre (east of a line from North Dakota to Texas). They also indicate records in Western USA on known hosts of *H. irregulare* or other *Pinus*, in Idaho, Nevada, Utah.

The uncertainties above close most gaps on a map of the USA. Korhonen and Stenlid (1998) also mention that, although rare in parts of central North America, *H. annosum* has been reported on *Pinus* spp. (mostly hosts of *H. irregulare*) in most US states. It is considered appropriate to estimate in this PRA that *H. irregulare* occurs throughout the USA.

- **Canada.** CABI (2014) contains a record of *H. annosum* s.l. in Nova Scotia (from 1970). Due to its location in Eastern Canada, it may relate to *H. irregulare*. Filip and Morrison (1998) report that there are no records of *H. annosum* in other provinces of Canada East of the Rockies (Alberta, Saskatchewan, Manitoba, Northern Territories), although hosts are present (e.g. *A. balsamea*, *P. contorta*, *P. banksiana*).
- **Mexico**. No details were found on the situation in the rest of Mexico, especially in the Mexican states between the Central states mentioned by Linzer et al. (2008) and the USA. Both *H. irregulare* and *H. occidentale* are generally considered present through to Mexico. Tkacz et al. (1998) (USDA PRA on wood from Mexico), note that *H. annosum* (s.l., i.e. probably *H. irregulare* or *H. occidentale*) has been reported to occur commonly in Mexico on both *Pinus* and *Abies*. Garbelotto and Chapela (2000) report some findings of *H. occidentale*.
- **Caribbean**. Cuba and the Dominican Republic are named in the literature (Otrosina and Garbelotto, 2010), while some authors mention the Caribbean more generally (or its northern part – e.g. Shamoun et al., 2014). CABI (2014) gives a record of *H. annosum* s.l. for Jamaica (references from 1980 and 1982), also mentioned in Korhonen and Stenlid (1998). It is not known if *H. irregulare* is present in other Caribbean countries.
- **Central America.** Central America is not mentioned in general descriptions of the distribution of *H. irregulare* or *H. occidentale*, but CABI (2014) contains records of *H. annosum* s.l. in Guatemala (reference from 1957) and Honduras (no reference). It is not known which species these records refer to. It is likely that *H. irregulare* may be present in Central America, and possibly on Caribbean islands with endemic pine populations (M. Garbelotto, University of California, 2014-12, personal communication).
- **South America**
  Brazil. Two records are mentioned in Baltazar and Gibertoni (2009) for the states of Bahia and Sao Paulo. For Sao Paulo, they refer to Rick (1960) mentioning *Fomes annosus* (only abstract available). For Bahia, Goes-Netto (1999) mentions *H. annosum* (*Fomes annosus*) collected in the period 1910-1940. No further information was found. Auer and Dos Santos (2008, Ministry of Agriculture) consider *H. annosum* as exotic. It is not clear which species the two records above refer to.
  Guyana. Korhonen and Stenlid (1998) note that *H. annosum* was reported by CMI (1980) in this country, but that this record was not confirmed. No further information was found.
- **Other EPPO countries**. The presence of *H. irregulare* was investigated in France in 2009-2012 following increased damage by *Heterobasidion* in the Landes forest (South-Western France), and *H. irregulare* was not found (Lung-Escarmant et al., 2012). No information was found for other EPPO countries.

7. Host plants and their distribution in the PRA area

The most important hosts of *H. irregulare* belong to the family Pinaceae and Cupressaceae, in particular the genera *Pinus* and *Juniperus* and the species *Calocedrus decurrens*. Among *Pinus* spp., *H. irregulare* is considered more likely to be associated to *P. taeda*, *P. elliottii*, *P. ponderosa*, *P. jeffreyi*, *P. banksiana*, *P. resinosa* in North America and, in the infested area in Italy, to *P. pinea* and *P. halepensis*, than to other *Pinus* hosts. *Abies balsamea* is also considered as a main host. *Pseudotsuga menziensii* is host but is not frequently infested by *H. irregulare* in North America. There is some uncertainty about the frequency of association with some conifer hosts in North America, such as *Larix*, *Picea glauca*, *Thuja plicata*, *Tsuga canadiensis*. Several species of *Picea* are among the hosts, as well as the three species of *Larix* present in North America (*L. lyallii*, *L. laricina*, *L. occidentalis*).

A number of native conifer species of the EPPO region are known to be hosts according to records in Italy in the field (*Pinus pinea*, *P. halepensis*; Gonthier et al., 2004; Scirè et al., 2008) and in North America in an arboretum in California (*P. sylvestris*, *P. pinaster, P. brutia*) (Bega, 1962 for *H. annosum*, later confirmed to be *H. irregulare*). The susceptibility of *Picea abies, Pinus sylvestris* and *P. pinaster,* which are major species in the EPPO region, has also been determined experimentally (inoculation studies – references in Annex 1). Finally, several North American tree species that are widely planted in the EPPO region are hosts, such as *Pinus banksiana, P. radiata, P. strobus* and *P. taeda, Calocedrus decurrensPseudotsuga menziensii, Picea sitchensis*.

Regarding angiosperms, a number of species have been identified as hosts, most notably *Arbutus menziesii* and *Arctostaphylos* spp. for North America. For many other angiosperm hosts, reports are limited to a few sporadic records. There are several angiosperm hosts in the family Ericaceae.

The host list of *H. irregulare* is given in Annex 1. It is not limited to the hosts of *H. irregulare* in recent literature (post-2010), but also takes account of earlier host records for *H. annosum* (s.l. and synonyms) in North America. Records that relate to the North American "P group" of *H. annosum* were attributed to *H. irregulare* without uncertainty. In other cases, there could be an uncertainty on whether the record relates to *H. irregulare* or *H. occidentale*. However, because *H. occidentale* is not present in Eastern North America, host records for *H. annosum* relating to only Eastern locations were attributed to *H. irregulare*. Furthermore, *Pinus* and *Juniperus* are main hosts of *H. irregulare* (not of *H. occidentale*) and species of these genera are more likely to be hosts for *H. irregulare* (even for records from Western USA). Finally, angiosperms were attributed to *H. irregulare* (because *H. occidentale* is not observed on angiosperms - M. Garbelotto, University of California, 2014-12, personal communication).

Note on hosts in North America

In North America, the dominant conifer species, and consequently the main hosts, vary according to regions. Filip and Morrison (1998) describe the situation by region where *H. irregulare* occurs.

For Eastern USA/Canada (*H. irregulare* only):

- SE Canada/NE USA. *Pinus resinosa* is the main host, and mortality of *J. virginiana* and *P. banksiana* was observed. *H. irregulare* was also observed on *A. balsamea*, *Tsuga canadensis*, *Larix laricina*, *Thuja occidentalis*, *P. strobus* and several hardwood species. Since this publication, *A. balsamea* seems to also have sustained mortality in that region (Dumas and Laflamme, 2013 for Canada; Wisconsin DNR, 2014 for the USA).
- SE USA (major timber production area): *Pinus tadea*, *P. elliottii* are the most planted species and the most affected. *J. virginiana* is seriously damaged. *P. strobus*, *P. palustris*, *P. rigida*, *P. echinata*, *Chamaecyparis thyoides* are also affected (no details provided).

For Western USA (*H. irregulare* or *H. occidentale*):

- Coastal W USA. *P. jeffreyi*, *P. coulteri*, *P. radiata* and *P. ponderosa* in California are mentioned as being susceptible to infection and mortality (P group – i.e. *H. irregulare* – according to US Forest Service, ND). *Pseudotsuga menziensii* is a host, but is mainly attacked by *H. occidentale* (M. Garbelotto, University of California, 2014-12, personal communication).
- Interior W USA. The main species affected are *Abies concolor* (S group, i.e. *H. occidentale*), *A. grandis* (probably *H. occidentale*) and *P. ponderosa* (P group, i.e. *H. irregulare*). *Pinus jeffreyi*, *Calocedrus decurrens* and *Pseudotsuga menziensii* are also attacked by the P group, as well as *P. coulteri*, *P. cembroides* var *monophylla*, *J. occidentalis*.

Uncertainties on hosts

- Whether and which European species would be attacked in field conditions is not clear. However, *H. irregulare* has attacked species that were previously not recorded as hosts (*P. pinea*, *P. halepensis*).
- Although there is an uncertainty about which species of *Pinus* and *Juniperus* are attacked by *H. irregulare* in North America, and that may be attacked in Europe, it seems reasonable to assume that all *Pinus* and *Juniperus* species may be attacked, but levels of susceptibility may vary greatly between the species.
- In Italy, Gonthier et al. (2012) trapped spores of *H. irregulare* in pure oak stands in numbers similar to those found in infested stands of *P. pinea*. *H. annosum* was also present in the same geographic area, but its spores were not trapped in pure oak stands. This finding may indicate that *H. irregulare* has the

capacity to establish populations in pure oak stands. Several *Quercus* species are mentioned in the composition of forests where abundant spore production was observed by trapping (*Q. cerris*, *Q. frainetto, Q. robur, Q. pubescens*). However, these observations are only based on spore trapping as the presence of fruiting bodies in oak stands has not been verified. Studies have not yet been conducted to determine which oak species may serve as hosts. Consequently, none of the species above were added to the host list. However, it is noted that several North American *Quercus* spp. are on the host list (Annex 1).

- For Mexico, Farr and Rossman (2014) list host records for *Polyporus annosus* on *Citrus aurantifolia* and *Citrus* sp. *Citrus* is not reported as a host in the USA, not even from California where *Citrus* is a major crop. Filip and Morrison (1998) and Korhonen and Stenlid (1998) also mention a number of *Pinus* spp. for Mexico (not listed in Annex 1). There is no detailed information on which species these records relate to, and they were not added to the host list.
- Species attacked in the Caribbean, and possibly Central America and Brazil (see uncertainty in *Distribution*) are not known. Korhonen and Stenlid (1998) and Filip and Morrison (1998) report *P. caribaea* in Jamaica (but this country is not in the known distribution of *H. irregulare*).

8. Pathways for entry

Pathways for entry take account of the likelihoods of association of the pests with the pathway, their survival in storage and transport, and their transfer to a suitable host.

<u>Are there pathways for entry?</u>

This question is important for this PRA as the spread of *Heterobasidion* between continents was previously considered unlikely due to the lack of resting propagules, the short life span of airborne basidiospores, and the inability of the fungus to grow freely in the soil. The introduction in Italy is the only known case, to date, of movement between continents. It is attributed to movement of infected wood (crates, pallets, wood latrines or other military equipement), discarded when the American Army moved North during World War II (Gonthier et al., 2004; Garbelotto and Gonthier, 2013). The Castelporziano Estate, where the fungus was first introduced, is the Presidential Estate, which has been closed to the public for centuries; it contains mostly native vegetation, and *H. irregulare* cannot have been introduced via planting of exotic species (Gonthier et al., 2004; Linzer et al., 2008).

Until *H. irregulare* was detected in Italy, there seem to have been only a few incidences of human-mediated transport (reported in the literature) for *H. annosum* s.l., probably at short-medium distance.

- Jørgensen (1955) makes the hypothesis that infection of living hedge trees/bushes by *H. annosum* in Denmark was linked to the use of infested conifer fence posts, with transmission by root contact.
- Korhonen et al. (1998) mention the isolation of *H. annosum* (s.l.) from pine timber used to construct a potato pit north of 64°N, without further infestation. *H. annosum* does not occur naturally there at this latitude.
- In an experiment carried out over 20 years in Denmark, Wagn (1987) showed that *H. annosum* s.l. can be transmitted from infected poles to living trees of many species, and then spread through the roots to neighbouring trees of the same species.

No direct evidence of human-mediated dispersal was found in the literature for North America. No evidence was found that measures are taken on infested timber or plants to prevent the spread of the disease (even if it seems that some studies are being conducted, e.g. Wisconsin DNR (2014) mentions studies on the risk of infected wood carrying fruiting bodies). However, in an extensive genetic study (Linzer et al., 2008), which showed a clear separation between isolates from Eastern and Western North America, one isolate from Eastern Canada belonged to the group of Western North American isolates. It is not known if this is due to the presence of rare ancestral alleles or to more recent long-distance movement of fungal isolates (which could be due to human-mediated transport).

In a PRA for wood of *Pinus* and *Abies* from Mexico, Tkacz et al. (1998) considered the probability of entry of *H. annosum* as high because it lives saprophytically on the wood, and would be adapted to transport across substantial distances, and that colonization and spread potential by conidiospores and basidiospores is important. Garbelotto and Gonthier (2013) also support that *H. annosum* s.l. may be transported at short and long distances in infected wood. Finally, it is worth noting that Korhonen and Stenlid (1998) advocated that quarantine measures should be used to prevent the spread of the different types between continents.

<u>Biological considerations for defining and rating the pathways</u>
H. irregulare infests the roots and stems of trees (depending on species – see EPPO Datasheet). Despite the lack of resting propagules, the fungus may be present and survive under several forms:

- Mycelium may survive for many years in the wood of stumps and living trees, and may also survive in cut wood, which in the right conditions may lead to the development of fruiting bodies.
- Fruiting bodies may be present on the stems and roots of infested trees. The presence of fruiting bodies means that the wood is colonized and that new fruiting bodies may develop.
- Spores may survive for some time in the absence of the host and in favourable conditions.

There is some evidence that insects can be associated with transfer of spores, but this is not thought to play a major role for the disease dynamics (Nuorteva and Laine, 1972; Kadlec et al 1992; Gonthier and Thor, 2013).

The likelihood of entry seems highly dependent on the capacity of the fungus to transfer to a suitable host. Such transfer would require that the pathogen, once at destination, comes directly in contact with either:

- **Recently cut stumps or wounds on stems** (noting that infection of stumps is considered more likely than through wounds in living trees for some species including pines). Infection would require that spores are released and reach stumps or wounds on stems.
  - The most likely mechanism by which such transfer could be achieved is the formation of fruiting bodies at destination from mycelium present on the commodity. Development of fruiting bodies requires certain conditions (especially sufficient wood moisture), and some time (a few weeks to a few years). However fruiting bodies have been shown to develop on cut logs, as well as pieces of wood. In experiments, infested spruce cull pieces carrying *H. annosum* developed fruiting bodies if left on the ground (Müller and Korhonen, 2006). Development of fruiting bodies is more likely if there is contact with soil (ensuring sufficient moisture).
  - Fruiting bodies that were present on infested trees at felling and remained associated to the commodity during transport, are not likely to facilitate transfer of the fungus. This is because the pores must be oriented precisely vertically downwards for spores to be released and further spores produced.
  - The role of conidiophores in the epidemiology of the disease is not known. They may however form, disperse and germinate to cause infection under certain conditions, although there is no data to support this.
  - If basidiospores or conidipores are incidentally present on a commodity, they are unlikely to come in contact by themselves with stumps or stem wounds (see below).
- **Roots of living host trees.** The effectiveness of this mode of transmission depends on the tree species (see EPPO datasheet).
  - The most likely mechanism by which transfer to a host could be achieved in this case is that mycelium present on infested commodities (e.g. in the roots of infested plants or in wood commodities) comes in contact with susceptible roots (e.g. planted, buried, used on or in the ground).
  - Basidiospores/conidiospores present on the infested commodity could also be deposited/washed down into the soil and come in contact with susceptible roots (the role of conidiospores is unknown, but they may also initiate infection). This would require that the spores remain viable and come into direct contact with host roots under appropriate conditions for infestation. Spores can be present at the surface of bark or foliage or in soil or on other material, for example if they have just been released before the commodity was prepared for export (high viability), and survive in the consignment. However, their viability is limited by many factors, and they are unlikely to come in contact with suitable host material on their own (i.e. they would need to be washed down or blown to a suitable host). This seems to be a less likely means of transfer.

In all cases, successful infection of stumps, wounds or roots depends on many factors, including the tree species, timing of deposition after logging, competition with other fungi, temperature, humidity on and above the material, proximity between the source of inoculum and the receptive material. The survival of *H. irregulare* on wood material may decrease with time, as spores have a limited viability, and mycelium may be outcompeted by other fungi on cut wood. If the conditions are favorable, the infection rate will be significant, but it could also be nil in periods which are unfavourable.

H. irregulare grows as saprobe on some species. New species that have been saprophytically colonised have been reported from Italy (*Erica arborea*). Such ability to grow as saprobe has already been reported for other

H. annosum s.l. (Jørgensen, 1955; Wagn 1987). It is not excluded that *H. irregulare* would first establish on some deciduous species, produce fruiting bodies and spores, and then spread to conifer hosts, but this is considered less likely than direct infection of conifers. Stumps of freshly cut trees may provide a less selective substrate than living plants and allow the development of fruiting bodies, and basidiospores then colonize susceptible hosts.

In conclusion, although entry and transfer are possible from the biological point of view, they are constrained by many factors. Successful transfer seems to result from a series of "lucky" circumstances (tree species, timing, lack of competing fungi, conditions ensuring survival, stumps or wounded stems or roots in the vicinity of the infested commodity, or contact with suitable roots), rather than the natural ability of the pest to transfer to new hosts. However, the fungus is known to have competitive advantages that would favour transfer (including high sporulation – see section 2), and transfer is known to be possible (Italy, as well as Jørgensen-1955, Wagn-1987).

<u>Commodities and hosts to be covered in the pathways</u>
Different types of wood commodities could carry the fungus (as mycelium, spores), as well as bark (because the fungus may be present in wood attached to the bark). Plants for planting seem an obvious pathway from the biological point of view. Plant parts, such as Christmas trees, could also be infected.

<u>Hosts covered in the pathways</u>
Coniferous and angiosperm host species are covered differently.

- For conifers, all hosts were considered for several wood commodities, bark, plants for planting and Christmas trees.
- For angiosperms, *H. irregulare* was recorded in North America, but in most cases only occasionally, on species in the genera *Quercus*, *Arbutus*, *Arctophylos*, *Rhamnus* and *Prunus serotina*. There are also uncertain records for species in other genera (including some of importance in the PRA area). In some hosts, it seems that the pest is not pathogenic, but is associated with the species and may produce fruiting bodies. In Italy, *H. irregulare* was found on *Erica arborea*. There are a few records on *Quercus* in the USA. Wood commodities seem relevant as a pathway for *Quercus* (as it seems to be amore important host, and because it is traded as wood) and possibly *Prunus serotina* (which is also traded as wood). Other known hosts (such as *Arbutus menziesii*, *Arctophylos* spp., *Erica arborea* and *Rhamnus* spp.) would probably not be traded as wood. *Arbutus menziesii* and *Arctophylos* spp. are commonly attacked in North America, and may become associated to wood consignments (e.g. as firewood, wood chips). For plants for planting, all deciduous host species were covered, because there is a general concern of expanding trade of plants for planting worldwide, and that many species may be traded as ornamentals.

Consequently, the following pathways were studied (all "from countries where the pest occurs"):

- Wood of coniferous host species (except particle wood, waste wood and wood packaging material)
- Wood of *Quercus* and *Prunus serotina*, *Arbutus menziesii*, *Arctostaphylos* spp. (except particle wood, waste wood and wood packaging material)
- Wood packaging material
- Particle wood (conifer and deciduous) and waste wood
- Bark of host species.
- Plants for planting of host species (conifers and angiosperms)
- Plant parts not intended for planting (Christmas trees).

8.1 Possible pathways

Note: pathways cover both entry both from outside the EPPO region and spread from the infested area in Italy.

Wood of conifer hosts from countries where *H. irregulare* occurs Pathway prohibited in the PRA area?: No (only a few prohibitions for a few specific commodities) Pathway subject to a plant health inspection at import? Yes in some countries, no in others Pest already intercepted on the pathway?: Not known
This pathway covers wood sawn or round, as well as firewood. Wood packaging material, particle wood and waste wood are covered in other pathways.

Association to the pathway at origin and survival. Among the conifer hosts, according to current knowledge, *H. irregulare* is more likely to be associated to *Pinus*, *Juniperus*, *Calocedrus decurrens*, *Abies balsamea*. All *Juniperus* spp. are covered here, as they are considered likely to be hosts. Regarding *Pinus*, *H. irregulare* is considered more likely to be associated to *P. taeda*, *P. elliottii*, *P. ponderosa*, *P. jeffreyi*, *P. banksiana*, *P. resinosa* in the USA and to *P. pinea* and *P. halepensis* in the infested zone in Italy. Other *Pinus* species are of lower risk as they are less frequently infested. *P. menziensii* is not frequently infested by *H. irregulare*. There is some uncertainty about the frequency of association with other conifer species (see section 7). In the infested area in Italy, *H. irregulare* is present in 80% of the sampled *P. pinea* stands (forest and urban gardens) (P. Gonthier, University of Torino, 2014-12, personal communication).

In the USA, *H. irregulare* is widespread, including in main regions of wood production. There is some management practices aimed at reducing levels of infection in forests for the production of wood where *Heterobasidion* occurs. However, management measures mostly aim at preventing the local spread of the pest, but would not ensure that the logged wood is free from infection. Detection is difficult at early stages of infestation.

Wood may carry mycelium, at the interface between the bark and the sapwood, or in the sapwood or the heartwood (depending on species). The lower part of the stems and the root systems may be colonized. The presence of fruiting bodies would be a good indicator that the wood is colonized. Basidiospores or conidiospores may incidentally be associated to wood, but their survival requires specific conditions (especially they are sensitive to light), and transfer would be complicated.

On cut wood, *H. irregulare* may be exposed and susceptible to dessication, but there is no data on this. The main factor for its survival may be competition with other wood decay microrganisms. It is known to survive for long periods on stumps and roots, as well as on logs, as fruiting bodies form on the underside of fallen trees and logs. *H. irregulare* has been shown to survive on wood material and to cause infection in Italy and *H. annosum* s.s. has been shown to cause infection of living plants via fence posts in Denmark.

Different types of wood could carry the pest:

- *Logs, with or without bark*. Mycelium is the most likely form to be associated with such wood, and fruiting bodies might have formed. Spores may incidentally be associated. Wood is commonly stored before use, which would favour the development of fruiting bodies and conidiophores from mycelium. Such wood may be used for construction purposes and if infected wood is partially or fully underground and close to susceptible trees, this may facilitate transfer. It is not known whether untreated wood of poor quality is used, especially underground, for some purposes or in some geographic areas of the EPPO region).The risk that the pest is associated is not considered different for wood with or without bark, because mycelium and fruiting bodies could be present in both cases . *H. irregulare* is less likely to be associated with high quality wood material (as visible stain and rot may make the wood unsuitable for trade).
- *Firewood*. Firewood may carry fruiting bodies, mycelium and incidentally spores. Such wood may be stored for long periods at destination, which may allow the development of fruiting bodies on mycelium-infested wood. There is no indication on the species composing firewood for export. However conifers, including pine, are expected to be used.
- *Poles*. These may carry mycelium. Poles may be made of lower quality wood, which may be infested, and through their intended use may come in contact with roots of hosts. Such wood to root infection may be less likely but has been shown to be possible (Jørgensen, 1955; Wagn, 1987). Conifer wood used outdoors is short-lasting, and poles are likely to be treated by impregnation, although it is not known if low quality untreated poles may be used for some purposes. Statistical data also cover categories such as hoopwood, which were considered together.
- *Sawn wood.* Some mycelium could be associated with sawn wood which is green and not treated, but this is likely to be only a small part of the exported sawn wood. If infested when produced, the visible decayed areas would presumably be removed, as they would limit the value of the commodity and rot lowers the quality/properties of the wood, which may limit the possible association of *H. irregulare* with that kind of material. However, it is unclear whether incipient decay would be equally discarded. In addition, once at destination this wood may be stored in conditions that are favourable to the development of fruiting bodies.
- *Railway and tramway sleepers (ties).* Coniferous or deciduous trees are used to produce such sleepers, which may bring the fungus in contact with soil. Although sleepers are more likely to be treated, it seems that they are also traded in an untreated form (from data in Eurostat). However, even if sleepers of host species are used, they are likely to be subject to quality and structural/resistance requirements that prevent use of infested wood. In the case of *Picea sitchensis* (*H. annosum* s.l.), it was shown that rot in the wood, even at early stages of infection, affects the strength of the wood (Korhonen and Stenlid, 1998). Sleepers and ties are not considered further.

Current phytosanitary requirements in the PRA area. The phytosanitary requirements in place would not prevent entry of *H. irregulare* into the whole PRA area. Some countries have requirements in place for the wood of conifers (especially in relation to *Bursaphelenchus xylophilus*) (see Table 1 in Annex 2). A few countries prohibit specific types of conifer woods from the origins considered (e.g. wood with bark, *Pinus* non-squared wood, fuel wood). Although *Inonotus weirii* is regulated in the EU, there are no specific requirements for wood associated with that species. Some countries require treatment, which in some cases may also eliminate *H. irregulare* (especially heat treatment), but there are often options of other treatments, which would not be effective. Many countries have general requirements for phytosanitary certificates, import permits or inspection, but *H. irregulare* is not easy to detect and its presence can be easily overlooked. Inspection of wood consignments is also difficult.

Transfer at destination. If mycelium is present, fruiting bodies may develop (fruiting bodies are known to form on logs and fallen trees). This would require that the wood is stored for a long period in conditions conducive to the development of fruiting bodies, i.e. in high relative humidity, in contact with soil, in containers, or protected with waterproof sheets, etc. The period for the development of fruiting bodies depends on whether the wood is already colonized, in which case 6 weeks may be sufficient (see EPPO Data sheet, Korhonen and Stenlid, 1998), or if fruiting bodies need to develop from a less advanced stage of colonization, which may take at least one year. This is the most likely mechanism by which transfer could be achieved, because wood commodities are commonly stored outdoors. Hosts occur throughout the PRA area. Transfer would be facilitated if logging and thinning operations are conducted in a nearby stand (as infection through wounds is less likely for most host species), thereby allowing infestation of stumps of recently cut trees.

Wood for use on or in the ground (e.g. construction, scaffold) could come in contact with roots of living trees, which may also be wounded in the process, i.e. providing a suitable entry to the pathogen. Wooden poles or ties may come in contact with roots. It is not known whether untreated wood of poor quality or poles are used underground for some purposes or in some geographic areas.

Finally, spores present on their own on wood commodities, even if they remain viable, are unlikely to come into contact with suitable host material on their own (i.e. they would need to be washed down or blown to a suitable host).

Trade. The following sources were used. Only USDA-FAS (2014) gives detailed data for individual or groups of conifer species.

- FAOStat (imports to EPPO countries): coniferous roundwood (imports to EPPO countries).
- Eurostat (imports to EU countries): roundwood of conifers, firewood, as well as several miscellaneous categories without indication of tree species: hoopwood, posts and beams.
- USDA-FAS (2014) (exports from the USA): coniferous wood for pulp, logs of conifers (individual species or groups of species), poles of conifers.

In this data, there were no imports of such commodities from Cuba and the Dominican Republic (only in 2008, 29 t to France), and imports from Mexico only where mentioned below. No information was searched on exports of conifers from Italy, as the area of infestation is not an area of wood production. From the data available, the categories below are traded.

- **Roundwood of conifers** is commonly imported from Canada and the USA.

- From the USA, FAOstat (Table 1 in Annex 3) reports imports of “roundwood of conifers” by EPPO countries for a total of over 210 000 m^3 in 2012, to 27 EPPO countries. The main importer was Turkey (98 000 m^3), imports over 10 000 m^3 were also made by Spain and France, and many countries imported over 1000 m^3. From Canada, there were imports by 7 countries, the majority to Ireland (over 44000 m^3 of 52 000 m^3). Imports from the USA and Canada fluctuate depending on the year and seem to be decreasing. From Mexico, 4 countries imported over 230 m^3 in 2012 (mostly France).

- Eurostat for the EU (Table 2 in Annex 3) does not correspond to the data above for the large imports from Canada to Ireland, but still indicate some import of „coniferous wood in the rough“ from both USA and Canada, as well as to France from Mexico.

- In details by species (USDA-FAS, 2014; Tables 3 in Annex 3), over 700 000 m^3 were exported to 3 EPPO countries for pulp wood (mostly Italy, also Germany, and little amount to Morocco). Greece, Spain and UK had minor imports in previous years. „Southern yellow pines“ (*P. taeda*, *P. palustris*, *P. rigida*, *P. echinata*, *P. elliottiii*, *P. virginiana*; thus including the main hosts in SE USA, *P. taeda* and *P elliottii*) were imported for a total of over 9000 m^3 to 13 countries in 2013, and 12 additional countries in 2006-2012. Imports seem to be decreasing. Other conifers species are traded in quantities, such as about 6000 m^3 of *Pseudotsuga menziensii*, about 500 m^3 of *P. ponderosa* and other pines, 1600 m^3 of *Thuja plicata*, and about 3000 m^3 of unspecified conifers.

- **Firewood** (440110). Some imports of firewood are registered in Eurostat from the USA and Canada (highest in 2013, with 100 t to France and 21 t to Italy), and (very minor) from Mexico (100 kg in 1 year) (Table 4 in Annex 3). For the years considered in 2006-2013, there were imports by 18 EPPO countries of quantities over 1 t. From the USA, UK was the only regular EPPO importing country. In 2013, there were imports to UK, Estonia (over 65 t), Hungary (over 15 t) and smaller quantities to Sweden, Germany, Denmark and France.

- **Hoopwood, poles etc.** From the USA (Table 5 in Annex 3), over 14 000 untreated conifer poles were exported to mostly Italy, but also Russia, Morocco and Israel in 2013. Quantities and destinations vary depending on years, and 13 EPPO countries imported in the years looked at for 2006-2013.

Eurostat report irregular and small imports of "poles and beams of wood" (not specified if deciduous or conifers) over the same period (Table 6 in Annex 3). The category "hoopwood; split poles; piles, pickets and stakes of wood, pointed but not sawn lengthwise; wooden sticks, etc.; chipwood and the like, of coniferous wood" indicates only small imports, except regular imports over 1400 t to Ireland from Canada (Table 7 in Annex 3).

The season of imports is not considered important for *H. irregulare*, and this was not verified.

Conclusion. Major EPPO countries where conifer hosts grow import conifer wood, including pine wood, and the hosts are widespread in the EPPO region. There is no indication on how the wood is used, or whether it would be stored outdoors on soil for a sufficient time (allowing the formation of fruiting bodies) or used in a way to put the fungus in contact with roots. Apart from firewood, most wood would presumably be used before this can occur (if only to maintain the quality of the wood and avoid both sap stain and rot by various fungi), but it cannot be excluded that some wood is stored for longer periods. Transfer is the crucial issue in relation to entry, and would require specific conditions.

From North America, the likelihood of entry of *H. irregulare* on conifer wood is considered as "moderate/low" (with a moderate uncertainty linked to the transfer process) for the hosts with the higher likelihood of association (see 'association' above), in the absence of treatment, and as "low/very low" (moderate uncertainty) for other hosts.

From the infested area in Italy, the likelihood of entry is considered as "moderate/low" (with a high uncertainty, linked to whether there is any movement of wood from that area). In the infested area, the pest is likely to be associated to *P. pinea.* Populations have now developed, which may increase the inoculum associated to wood. In addition, thinning is expected to happen for the first time in the near future in some pine stands of the outbreak area. However, trade from the infested area would be much lower than from the USA.

Likelihood of entry on the pathway:	**Uncertainty**:
From North America, hosts with higher likelihood of association: moderate/low	- moderate (transfer)
From the infested area in Italy: moderate/low	- high (whether there is any movement of wood from the infested area, transfer)
From North America, hosts with lower likelihood of association: low/very low	- moderate (transfer)

Wood of *Quercus, Prunus serotina, Arbutus menziesii, Artostaphylos* spp. from countries where the pest occurs

Pathway prohibited in the PRA area?: No

Pathway subject to a plant health inspection at import?: Yes in some countries, no in others

Pest already intercepted on the pathway?: Not known

H. irregulare could be present in wood of *Quercus* or *Prunus serotina, Arbutus menziesii, Artostaphylos* spp., in a similar way as for conifers above. This association is likely to be less frequent than for the main conifer hosts. Other non-coniferous species have an even lower likelihood of association. It is unclear if *H. irregulare* is pathogenic on some of the recorded host species. Infections by *H. irregulare* on understorey *Prunus serotina* are also reported in Wisconsin (Wisconsin DNR, 2014). There are no details on how extensively the wood is colonized.

The main commodity of concern is probably firewood (low quality wood). Trade data for firewood is given in the previous pathway.

FAO Stat does not provide specific data for wood of these species. For the EU, there is a trade of *Quercus* wood from the USA, in decline according to Eurostat (990 t in 2013 to 6 countries) (Table 1 in Annex 4), and from Canada (minor quantities). From the USA, USDA-FAS reports exports of oak logs for 58 000 m^3, to 29 EPPO countries (including more EU countries than in Eurostat).

No data was available in USDA-FAS (2014) on exports of *P. serotina* wood. However, *P. serotina* wood is valuable and imported to Europe (EPPO List of Invasive Alien Plants, which also mentions that trees with high quality wood grow predominantly in Pennsylvania, New York, West Virginia).

Some countries of the EPPO region make requirements for wood of *Quercus* Table 1 in Annex 2), but not all, and the

requirements would be insufficient to prevent entry (similar reasons as for conifers). Once at destination, the difficulties of transfer would be as for conifer wood. In addition, logs of *Quercus* and *P. serotina* are more valuable than pine, and less likely than conifers to be stored for long periods outdoors on soil (except where traded as firewood). **Conclusion**. The pest can be associated with *Quercus* and *P. serotina*, *Arbutus menziesii* and *Artostaphylos* spp., but the likelihood of association is considered lower than that of conifer wood, as well as the probability of transfer. Firewood is covered in the previous pathway. The overall likelihood of entry was rated as low/very low with a high uncertainty	
Likelihood of entry on the pathway: - Low/very low	**Uncertainty**: - high (association with *Quercus, P. serotina, A. menziesii, Arctostaphylos* wood, transfer)

Wood packaging material (including dunnage) Pathway prohibited in the PRA area?: No Pathway subject to a plant health inspection at import?: Yes in some countries, no in others Pest already intercepted on the pathway?: Not known	
H. irregulare could be present on wood packaging material as mycelium or young basidiocarps, especially as low quality wood may be used for such material. This is one of the pathways suspected for the introduction to Italy*. P. pinea* may be used for wood packaging material for light commodities (L. Montecchio, University of Padova, 2014-12, personal communication). This pathway is not assessed in details here, as, where applied, treatments in ISPM 15 *Regulation of wood packaging material in international trade* (FAO, 2009) should be effective in destroying *H. irregulare*. ISPM 15 requires that all wood packaging material moved in international trade should be debarked and heat treated (56°C for 30 min at the core) or fumigated with methyl bromide (and stamped or branded with a mark of compliance). These treatments are internationally considered adequate to destroy insects and nematodes present in wood packaging material at the time of treatment. They will also probably destroy *H. irregulare,* since Allen (2014) reports that 46°C for 30 min kills *H. irregulare*. No specific information was found on the effect of fumigation with methyl bromide on *H. irregulare*, but the schedule of ISPM 15 is expected to work. In the case of untreated wood packaging material (e.g. for movements within the EU), the fungus is less likely to be associated than for conifer wood (as non-hosts species would also be used to produce such material). There is no specific information on the volumes of untreated wood packaging material moving in trade, but there are generally large quantities of wood packaging material moving in trade. Transfer would require that the fungus comes in contact with stumps or wounds on living trees or roots, i.e. that fruiting bodies are produced from mycelium present on wood packaging material, or that the material is buried and comes in contact with suitable roots. Used or damaged wood packaging material may be discarded and left lying on the ground for long periods in or close to forests, which may be a way by which fruiting bodies could develop and basidiospores cause infection. Pallets may remain on construction sites for very long periods. However, wood packaging material would dry faster than logs (due to the size of individual wood pieces), and competition with other fungi may occur. *H. irregulare* is thought to have been introduced into Italy during WWII with discarded infested pine wood material. **Conclusion**. This pathway is already regulated in some instances, but presents a risk of spread of *H. irregulare* if ISPM 15 treatments are not applied (e.g. within the EU). The pest is less likely to be associated with wood packaging material than with wood, but volumes are huge and wood of lower quality is used. Transfer is considered less likely than for wood, but it is likely that discarded wood packaging material could be left outdoors on soil for long periods. However, the EWG believed that the material may become unsuitable for the fungus faster than when in association with other types of wood.	
Likelihood of entry on the pathway: - Moderate if ISPM 15 treatments not applied - Very low if ISPM 15 treatments are applied	**Uncertainty**: - moderate (transfer) - low

Particle wood and waste wood of conifer and deciduous hosts from countries where *H. irregulare* occurs

Pathway prohibited in the PRA area?: No in most countries (one country prohibits conifer wood chips and *Quercus* waste wood)

Pathway subject to a plant health inspection at import?: No in most countries

Pest already intercepted on the pathway?: Not known

Hosts may be used alone or in mixture with other coniferous or deciduous species to produce particle wood and waste wood. Pine is commonly used for wood chips. Wood chips are used for fuel and energy production, pulp and fiberboard, mulch and decoration in gardens, playground surfacing.

Association to the pathway at origin and survival. In areas where the pest occurs, *H. irregulare* may be associated with conifers. *H. irregulare* has a higher probability to be associated with coniferous wood chips than with deciduous wood chips. There is management in plantations where *H. irregulare* is known to occur, but possibly little in other places. Trees used to produce wood chips are more likely to have a high concentration of pest organisms, because wood chips are typically made of low quality wood. A large part of wood chips would be produced from uninfested material (e.g. other species) and parts of trees where the fungus does not occur (branches, top part etc.), but it cannot be excluded that infested material is used.

In Finland, 8% of chips for energy wood/biocoal production are produced from defective roundwood from Southern Finland's spruce stands with *H. annosum* (Heilala et al., 2013). Logs cut off because of rot are one source of wood for wood chips (Serup et al., 2005). It is not known if the lower parts of the tree and roots are used to produce wood chips in North America, but in Finland 14% of chips for energy wood/biocoal production are produced from stumps (Heilala et al., 2013). For pulp, using *Heterobasidion*-colonized *Picea* wood is a common practice in Nordic countries (A. Hietala, Norwegian Forest and Landscape Institute, personal communication). It is not known if wood chips intended for pulp and produced from non-resinous heartwood species (i.e. where decay may rise in the stem) are imported from North America, but this would present a risk.

Wood chips are produced by grinding or chipping, but the mycelium may remain on the wood and could survive in small pieces. Chipping is not expected to make the wood unsuitable for survival but the mycelium may be exposed to desiccation. The size of the chips is irrelevant, except that big chips may carry more inoculum than small ones, and may dry slower.

Waste wood may be produced as a result of sawing or squaring logs, and may contain the fungus. Where particle wood and waste wood are agglomerated in pellets, logs or briquettes, agglomeration would probably make the wood unsuitable for the fungus and the probability of survival is very low (and transfer to standing trees highly unlikely).

Chips are usually stored in big piles. The temperature in the core of the bulk is high due to composting effect. VKM (2013) reports that experiments on survival of pest organisms during storage and ship transport of wood chips are scarce. Heat development is an occasional phenomenon which depends on moisture content, quality of the wood chips, external temperature and size of the pile. In some cases, considerable heat development can occur within the chip pile, or parts of the chip pile. Comparing to lethal temperatures described in ISPM 15, temperatures in chip piles may in some cases reach lethal levels for biological organisms in the wood chips (i.e. 56°C). During heat development, higher temperatures are usually associated with the core of the chip pile, while temperatures in the periphery of the pile are much lower and seldom lethal. Consequently, part of the wood chips consignment/pile and waste wood are likely to present appropriate conditions for the survival of *H. irregulare*.

One issue would be whether *H. irregulare* would be outcompeted by other rot fungi. Glaeser and Burdsdall (2008) in relation to fungi in wood chips moved from Chile to the USA, conclude that fungi can survive on wood chips, but that introduction of non-native pathogenic fungi is unlikely due to rapid growth of antagonistic fungi.

It is considered likely that a huge production of conidiophores in moist chip piles would be possible, and that abundant conidiospore production may provide a way to infect roots of neighbouring trees in certain circumstances. Development on bigger wood pieces would be possible.It is not known if fruiting bodies would be produced on chips, but it was shown that fruiting bodies could develop from infested spruce cull pieces left on the ground (Müller and Korhonen, 2006; Bruna et al., 2013), and wood chips are sometimes large. Development of fruiting bodies would require some time and suitable environmental conditions.

It is not considered likely that wood chips would become infected after processing. During storage in the open in an area where infected trees occur, basidiospores may land on the chips, but they would not survive long.

Current phytosanitary requirements in the PRA area. Many countries do not make phytosanitary requirements for wood chips or waste wood (Table 2 in Annex 2), and this pathway is open in most of the PRA area. Where phytosanitary import requirements are in place, the required treatments may be effective against *H. irregulare.* Inspection would be carried out at origin and at destination, but symptoms are not characteristic. In addition, wood chips of non-host species may be mixed with those of host species. Finally inspection of wood chips consignments is difficult and detection would depend on the intensity and ability of inspection.

Transfer at destination. Transfer to a suitable host would require that the wood chips or waste wood are stored outdoors on soil in the vicinity of host species for a sufficient time (allowing the production of fruiting bodies, conidiophores or contact with tree roots), or used in specific conditions allowing the fungus to come in contact with roots of host plants (e.g. mulching; Gonthier et al., 2014a). The hosts are widespread in the PRA area. Wood chips for energy, processing (e.g. fibreboards) or pulp may be stored in such conditions. It is commonly the case in the PRA area that large quantities of wood chips are stored close to forests of origin. The EWG believed that the material would probably become unsuitable for *H. irregulare* faster than wood, and fruiting bodies, if any, are likely to be smaller than on wood, unable to develop completely (maturation) and, produce fewer, if any, basidiospores (although conidiophores may be produced).

Trade

Wood chips. VKM (2013) stated that a rapid increase in import is expected due to the targets of the EU energy policy towards 2020. Data on trade of wood chips and waste wood were available from FAOStat (all wood chips, imports to EPPO countries), EU trade statistics (Eurostat, deciduous and coniferous wood chips, imports to the EU) and the USA (USDA-FAS, 2014; deciduous and coniferous wood chips, exports to EPPO countries).

- FAOStat (Table 1 in Annex 5) indicates imports of wood chips to 21 EPPO countries from the USA in 2012, with over 2.2 millions m^3 (over 2 millions m^3 to Turkey, and significant imports over 10 000 m^3 to Norway, Germany, Italy and France). From Canada, there were imports to 16 countries for a total of over 880 000 m^3, also predominantly to Turkey (870 000 m^3).
- In the EU (Tables 2 and 3 in Annex 5), imports of coniferous and deciduous wood chips from the USA in 2013 reached respectively over 940 and 1100 t. Very small quantities were imported from Canada. Whereas there were large imports in past years (e.g. ≈100 000 t from Canada in 2008, 40000 t from the USA in 2006 for coniferous wood chips), imports seem to have decreased. Germany is the only country that imported deciduous wood chips from Mexico, but such exports seem to have stopped after 2011.
- USDA-FAS (2014; Tables 4 and 5 in Annex 5) indicate variable but high exports of both coniferous (around 600 000 metric tonnes) and deciduous (around 180 000 metric tonnes) wood chips to the PRA area in 2013, the large majority to Turkey followed by Italy for coniferous wood chips and France for deciduous wood chips. Exports to 13 EPPO countries are reported in 2013. Note: most wood chips imported to Turkey are destined to fiberboard production, i.e. agglomerated form (S. Soykan, NPPO of Turkey, 2014-11, personal communication).

Imports seem to have increased considerably between 2012 and 2013 for coniferous wood chips to Italy, and for deciduous wood chips to Denmark, the Netherlands, Turkey, Sweden and France. Imports are irregular depending on years.

Waste wood. Eurostat (Table 6 in Annex 5) indicates imports from the USA to Belgium, but also France and Germany and a few other countries. There were considerable imports from Canada to UK, Italy, Denmark, Netherlands, Sweden until 2011, but these seemed to have been pellets (as there was a change of categories and pellets are not recorded in this category in 2012-2013). USDA-FAS (2014) report over 1100 metric tonnes in 2013 (excluding pellets) (Table 7 in Annex 5) mainly to the UK, the Netherlands and Germany. The volumes and importing countries vary a lot.

Conclusion. The probability of entry is considered as "moderate-low" for coniferous wood chips and waste wood, and as “very low” for deciduous wood chips. The association of *H. irregulare* with conifer wood chips is considered similar as for wood, but would be lower for deciduous wood chips. The likelihood of transfer in both cases is lower than for wood, but the volumes traded are important. Transfer would require that wood chips or waste are stored outdoors or used in particular conditions outdoors to bring the fungus in contact with roots (e.g. mulch). There is a moderate uncertainty related to the species composition of wood chips and whether fruiting bodies would be produced.

The probability of entry on any particle wood and waste wood in agglomerated form is considered as "very low" as these products would mostly be used for burning and the probability of transfer would be even lower.

Likelihood of entry on the pathway:	**Uncertainty**:
- conifer particle wood, and waste wood (not agglomerated): moderate/low	- moderate (composition of wood chips, whether fruiting bodies could be produced, intended use)
- deciduous particle wood (not agglomerated): very low	- moderate
- Agglomerated particle wood and waste wood (conifer or deciduous): very low	- low

Bark of conifer and deciduous host species from countries where *H. irregulare* occurs Pathway prohibited in the PRA area?: Yes in a few countries, no in others Pathway subject to a plant health inspection at import?: Yes in some countries Pest already intercepted on the pathway?: Not known	
Bark of pine is widely used for various purposes, including mulch. It is not known if bark of other hosts is used (including *Juniperus,* and *Quercus* – apart from *Q. suber*), but it is not expected to be traded from North America. The bark commodity often includes pieces of wood. The bigger the size of bark pieces, the higher the risk. *H. irregulare* mycelium may be present in the wood and there may be mycelium below the bark. If any spores are incidentally present on the bark at harvest, they may survive for some time but have no means of reaching a host on their own. The association is considered possible for conifer bark, but less likely for deciduous species. For conifers, the probability of association of the fungus with bark is considered similar as for wood chips. Some wood is often associated with the bark, and it is the part of the wood that is normally infected. In addition bark pieces can be very large (up to 40 cm). The fungus may be exposed to desiccation, which would lower the likelihood of survival, although desiccation would be slower in the bulk of the consignments. Bark is usually stored in big piles. The temperature in the core of the bulk may be high due to composting effect, not allowing survival of *H. irregulare.* Nevertheless, part of the bark consignment may present appropriate conditions of moisture and temperature for the survival of *H. irregulare*. Bark is not subject to requirements that would completely prevent the introduction of *H. irregulare* into the PRA area. Most countries do not make requirements for bark. Bark is prohibited in a few countries, and conifer bark imported into the EU should be fumigated or heat treated (Table 3 in Annex 2). Detection would be difficult even if inspection is performed. It would also be complicated by the fact that bark of non-host species may be mixed with those of host species. The probability of transfer would be lower than for wood chips, and would be highest if the bark if stored outdoors on soil for sufficient periods or used in specific ways bring it in contact with roots (mulch). **Trade.** Data is lacking on the trade of bark. **Conclusion.** The probability of entry is considered as low for conifer bark (with high uncertainty) and very low for deciduous bark (low uncertainty), with a low uncertainty. The traded volume is probably much lower than for wood chips. No data was found on trade from countries where *H. irregulare* occurs.	
Likelihood of entry on the pathway: - bark of conifer hosts: low - bark of deciduous hosts: very low	**Uncertainty**: - high (whether there is trade, transfer) - low

Natural spread
Natural spread of *H. irregulare* from North America and the Caribbean to the PRA area is not possible due to the distance. This pathway covers natural spread from Italy. *H. irregulare* is expected to spread naturally from where it occurs. Similar natural spread would also be possible if the pest establishes in other part of the PRA area (covered in section 11. *Spread*). In Italy, the fungus has spread to a maximum of 79 km in one direction (southwards) since WWII. Natural spread is expected to be very slow until the fungus bridges the gap of hosts to the North and East of the current infested area. In the meantime, the inoculum will continue to build up. Natural spread will then be faster. However, spread to other EPPO countries is likely to take in the order of one to few decades in the absence of measures, and any containment measures are likely to slow down the spread. In addition, the pest was introduced in an area of sparse presence of hosts. The characteristics of distribution of hosts, especially *Pinus*, along the spread path will influence the spread. A distance of 80 km is also considered to be appropriate in any containment plan (Gonthier et al., 2014a) to cover for the spread by spores (even if there are reports of spores carried at hundreds of kilometres). In Italy, the fungus has spread continuously southwards. Spread southwards is expected to continue, although it will probably be constrained by drier and warmer climatic conditions. Once the pest reaches Sicily, further spread to other EPPO countries would require that spores are carried at long distance (all countries to the South are beyond 80 km from the coast of Sicily). Spread northwards and eastwards has, for now, not been reported. It is currently constrained by the absence of hosts in suitable densities (plantations) and age classes along the spread pathway (although pine is widespread in gardens and parks, the pathogen is spreading effectively in the presence of plantations). Northwards, i.e. in the direction of most other

EPPO countries, there is a gap of 50 km between the current distribution and the closest pine stands, which are currently young and are expected to become more suitable to infestation as they grow in the coming years. Spread within that distance (50 km) is not as likely as spread below 30-40 km (see section 11. Spread). The fungus could also reach other EPPO countries by moving first eastwards and then northwards. Spread eastwards inland has been limited to 18 km at most so far. Also here, only young pine stands are present, which are expected to become more suitable to infestation as they grow in the coming years. Finally, there is a trade of several commodities that may carry the pathogen and it is likely that human-assisted spread occurs before the fungus reaches another country by natural spread. **Conclusion.** The probability of entry by natural spread was rated as "moderate/high" unless mitigation actions are taken. Natural spread is in any case slow. There is a moderate uncertainty related to the capacity of the fungus to "jump" host gaps over 30 km and to when the young stands in the north and east will become suitable for infestation. The probability of spread will increase if new outbreaks appear in the EPPO region, especially in areas of dense presence of suitable hosts.

Likelihood of entry on the pathway:	**Uncertainty**:
- Moderate-high, although slow	- moderate (whether it can jump large gaps to the closest host presence, suitability of young stands, probability may be higher if it is introduced to EPPO countries with dense host presence)

Plants for planting (except seeds) of host species from countries where *H. irregulare* occurs Pathway prohibited in the PRA area?: Yes in some countries, especially conifers and Quercus Pathway subject to a plant health inspection at import?: Yes (in many countries) Pest already intercepted on the pathway?: Not known
This pathway covers all coniferous and deciduous hosts, and relates to plants for planting with roots. Seeds are not infested by *H. irregulare*. This pathway has apparently never led to movement of *H. irregulare*, and there does not seem to be any measures for plants for planting in relation to *Heterobasidion* species, but it was nevertheless studied. No direct reports were found of *H. irregulare* infecting nursery stock, and movement of nursery stock from areas where the pest occurs does not seem covered in management measures in the USA (nor in similar management for European species of *Heterobasidion*). **Association with the pathway and survival.** Plants seem, from the biological point of view, an obvious pathway by which mycelium may be transported. Spores could also be present in the growing medium or on the plants (although they are likely to have limited survival capacity) (but transfer to a host would be complicated). Infestation of plants for planting would require that their roots come in contact with infested material in the soil (large pieces of infected roots or wood). However, it would require that plants for planting are produced directly in soil (or containerized in the presence of high inoculum pressure) close to infested trees (i.e. in the forest). If large wounds are created on the trees (e.g. through pruning), this may also increase the risk of infection. In Scandinavian forestry, the wound size below which the risk of developing a decay in spruce trees is low is15 cm^2 (Isomaki and Kallio, 1974). *H. irregulare* may be associated to very small trees. Some plants for planting may have a large diameter, especially for ornamental purposes. The EWG noted that the risk of association of the pathogen would be higher for larger plants and lower for seedlings; however it is not possible to define an age or size that would sufficiently reduce the risk. If *H. irregulare* was present at proximity of nurseries producing host plants, and infestation occurred, early stages of infestation would be difficult to detect, but symptoms may appear early during the course of the disease. It is not known if young plants would survive attacks long enough to be traded. Nursery plants are commonly subject to regular inspections, and the disease may be detected. In Europe there is a massive production of plants for planting grown from seed in one area to be used in other. This may increase the risk if such plants are grown in an infested area. **Transfer at destination.** Transfer at destination would be likely as plants for planting will be planted within a few weeks in a suitable environment and suitable host plants are widespread in the PRA area. The infested tree may come in contact with roots of hosts, or the infested tree may die and fruiting bodies and basidiospores be produced. The risk of transfer would be higher for large plants. One plant planted at the right site would allow for the development of a disease center (from an initial mycelium). **Requirements in the PRA area.** Import of conifer plants for planting is prohibited in a number of EPPO countries (including the EU). In other countries, it may be allowed but trade of plants for planting is subject to measures in many EPPO countries (Table 4 in Annex 2). Where requirements are in place, inspection may be performed for other pests, but

would not necessarily detect *H. irregulare.* However the pathway is open in part of the PRA area, both for conifers and deciduous hosts.

Trade. According to the data from several EPPO countries, some *Quercus* plants were imported from the USA (over 5400 units, incl. *Q. coccinea*, *bicolor*, *dentata*, *ellipsoidalis*, *macrocarpa*, *muehlenbergii*, *palustris*, *robur*, i.e. no known hosts) in 2010. *Prunus serotina* and *Rhamnus* were not mentioned in this data. Import of conifer plants is prohibited in the EPPO countries that had provided data and no data is available for other EPPO countries. *Pinus* and *Juniperus* are grown extensively in the EPPO region, and it seems unlikely that these species would be traded as plants from outside the EPPO region (although species of *Pinus* or *Juniperus* that are not widespread in the PRA area may be imported for ornamental purposes, where they are not prohibited). Within the EPPO region, no data was found on trade of *Pinus* plants for planting, but the area where the pest occurs in Italy is not a main area for the production of pine plants. Italy is a major producer of *P. pinea*, however it is not known if there are large nurseries producing plants for planting of *P. pinea* for retail in that area. A large forest nursery producing conifers is present in Italy to the north of the infested area (Pieve Santo Stefano, Toscana).

Conclusion. The probability of entry on plants for planting was rated as low with a high uncertainty. Biologically, plants for planting would be a favourable pathway and transfer is likely. The risk would be highest for large plants. However, plants for planting are less likely to be infested than other commodities considered, and the trade is probably small. There is also an uncertainty on whether infested young trees would be traded as plants for planting (whether young trees would survive attacks to be traded, whether the disease would be already visually detectable and the trees would not be exported).

Likelihood of entry on the pathway:	**Uncertainty**:
- low	- high (whether there is trade, whether plants for planting would be produced in infested areas, whether they are attacked and traded)

Christmas trees of conifer host species from countries where *H. irregulare* occurs

Pathway prohibited in the PRA area?: In part

Pathway subject to a plant health inspection at import?: Not known

Pest already intercepted on the pathway?: Not known

There are reports in the USA of Christmas trees infested with *H. occidentale* (Dart et al., 2007). Infection in Christmas tree plantations is facilitated as stumps are generally not removed/treated. Infection can be extremely high in Christmas tree plantations where the disease is present in nature nearby (500 to 2000 m). However treatment or removal of stumps appears to mitigate disease incidence significantly (M. Garbelotto, University of California, 2014-12, personal communication). Many host species seem to be used as Christmas trees in the USA, including the hosts *J. virginiana*, *A. balsamea*, *Pseudotsuga menziensii*, *P. ponderosa*, *P. resinosa*, *P. strobus*, *P. sylvestris*, *Picea glauca* (University of Illinois, 2014).

Basidiospores, fruiting bodies or mycelium may be present on such material. Spores would have a short survival and transfer to a host would be complicated. If mycelium was present in the stem, transfer to a healthy host would require that trees are discarded in conditions that allow such transfer (i.e. proximity of hosts) and that the fungus remains viable (while this material may dry). Even if no evidence was found in the literature, this is theoretically possible as such trees are commonly discarded in gardens or in nature.

If there were imports of infested Christmas trees, fruiting bodies may be noticed at inspection, but not mycelium. However, import of Christmas trees of most conifers is prohibited in some countries (including the EU with the prohibition of "plants (other than fruit and seeds) of *Abies*, *Cedrus*, *Chamaecyparis*, *Juniperus*, *Larix*, *Picea*, *Pinus*, *Pseudotsuga*, *Tsuga*"). In other EPPO countries, it is not known if Christmas trees are imported from North America, but it seems rather unlikely as there are major producers of Christmas trees in Europe, notably Denmark. In addition, USDA-FAS (2014) does not indicate exports of cut foliage (06049100 – covering Christmas trees) to EPPO countries. For Canada, no EPPO countries are mentioned in a list of countries importing Canadian Christmas trees (http://www.canadianchristmastrees.ca/media_fr.html - the Netherlands would refer to Dutch territories in the Carribean). From Italy, there is no information on whether Christmas trees are produced in the infested area, but the species found infested so far are not common Christmas trees, and the infested area is not a main area of production of Christmas trees .

Conclusion. The probability of entry on Christmas trees was rated as low/very low with a moderate uncertainty. The association is similar to that of wood, but transfer to a suitable host would be more likely because Christmas trees are commonly discarded. The pest could be associated to Christmas trees but the current trade from North America and from the infested area in Italy is probably very low (at most). However, there are uncertainties related to such a trade (existence, volume, species traded). The likelihood of entry on this pathway would increase if there was a known trade.

Likelihood of entry on the pathway:	Uncertainty:
- low/very low	- moderate (whether there is trade, whether trees are produced in infested areas)

8.2 Pathways considered very unlikely, not considered further

Articles made of wood. Apart from the wood categories covered above, wood has many uses, including for furnitures, construction and decorative objects. Wood for construction is partly covered under the wood pathway. For other uses, the presence of rot may exclude the wood from being used, or it may be limited to decorative purposes (because of the patterns created by the fungus). In some trees, butt and roots are used as they present interesting patterns, but it is not known if this is the case of any of the hosts. In addition rotten wood decays and is brittle. It is also likely that wood would be dried before being used for such objects, which would limit survival of the pest. In many cases, it may also receive some treatment or coating. Transfer to a host would be very difficult in all cases.

Objects that may present a risk would be those made of low quality wood and used in the soil. Apart from poles (considered with wood) and wood packaging material (considered separately), the EWG could not find examples. There is no information available to study of this pathway in detail. In any case entry on this pathway is considered very unlikely.

Soil or growing medium. Debris of infested wood or roots in the soil may carry the pathogen, or spores may be present in the soil after having been washed down into the soil. However, *H. irregulare* has a limited survival in soil, which is one reason why its transfer between continents was considered unlikely, and transfer to living plants is also considered less likely than for other mechanisms. Soil trade (including of forest soil) is also prohibited in many EPPO countries, and soil traded on its own is in any case unlikely to come from forest areas (not fertile soil).

Plants for planting of non-host species grown in areas infested by *H. irregulare*. Spores, debris of roots or wood infested by *H. irregulare* may persist in soil. If a nursery producing plants for planting of any species was established in an area that was infested by *H. irregulare*, infested wood or roots may be present in the soil. Even if such forest areas are used to establish nurseries, it seems unlikely that infected wood or root pieces of a suitable size would be left in the soil. In addition, plants for planting are often grown in pots, i.e. not directly in the soil. *H. irregulare* has a limited survival in soil, and any infested wood and root debris in soil would decay and become unsuitable. Furthermore, at least in the EU, there are requirements for plants for planting that would ensure that growing medium associated to plants is free from the pest. Finally, once at destination, debris or spores in the growing medium would have to be in contact with roots of host plants and the fungus transfer to those. There is no information to study this pathway, no evidence that this could happen, and it seems on the whole very unlikely.

***P. pinea* nuts and cones.** There is no information on whether these may be infested, but they may incidentally carry spores. This is not documented in the literature for North America (where production of pine nuts is marginal). Pine nuts produced in Italy are traded (within or outside the country) (see section 9.1). Cones of *P. pinea* are also traded whole (and fresh) for the purpose of extracting pine nuts or for ornamental purposes. No information was found referring to any *Heterobasidion* spp. on conifer cones. In addition, the intended use of pine nuts makes transfer very unlikely. For cones, once pine nuts are extracted or the cone has fulfilled its ornamental purpose, cones must be discarded. Even if this happens outdoors (where they may be close to host plants), spores have a limited survival and would not be likely to come in contact on their own with exposed wood surface. There is no information available to study this pathway, which is considered very unlikely due to the difficulties of transfer.

Other part plants of host species from countries where the pest occurs. *H. irregulare* is not known to be associated to other plant parts of its hosts, such as cones or seeds of other conifer species, foliage not including stems (i.e. other than Christmas trees). Even if basidiospores were incidentally present on such material, they would have a short survival and limited means to reach a host at destination.

8.3 Pathways not judged possible, not considered further

Harvesting machinery and machines used in forest. This is not likely to be a pathway for international movement, but is covered under Spread (section 11).

8.4 Conclusion

The likelihood of entry is considered as moderate-low from North America and moderate from the infested area in Italy. Although natural spread will happen, and the pest will gradually spread towards other EPPO countries, a single introduction with untreated wood packaging material (wood packaging material may not be treated between EU countries) may occur, resulting in long distance spread. This is a less likely event but could result in an additional outbreak in a new area. The higher risk of entry to other EPPO countries at the moment is from the infested area in Italy. However it is considered possible to contain this outbreak, because spread has been very slow and therefore the introduction of measures to prevent further introductions into the EPPO region are seen as beneficial.

The volume of trade for some of the pathways considered is not known, and transfer will be complicated for all pathways except plants for planting. The probabilities of entry were rated as below for the different pathways under 8.1 (pathways under 8.2 are all considered very unlikely).

Pathway, from countries where *H. irregulare* occurs	**Probability (uncertainty)**
Natural spread	Moderate/high, although slow (moderate)
Untreated wood packaging material	Moderate (moderate)
Wood of conifer hosts with higher likelihood of association from North America	Moderate/low (moderate)
Wood of conifer hosts from Italy	Moderate/low (high)
Conifer particle wood and waste wood (not agglomerated)	Moderate/low (moderate)
Plants for planting (except seeds) of host species	Low (high)
Bark of conifer host species	Low (high)
Wood of conifer hosts with lower likelihood of association from North America	Low/very low (moderate)
Christmas trees of host species	Low/very low (moderate)
Wood of *Quercus, Prunus serotina*, *Arbutus menziensi*, *Arctostaphylos* spp.	Low/very low (high)
Deciduous particle wood and waste wood	Very low (moderate)
Bark of deciduous host species	Very low (low)
Wood packaging material treated by ISPM 15	Very low (low)
Agglomerate particle wood and waste wood (conifer or deciduous)	Very low (low)

Rating of the likelihood of entry	*Low* ☐	*Moderate* ✓	*High* ☐
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

9. Likelihood of establishment outdoors in the PRA area

Establishment requires that host plants are present to which the pests can transfer, that climatic conditions are suitable and that the current practices (management, pest control etc.) in the EPPO region do not prevent establishment.

9.1 Host plants in the EPPO region

Host plants occur throughout the EPPO region. *Pinus* species are present in the wild and extensively planted across the EPPO region for forestry and amenity purposes. The distribution of *P. pinea*, *P. halepensis*, *P. pinaster, P. brutia* and *P. sylvestris* are presented in Annex 6.

P. pinea is cultivated and used for pine nuts production, and is also a landscape tree in the Mediterranean Basin. *P. halepensis* is native and also grown in the Mediterranean Basin, for forestry and as a landscape trees. In the PRA area, both *P. pinea* and *P. sibirica* (*P. cembra* subsp. *sibirica*) are used for nut production (Sharashkin and Gold, 2014).

A few hosts that have not yet been found to be attacked in plantation conditions (but only in arboretum or susceptible in inoculation trials) are important in the EPPO region. *P. sylvestris* is one of the main forest species in the EPPO region. *P. pinaster* is an important species for timber production and as ornamental in the Western Mediterranean area, and *P. brutia* in the Mediterranean and Black Sea region (http://www.iucnredlist.org/details/42347/0).

There is a wide diversity of native species of host genera in the EPPO region, for example:

- for *Pinus* - *P. nigra*, *P. cembra*, *P. mugo*, *P. uncinata*, *P. peuce*, *P. heldreichii*, *P. canariensis.*
- for *Juniperus* - *J. thurifera*, *J. oxycedrus*, *J. phoenicia*, *J. cedrus*, *J. brevifolia*, *J. excelsa*, *J. foetidissima*, *J. drupacea*, *J. communis*, *J. sabina*

In addition there are many other conifer species such as *Picea abies*, *Larix decidua*, *Abies. alba*, *A. sibirica*, *A. cephalonica*, *A. borisii-regis*, *A. equi-trojani*, *A. cilicica* (EEA, 2006), *A. nebrodensis* (red list – Sicily), *A. nordmanniana*, *Picea omorica*. Hybrids are also grown, such as between *L. decidua* and *L. kaempferi.*

Some North American conifer host species have been extensively planted in the EPPO region for forestry purposes, such as *P. radiata*, *P. contorta* and *Pseudotsuga menziensii* and are among the most used non-native species in Europe (Korhonen et al., 1998; EEA, 2006). In France, *P. menziensii* is the second most sold species for forest seed and plantlets (http://agriculture.gouv.fr/IMG/pdf/08_EvolutionVentesPlantsForestiers2012-2013_cle88177e.pdf), and *P. radiata* and *P. taeda* are also important. *P. strobus*, *P. banksiana*, *Picea sitchensis*, *Calocedrus decurrens* are also used for afforestation in France (Tison and De Foucault, 2014). *Picea sitchensis* is also used in Europe (EEA, 2006). In countries of the former-USSR, the following hosts in North America are mentioned as being cultivated in one or several countries (EPPO, 2000): *A. balsamea*, *Picea glauca*, *Pinus banksiana*, *P. cembroides*, *P. coulteri*, *P. edulis*, *P. jeffreyi*, *P. lambertiana*, *P. palustris*, *P. ponderosa*, *P. radiata*, *P. strobus*, *Thuja plicata*. These species may be grown in other countries too. Hybrids such as between *P. sitchensis* and *P. glauca* are also used (Norway). Due to the express nature of this PRA, all hosts were not checked, but it is expected that most conifer hosts may be used at least as ornamental in the EPPO region.

The host status of most Quercus species is unknown. Many native *Quercus* species occur in the EPPO region, such as *Quercus robur*, *Q. petraea*, *Q. cerris*, *Q. frainetto*, *Q. robur*, *Q. pubescenspubescens.* Some North American species such as *Q. rubra* are widely cultivated (Gonthier et al., 2012; EPPO, 2000, EEA, 2006). *Erica arborea* is a European species native to the Mediterranean Basin. It is also grown as an ornamental. *Prunus serotina* is native to North America, but has been introduced in conifer forests in Europe for various purposes, and is invasive in some habitats, for example semi-natural or managed woodland (EPPO List of Invasive Alien Plants).

9.2 Climatic conditions

According to the classification of climate types of Köppen-Geiger (Map in Annex 7), the climate types that occur in North America where *H. irregulare* is present also occur in the largest part of the PRA area, including North Africa, the Near East, as well as the northernmost and easternmost parts of the of the region. In North America, the distribution of *H. irregulare* includes areas of Mediterranean-type climate, such as California, where it is widespread. *H. irregulare* has shown that it is better adapted to the Mediterranean climate in Lazio, Italy than *H. annosum* s.s. It is also present in the Circeo area, which has a more humid climate than the rest of the infested area in Italy. Finally *H. annosum* s.s. occurs widely in the EPPO region south of 62°N (northern limit in Sweden, J. Stenlid, personal communication; Witzell et al., 2011). It is expected that the climate would be appropriate to *H. irregulare* throughout the EPPO region.

Based on its native range and its prevalence in Italy, the EWG considered reasonable to assume that *H. irregulare* is more adapted to warmer climates than *H. annosum* s.s., resulting in a higher prevalence. There is no such information for its northern distribution, however *H. irregulare* is present in Quebec.

To the South, *H. irregulare*, like *H. annosum* s.s., may be constrained by conditions that are warmer and dryer than in Lazio, although *H. irregulare* has shown to be more adapted to drier conditions than *H. annosum* s.s. in Italy where both species occur (see details in section 2 of this PRA). In any case this would affect its prevalence more than its establishment (*H. annosum* s.s. occurs in such areas). Establishment may be possible only during part of the year because infection during the summer would be constrained by high temperatures (see EPPO Data sheet - high summer temperatures reduce sporulation and also result in high stump temperatures that prevent infection). In southern parts of Italy, *H. annosum* s.s. is more likely to be found at higher elevations. In the southern part of Europe, the Near East and North Africa, the situation of *H. irregulare* may be similar.

H. irregulare performed better than *H. annosum* s.s. (saprobic and fruiting abilities) in inoculation experiments on pine logs (18-20°C and 80% relative humidity). This suggests that it may have a better transmission potential in most of the EPPO region.

To the North, establishment of *H. irregulare* may be possible only during part of the year because infection during the winter would be constrained by low temperatures. It is not known if *H. irregulare* would have the same northern limit of 62°N as *H. annosum* s.s. that, for unknown reasons, does not occur despite of the presence of hosts (while *H. parviporum* is present). Witzell et al. (2011), for Sweden, conclude this limit is not due to temperature regimes.

It cannot be excluded that hybridization will influence climatical adaptation and other traits of *H. irregulare* and *H. annosum* s.s. Gene introgression from *H. irregulare* into *H. annosum* s.s. may also increase the transmission potential of the native species.

9.3 Management conditions

It is not expected that current management conditions in the EPPO region would prevent establishment (but they may have an impact on spread). Plantations and forests are subject to a certain level of management in part of the EPPO region, especially in forest plantations where *H. annosum* s.s., *H. parviporum* or *H. abietinum* occur. Some countries, such as in Sweden, Finland, Poland, UK are applying at large scale management practices against *Heterobasidion* that may decrease significantly, but not exclude, the risk of establishment (thinning at low risk season, stump treatment with chemical or biological control agent at felling, minimizing wounding). In Sweden and Finland, stumps are occasionally used for energy purposes.

Ornamental and landscape trees may be subject to minimal management. There are also wide areas of unmanaged or minimally managed conifer forests throughout the EPPO region.

9.4 Biological considerations

Although many factors may play against establishment, *H. irregulare* has an abundant spore production (Scirè et al., 2011, Garbelotto et al., 2010). In Italy, it has been shown to have competitive advantages (detailed in section 2) over *H. annosum* s.s. Both in North America and Italy, it has been recorded in a variety of environments, including forests, plantations, and parks. The saprophytic ability of *H. irregulare* makes it a stronger invader of root systems of its hosts than *H. annosum* s.s. (increasing both establishment and secondary spread).

The main factors that may prevent the successful infestation of *Heterobasidion* in its hosts and its capacity to colonize new trees are competition with other fungal root colonizers and wood decay species, naturally-present antagonistic and non-pathogenetic fungi, abiotic factors (e.g. temperature, humidity) (see EPPO Data sheet). These would be important for establishment, but at least temperature and humidity are likely to be suitable for infection during part of the year, as they are throughout the EPPO region for *H. annosum* s.s (see EPPO Data sheet). Soil type (e.g. sandy soils present a higher risk, peat soil a lower risk) is more relevant for spread than to establishment of the fungus on a host.

Establishment may be facilitated if *H. irregulare* was introduced in a pine plantation in an area of continuous presence of *Pinus* or *Juniperus*, or where other species present could sustain spore production (e.g. oak). Gonthier et al. (2014a) mention that *H. irregulare* has been able to cross gaps of pine presence of 10-30 km. If the pathogen was introduced on a single pine tree separated by such a distance from others, the mycelium would expand locally and, provided successful sporulation happens, the fungus would be able to cross such gaps.

The likelihood is rated as high due to the large presence of hosts in the EPPO region and the competitive advantages that may compensate for the fact that there are many factors that need to be favourable before infection occurs.

Rating of the likelihood of establishment outdoors	*Low* □	*Moderate* □	*High* ✓
Rating of uncertainty	*Low* ✓	*Moderate* □	*High* □

10. Likelihood of establishment in protected conditions in the PRA area

Young host trees would generally be grown in open nurseries, and not under protected conditions.

11. Spread in the PRA area

11.1 Natural spread

There are two components to natural spread (Redfern and Stenlid, 1998; D'Amico et al., 2007; Garbelotto et al., 2010, Garbelotto and Gonthier, 2013):

- *Spores.* Airborne basidiopores infect stumps from freshly cut trees or wounds on standing live trees. Spores may also be deposited on foliage, bark or soil, and reach suitable hosts locally. The role of conidiospores in the life cycle and infection process of *Heterobasidion* species is not fully understood.
- *Mycelium.* Spread through root contacts and grafts to roots of surrounding trees.

Spread of mycelium. Wood colonization reported for *H. annosum* s.l. occurs at a rate of 0.2-2 m/year (Stenlid and Redfern, 1998; Gonthier et al., 2007, citing others). In Italy, based on the size of disease gaps in infested *P. pinea* plantations and assuming a 40 years lag between the infestation at the site of first introduction and the infestation of sites colonized subsequently, the rate of enlargement of gaps was estimated to be 40 cm per year (Gonthier et al., 2014a). Individual mycelia can develop to occupy an area of 50 m diameter, but in most cases the diameter is less than 30 m and involves only a few trees (Garbelotto and Gonthier, 2013; Gonthier and Thor, 2013).

Spread of spores. 99% of spores deposit within 100 m of the source (Korhonen and Stenlid, 1998). In a model describing the dispersal gradient of *H. annosum* s.l., only 0.1% of spores travelled 100 m (Stenlid, 1994). Spore dispersal is often limited to a few hundred meters at most, and is minimal at 80 km (Gonthier et al., 2007 citing others; Garbelotto et al., 2013; Gonthier et al., 2014a). Some spores may disperse at longer distances. Garbelotto and Gonthier (2013) note that during thinning operations or cuttings, the presence of active fruiting bodies increases the risk of stump infection within but not between forests.

Overall spread. Little data was found on the rate of spread in North America. In Canada, based on years of detection, Laflamme (2011) and Laflamme and Dumas (2013) estimate that, within 80 years, the fungus has been found in sites distant by 800 km, and will reach the boreal forest within 5 years. The 2010 US Forest Service Guidelines on National Forests in the Lake States notes that sites within 25 miles (40 km) from a known infection center should be considered to be at high risk of infection, sites 25-50 miles (40-80 km) at moderate risk, and sites beyond 50 miles (80 km) at low risk (Wisconsin DNR, 2013).

In Italy, the rate of spread was estimated to be 1.3 km per year (based on an initial outbreak in Castelporziano, the current extent of the disease and the time elapsed since introduction) (Gonthier et al., 2007). The estimated spread rate may be underestimated as the pathogen would not have started to spread immediately after its introduction. This spread occurred in an area where there is no continuity of pine, but single trees interspaced in the landscape (Gonthier et al., 2007). Gonthier et al. (2014a) note that infection of *P. pinea* is driven by host density rather than by host population size. Basidiospores were trapped even in small and isolated clusters of trees, but no or very low numbers of spores were trapped along pine-lined roads between infested sites, which are sometimes located tens of km from infested stands. Because the gap with other pines to the north is 50 km and in the south 24 km, Gonthier et al. (2014a) assume that *H. irregulare* has been able to cross gaps up to 20-30 km but not 50 km. In regions where pine habitats are 500 m-10 km apart (e.g. pine stands from Tuscany, Italy to northeastern Spain, or *P. sylvestris* plantations in central and northern Europe), *H. irregulare* may spread much faster than 1.3 km per year (Gonthier et al., 2007). A buffer zone of 80 km is proposed in Gonthier et al. (2014a) in the framework of a containment plan.

In conclusion, natural spread will depend on many parameters, including the success of the fungus to bridge gaps in areas with discontinuous pine presence. The spread of *H. irregulare* to its current distribution range in Italy took a long time, and further spread is expected to be slow, but may accelerate if the fungus reaches or is introduced into areas of more favourable host presence (continuous stands, high host density) and climatic conditions that enable wide sporulation regimes. Spread may be helped if *H. irregulare* was able to maintain populations in pure *Quercus* stands (Gonthier et al., 2014a). Other hosts may also have a role, for example when *H. irregulare* reaches maquis areas where *P. pinea* grows with *Erica arborea* and others such as *Juniperus* spp. (Gonthier et al., 2014a).

11.2 Human-assisted pathways

Human-assisted pathways may carry the pest although there are only few known cases where this has happened (see section 8 of this PRA). In Italy, Gonthier et al. (2014a) note that there is limited movement of *P. pinea* wood in the area and it is unlikely that the spread of *H. irregulare* has been due to human transport. Within the EPPO region, *H. irregulare* may be transported with all forms of host wood and bark, and possibly plants for planting. *H. irregulare* was introduced in Italy through a human-assisted pathway, and if no measures are applied it may happen again (especially because the pest has become more prevalent in forest plantation areas in the USA). Harvesting machinery (including sawchains) may play a role for spread, although there is no evidence of this. Wisconsin DNR (2014) recommends that equipement is cleaned to avoid bringing the fungus to healthy areas.

11.3 Estimates of spread and expected spread within the EPPO region

The EWG considered that it is reasonable to assume a rate of advancing front of the disease of 10-20 km per year when *H. irregulare* reaches areas of more continuous presence of hosts than in the currently infested area in Italy. The larger the gaps between available hosts, the slower the spread. With gaps of hosts of 10-20 km, the spread is expected to be similar to the spread in Lazio (1.3 km per year). It is expected that the disease will be clustered, with different incidences in different stands (due to site factors, stochasticity of infection events etc.). In case of new introductions in the EPPO region, an incubation period of some years is needed for the formation of the fruiting bodies that in turn facilitate the establishment of the pathogen in new areas.

The presence of *H. annosum* s.s. will not prevent the spread as it is fully interfertile with *H. irregulare*.

Forest management practices that are currently applied against *H. annosum* s.s. or are put in place (i.e. thinning at low risk season, treating stumps, avoiding wounds including due to felling and extraction of resin) could reduce the spread of *H. irregulare*. Many of these practices are successfully used in the USA to slow the spread (see 12.5). However, they would need to be applied consistently across stands.

From Italy, pine wood is not extensively produced in the area where the pest is present. However, movement of untreated wood packaging material made of infested wood or firewood from the outbreak area to other parts of Italy or other EPPO countries cannot be excluded. Pathways from North America could introduce the pests to multiple locations, from which it could also spread, and could also provide new genotypes from different sources that could increase adaptative potential of *H. irregulare*. Multiple introductions in several areas would amplify the number of sites from which the pest could spread to reach areas where host trees are widespread in central and northern Europe. The PRA area has regions with dense presence of pines, and the consequences would depend on how effectively *H. irregulare* is able to infect, kill and sporulate on other *Pinus* species such as *P. sylvestris* and *P. pinaster*, and compete and hybridize with local *H. annosum* s.s. populations. Plants for planting, if a pathway (see section 8 of this PRA), may play a more important role for spread within the PRA area than for spread via international trade.

The magnitude of spread will also depend on the implementation of containment measures, and of the trade of wood and other material from infested areas. Containment options are available to slow down the spread (see section 16 of this PRA).

Ultimately, it seems unlikely that spread can be stopped in the absence of containment measures, and it could spread to all areas of the EPPO region where pine occur, with additional unknown effects linked to its competition with other *Heterobasidion* and hybridization between species.

Rating of the magnitude of spread	*Low* □	*Moderate* ✓	*High*
Rating of uncertainty	*Low* ✓	*Moderate*	*High* □

12. Impact in the current area of distribution

12.1 Nature of the damage

H. irregulare causes root and butt rots in its host plants. It colonizes the cambial layer and sapwood of its hosts and, in some species the heartwood. The colonization by mycelium in the wood results in staining (at initial stages of the disease, dark, almost purple stain and later white rot). On some species, including many pine species, infection of roots is extensive, and trees may die within a few years of infection). On non-resinous tree species, infested trees may remain alive for several decades, even in the presence of extensive rot extending high into the stem heartwood.

H. irregulare causes direct damage on wood via staining and rot. No specific data was found for *H. irregulare*, but rot in the wood, even at early stages of infection, may also reduce the strength of the wood and pulping qualities (Korhonen and Stenlid, 1998; for *Picea sitchensis* for *H. annosum* s.l.). Rot decreases the volume of marketable timber.

The fungus leads to reduction in tree growth (Garbelotto and Gonthier, 2013) and decreases site productivity. Infested trees are also predisposed to wind damage (Georgia Forestry Commission, 2013). This has also been shown for *H. annosum* s.l. in southern Sweden on *Picea abies* (Oliva et al, 2008). Infested trees may also present increased susceptibility to attack by bark beetles (US Forest Service, ND).

12.2 Direct and indirect impacts

H. annosum s.l. is a major pathogen in forest plantations in the Northern hemisphere. The economic consequences in North America are expected to be of a similar magnitude than in Europe, where economic losses by *H. annosum* in Europe were estimated to be around €800 million annually to forest owners through tree mortality and wood decay (Woodward et al., 1998).

In North America, *H. annosum* s.l. has been known to occur for at least a century, but reports of significant damage are more recent. The first reports of southern pine mortality came from Georgia and South Carolina in 1954 (Ostry and Juzwik, 2008). The disease has become more prevalent in pine plantations in recent years (e.g. Wisconsin DNR, 2014, Blanchette et al., 2015). Disease incidence is reported to increase with stand age at rates that depend on host species and silvicultural management techniques (EPPO, 2013). In the USA, although *Heterobasidion* is present in various environments, it causes most problems in plantations that have been thinned (Georgia Forestry Commission 2013). Filip and Morrison (1998) report minimal mortality of seedlings in regeneration areas, while others indicate losses. In California (where both *H. irregulare* and *H. occidentale* occurs), *Heterobasidion* root and butt rot is one of the most important conifer diseases, and affects about 2 million acres (over 800 000 ha) of commercial forest land by causing an annual volume loss of 19 million cubic feet (≈500 000 m^3) (US Forest Service, ND). Finally, in a 6-year study on 20-years old *P. elliottii* in Eastern USA, in trees with more than 50% of their roots infected, reduced diametric tree growth was observed three year after thinning, and reached 20% in trees with vigorous crowns. Height growth was reduced by 40% (Froelich et al., 1977).

In Italy, *H. irregulare* is found in monospecific pine plantations, in urban parks and in oak-pine mixed woodlands (Gonthier et al., 2014a). It is present in 80% of the sampled *P. pinea* stands (forest and urban gardens) in the infested area, while *H. annosum* s.s. is present in 60% of these stands (Gonthier et al., 2007; Gonthier et al., 2014a). Mortality of trees was observed in the infested area, and it is higher in sites where *H. irregulare* has been present longer. Significant mortality of groups of trees (up to 100) was reported for *P. pinea* (D'Amico et al., 2007; Gonthier et al., 2007). For the oldest infection site in Castelporziano/ Castelfusano, the average size of a disease center is 2071 m^2, the largest center is 3.7 ha, the percentage of the total forest area covered by infection centers is 6%, and the average number of infection centers if 0.29 per ha. *P. pinea* is used for pine nut production in the infested area, and losses in pine production are probably comparable to losses in cover.

Mortality is observed on many pine species (most notably *P. resinosa*, *P. taeda*, *P. elliotii*, *P. strobus*, *P. banksiana*, *P. jeffreyi*, *P. coulteri*, *P. radiata* and *P. ponderosa* in North America, and *P. pinea* in Italy) as well as on other conifers, most notably *Abies balsamea*, *Juniperus virginiana* (Dumas and Laflamme, 2013, Wisconsin DNR 2014, Gonthier et al., 2007, Filip and Morrison, 1998). On *P. elliottii*, mortality centres were observed 2-3 years after thinning and 30% mortality is observed in some stands (Filip and Morrison, 1998).

Export markets do not seem to have been affected so far in North America, but the fungus may impact export of all wood categories (also if the production decreases). The fungus is not reported to cause impact on pine nut production in the USA, but the USA is not a major producing country.

12.3 Environmental impact

Mainly in artificial, even-aged plantations *H. irregulare* affects the species composition, stand density and structure of forests. When tree mortality occurs in a forest, gaps result in changes of light, moisture and temperature (EPPO, 2013). *H. annosum* creates stand openings, enhances diversity, provides wildlife habitat, and alters forest structure, composition, and succession (US Forest Service, ND). In California, the gaps are taken over by fir trees, bringing the forest from mixed forest with high biodiversity, to monospecific stands with lower biodiversity, low fire and drought resilience and high level of insect attacks (M. Garbelotto, University of California, 2014-12, personal communication). Like all wood parasites, the fungus also causes massive release of CO_2 from decaying wood, thus representing a major threat to the ability of coniferous forests to serve as a natural carbon sink (Olson et al., 2012). Run-off and erosion can be increased in infested sites, and water quality be negatively impacted (Neary et al., 2009).

12.4 Social damage

In recreation areas, *H. irregulare* leads to depletion of the vegetative cover. It also increases probability of tree failure, and creates a hazard for visitors and facilities (US Forest Service, ND). It has led to closure of recreation sites, campsites for extended periods, damage to building due to fall of trees, and multiple deaths caused by fallingof infested trees in recreational areas (Rizzo and Slaughter, 2001).

In Italy, *H. irregulare* has been found in monumental urban parks in and around the city of Rome (Villa Ada, Villa Doria Pamphili, Villa Borghese, Fregene monumental pinewood). Damage has also been reported in archaeological sites for example Coccia di Morto and Nettuno. The fungus is present in a national park (Circeo).

12.5 Possible options for control

There is no method that allows elimination of *H. irregulare* from a tree once infested. Control methods, both in North America against *H. irregulare* and *H. occidentale*, and in Europe against other species in the complex, aim at preventing infestation and limiting the local spread of disease centers. In California (US Forest Service, ND), the aim of management strategies is to reduce resource losses to levels which are economically, aesthetically, and environmentally acceptable. Although this section normally relates to the area of origin, examples from Europe of control of European *Heterobasidion* are also relevant and mentioned here.

The following measures are mentioned in the literature:

<u>Prevention of infestation at thinning/harvest</u>

- Conducting thinning/harvest at times when there are fewer spores (Korhonen et al., 1998). This varies according to the climatic conditions (see *Pest overview*).
- Starting in healthy stands and moving to infected areas, cleaning equipment before leaving the harvest site to minimize the risk of spreading the disease to a new location. Note: The significance of equipment contamination on the long-distance introduction of this disease is unknown (Wisconsin DNR, 2014).
- Use of a risk rating systems (e.g. on soil types, site factors, species composition, age, time of the year of harvesting) to determine if treatment of stumps is necessary (Georgia Forestry Commission 2013; Wisconsin DNR, 2013).
- Treatment of stumps at thinning/harvest. Sodium tetraborate decahydrate (borax, sporax®) (in the USA), disodium octoborate tetrahydrate (DOT, Cellu-Treat®), urea, and the biological control fungus *Phlebiopsis gigantea* have been used and are effective (Holdenrieder and Greig, 1998; Oliva et al., 2008; NRC, 2012; Pratt et al., 1998; Gonthier and Thor, 2013; Garbelotto and Gonthier, 2013; Dumas and Laflamme, 2013). Treatments may be applied manually or by chainsaws or harvesting machines. Stump treatment is used depending on the risk (site, tree species, rainfall patterns, temperature etc.). It needs to be applied at or just after harvest.
- Avoidance of logging injuries to basal stems and roots, damage to roots of living trees at harvest. This is more important for species where infection through stem or root wounds is possible (Korhonen et al., 1998)
- Whole stump removal (effective but expensive, and may be appropriate for specific situations such as arboretums and parks) (Korhonen et al., 1998). This is also time-consuming and unsuitable for most forest stands (Garbelotto and Gonthier, 2013).

- Although this is not mentioned in North American literature, Gonthier et al. (2014a) note that debarking and storing the logs without soil contact would help prevent the formation of fruiting bodies.

Prevention of infestation within an infested stand and to nearby forests and reduction of disease incidence:

- Sanitation felling in some circumstances (either only infested trees, or infested + healthy in e.g. 10-20 m radius) (Korhonen et al., 1998; Wisconsin DNR, 2014). Wisconsin DNR (2014) and Georgia Forestry Commission (2013) recommends clear cut of plantations that are severely infested.
- Changing tree species on infested sites (e.g. to non-susceptible deciduous) (Korhonen et al., 1998; Hagle, 2010, NRC, 2012), or at least not planting the most susceptible species on high risk sites (Georgia Forest Commission, 2013)
- Reducing damage to trees (Korhonen et al., 1998)
- Reducing the number of thinnings in a stand growing on a high-hazard site (Georgia Forestry Commission 2013).
- For *H. annosum* s.s., precommercial thinning is recommended early in a rotation, e.g. when tree height is below 6 meters, to reduce the impact by *Heterobasidion* spp. (lower stump surface andsmaller root systems) (Wang, 2012)
- Reduction of rotation length (Garbelotto and Gonthier, 2013, citing others)
- Trenching to prevent secondary infection via root contact in high value cases. The depth indicated is 40-70 cm in Korhonen et al. (1998), 60-80 cm in NRC (2012), 150 cm in Garbelotto and Gonthier (2013, citing others). Trenching combined with uprooting of all trees present within the trench is effective in preventing further spread of the pathogen and not prohibitive in terms of costs in both North America and Europe (Kliejunas et al., 2005, Pratt and Wang, 2013 cited in Gonthier et al., 2014a). Garbelotto and Gonthier (2013) indicate that uprooting of all infected trees and at least one row of healthy trees combined with digging 150-cm deep trenches was shown to be effective. However, digging trenches may injure roots. Trenching is rarely used in forestry (Garbelotto and Gonthier , 2013)

Little information was found in the literature of measures aimed at eliminating the fungus on wood, or controlling movement of infested material to prevent the introduction of the fungus in areas where it did not occur. In Wisconsin (where the species attacked would mostly be pine, i.e. roots and butt), recommendation is made that dead trees and the bottom eight feet (2.4 m) of trees that are showing dieback and/or yellowing of the foliage be left on the site to minimize the movement of fruit bodies to uninfected areas of the state (Wisconsin DNR, 2014). A study is also under way in Wisconsin on the frequency of fruit body formation on infested dead or symptomatic trees, to assess the risk of introduction of the disease in a new area through infected wood with fruit bodies.

Rating of the magnitude of impact in the current area of distribution	*Low* □	*Moderate* □	*High* ✓
Rating of uncertainty	*Low* ✓	*Moderate* □	*High* □

13. Potential impact in the PRA area

Will impacts be largely the same as in the current area of distribution? ✓Yes /No

There is an uncertainty related to the tree species that will be attacked in the EPPO region, as well as how *H. irregulare* will interact with *H. annosum* s.s. in areas where they both occur, or what the effects of hybridization will be. However, the host species are used in the EPPO region for wood and pine nut production, as ornamentals, and are important in the environment. The disease will spread slowly but continuously, and all pine trees of the EPPO region may be at risk in the long term. The pathogen has caused damage in the infested area in Italy where *H. annosum* is marginal or at low frequency, and the same differential impact may occur in other ecosystems.

If *H. irregulare* established in the EPPO region, it is considered that it could add to damage caused by *H. annosum* s.s. on a number of forest species, have a significant impact on pine nut production and possibly affect species that are not especially damaged by *H. annosum* s.s. *H. irregulare* has also shown its ability to move to different hosts, and, at least on the Italian Tyrrhenian coast, is more competitive than *H. annosum* s.s. In addition the impact of hybridization between the two species remain unknown, and hybridization may (or may not) lead to greater damage.

Although *H. irregulare* is quite similar to *H. annosum* s.s. in its life cycle, there are major differences that would influence the impact. *H. irregulare* has a much higher fruiting and saprophytic ability, resulting in higher rates of primary infection by basidiospores, and possibly also increased secondary spread of the disease through root contacts. In addition, hybridization occurs between *H. irregulare* and *H.annosum* s.s. and there is a risk for increased virulence and different host range (possibly different from the two existing species) in the long-term through introgression.

There is a strong genetic differentiation between the Western and Eastern (incl. Midwest) populations of *H. irregulare* (see section 2.) and the introduction in Italy is from the Eastern population. The introduction of genotypes of both populations may increase the risk to European forests by favouring better adaptation by admixture.

The potential impact in the absence of phytosanitary measures would be high in the long term. Finally, eradication is only considered possible in very limited circumstances (see 16.2).

Economic impact (without environmental impact)

- *Reduced productivity***.** In pine, *H. irregulare* would cause premature death of trees, reduction of growth rate, reduced wood quality. If *H. irregulare* attacks spruce in the EPPO region, mortality would be lower than in pine but the amount of damage to wood through rot would be more significant. In Europe, incidence and losses caused by *H. annosum* s.l. are generally high. In the United Kingdom, incidence of decay was as high as 68% in Sitka spruce, with a loss in value of 43%. Disease incidence of Norway spruce in alpine forests can locally be as high as 71%, with derived financial losses estimated between 18% and 34% (Garbelotto and Gonthier, 2013).
- Given the higher saprophytic ability (approximately a 5 times greater volume of wood is colonized by *H. irregulare* than by*H. annosum* s.s. on *P. sylvestris*) and sporulation of *H. irregulare*, there may be a higher transmission potential resulting in more disease centers, higher disease incidence and severity compared to *H. annosum* s.s.
- *Indirect loss of fruit*: effect on nut production is not reported in the USA (where there is no major production), but may be important in the EPPO region, where pine nuts are produced in particular from *P. pinea* and *P. sibirica* (=*P. cembra* subsp. *sibirica*, not yet known to be a host). *H. irregulare* may affect nut production by loss of trees. Five EPPO countries account for 20% of the world production in 2013: Russia (1000 metric tonnes), Spain (375), Portugal (275), Turkey (225), Italy (175) (Pakistan, China and Korea Rep. representing 78% of the production. Russia was considered as the third exporter worldwide in 2012 and Turkey in 2011) (but for only 5% and 9% respectively of worldwide exports, far behind China and Korea Rep.). Tunisia is also a producer (CIHEAM, 2011) and probably other countries around the Mediterranean Basin. A decline of *P. pinea* nut production in Italy has already been observed since the mid-2000s (due to *Leptoglossus occidentalis*) (Bracalini et al., 2013).
- *Loss of urban, landscape and garden trees*: decline and death of pine trees in parks, gardens and cities may occur. Dead trees would need to be removed, destroyed and replaced. Any containment plans would also require removal of some trees surrounding the infected trees.
- *Increase in production costs:* treatment or handling of wood will entail additional costs, as well as operations related to windthrown trees. Similar costs are already incurred by *H. annosum* s.s., but the species have a slightly different host range.
- *Impact on internal and external markets:* The presence of *H. irregulare* may have an impact on internal markets and on exports if it is declared a quarantine pest.

Environmental impact. Although *H. irregulare* is likely to affect more plantations, it may have an impact on hosts in the natural environment (e.g. sensitive environments, mountains, “protection” forests) and affect these important ecosystems.

There are many native *Pinus* and *Juniperus* species in the EPPO region, with limited distribution. *H. irregulare* may have impact on ecologically important species. Its ability to attack Juniperus and Ericaceae hosts may have severe ecological impact in heathlands throughout the EPPO region. There are also many endemic *Pinus* species in the Mediterranean area, which are currently not impacted by *H. annosum*, and may be more affected if *H. irregulare* establishes in these areas. Some endemic species, such as *Betula aetnensis,* are affected by *H. annosum* s.s. and may be further damaged by *H. irregulare*.

There may be damage in sensitive ecosystems, e.g. erosion in mountains where pine or spruce are used for protection forests and impact on Mediterranean maquis, ecosystems where pine and juniper are used for stabilizing dunes.

Gaps in monospecific forests will increase the structure diversity and biodiversity. However in some cases, there will be more ruderal species establishing in the gaps, including invasive plants.

Social impact. There may be effects on the pine nut industry. The recreational value of forests will be affected by death of trees. In cities, pine trees may have to be removed and replaced. This will affect the historical heritage of some sites (e.g. pine trees in historical and archeological sites in Rome and its area). Pines are also important in that area to provide shade (villas), and in some cases are essential to certain commercial activities (e.g. campsites). Trees of cultural significance and monumental trees may be affected, as well as individual trees that are symbols to a site (e.g. Italian stone pines as symbolic landmarks of the Mediterranean coast). If *H. irregulare* spreads to areas of timber production, social impact on the forestry industry may occur.

Costs likely to be incurred by the introduction of *H. irregulare* (other than direct costs linked to the impacts above)

- General costs: surveillance and monitoring, containment efforts (note: eradication was considered feasible only in very limited circumstances throughout this PRA – see section 16 of this PRA).
- Sanitation practices, phytosanitary measures for export.
- Costs of changing the tree species in infested areas, costs of removal, disposal and replacement of trees, obligation to reforest infected areas.
- Costs for research: some topics are identified in section 18.

14. Identification of the endangered area

H. irregulare has the potential to establish throughout the EPPO region where *Pinus* occurs, possibly up to the northern distribution border of *H. annosum* s.s. (62°N in Sweden). It is likely to be damaging on *P. pinea* throughout the Mediterranean and to add to the impact by *H. annosum* s.s. on other hosts throughout the PRA area.

15. Overall assessment of risk

The entry section (section 8) identified natural spread from the infested area in Italy and untreated wood packaging material as the pathways with the highest probability of entry (moderate-high). Entry on wood of conifer host species (with the higher likelihood of association) and particle wood of conifers and waste wood was rated as moderate/low. Although plants for planting were assessed with a low risk, they may be traded as large ornamental, which would present an increased risk. Bark of conifer hosts was rated with a low probability of entry. Christmas trees and wood of *Quercus*, *Prunus serotina*, *Arbutus menziesii* and *Arctostaphylos* spp. were rated with low/very low. Deciduous particle wood and bark, agglomerated particle wood and waste wood and treated wood packaging material were considered as unlikely pathways.

The risk of entry from outside the EPPO region is not high, while the risk of entry from natural spread from the infested area is higher. However, natural spread is currently constrained by a lack of suitable host around the zone of infestation. Entry into another EPPO country through natural spread may happen in the order of one to few decades in the absence of efficient containment measures.

Although the life cycles of *H. irregulare* and *H. annosum* s.s. are quite similar, there are major differences that would influence the impact from *H. irregulare*. *H. irregulare* has a much higher fruiting and saprobic ability, resulting in a much higher transmission potential. The fruiting ability leads to higher spore production, which results in higher rates of primary infection. The saprobic ability will lead to a higher inoculum potential in the secondary spread of the disease, thus possibly a higher rate of spread through root contacts. In addition, hybridization occurs between *H. irregulare* and *H. annosum* s.s. and there is a risk for increased virulence and different host range (possibly of the two species) in the long-term through introgression. All pine trees of the EPPO region may be at risk in the long term. Damage in the long-term could be substantial throughout the EPPO region, and significantly increased compared to that of European *Heterobasidion* species.

Considering the assessment of the probability of establishment and of potential impacts in the PRA area, the EWG supported that entry of *H. irregulare* into the EPPO region should be prevented and its spread contained. It also considered important to prevent further introductions of *H. irregulare* of different provenances in North America. In particular preventing introduction from Western North America would prevent introduction of genotypes of *H. irregulare* that are genetically distinct due to their long-term isolation. Preventing introduction from Western North America would also reduce the risk of introduction of the other North American species *H. occidentale*.

Finally, the second North American species, *H. occidentale*, has a similar biology with partially overlapping hosts. The hosts of *H. occidentale* are especially in the genera *Abies*, *Picea*, *Pseudotsuga*, *Tsuga* and *Sequoiadendron*. Given the importance of *Abies* and *Picea*, as well as *Pseudotsuga* (introduced), in the EPPO region, similar measures may be considered to prevent its introduction. However, this species is not fully documented in this PRA. The critical elements to be documented would be a detailed host list, as well as its distribution and the suitability of climatic conditions in the PRA area (considering that *H. occidentale* in North America occurs in a more restricted area area than *H. irregulare*). The biology and damage are similar. Pathways would be similar, but for different host species. Hosts and distribution are subject to similar uncertainties as *H. irregulare* (especially the fact that it is not clear which tree species are affected by *H. irregulare* in the Caribbean and Central America). Applying the measures defined for *H. irregulare* for wood and plants to relevant conifer genera (which may also be justified for *H. irregulare* due to uncertainties relating to its host range, which also includes uncertain hosts in the genera *Abies*, *Pseudotsuga* and *Tsuga*) would also help preventing the introduction of *H. occidentale*.

Stage 3. Pest risk management

16. Phytosanitary measures

Risk management options were determined for the import of wood (round or sawn, including firewood) of conifer host species, conifer particle wood and waste wood, and plants for planting of host species (16.1 and details in Annex 8). For wood packaging material, treatment according to ISPM 15 would reduce the risk, and risk management was not studied in details. Measures for bark, Christmas trees and wood of *Quercus*, *Prunus serotina*, *Arbutus menziesii* and *Artostaphylos* spp. were not studied in details, but similar measures could be used as for, respectively, particle wood, plants for planting and conifer wood (see table in 16.1). The risk of entry associated with the other pathways identified in section 8 is very low, and measures were not considered necessary.

Containment measures to slow the spread of *H. irregulare* in the EPPO region are described under 16.2. The EWG recommended that such containment measures should be taken in Italy, and this was agreed by the Panel on Phytosanitary Measures. Italy is the only country where the pathogen is present in the EPPO region. The pathogen is present in a limited area, which is favourable for containment because there is not a continuum of suitable forest. It is still possible to slow down and possibly even stop the spread of this pathogen and avoid its introduction into other EPPO countries. The EWG noted that, in the long term, any further spread of the pathogen would potentially have significant impact on European forests and trees.

16.1 Measures identified at import

The table below gives details on measures recommended for the various pathways. Additional details can be found in Annex 8, which presents the full consideration of measures according to the EPPO PRA scheme 5/3. The EWG recommended that phytosanitary measures be applied especially from North America and from the infested area in Italy.

The EWG recommended that measures for wood be applied to all coniferous hosts of *H. irregulare*, considering the remaining uncertainties on the importance of hosts. In addition, covering all hosts of *H. irregulare* would allow targeting some major hosts of *H. occidentale* including *Pseudotsuga menziensi*.

Measures identified for individual pathways (additional details in Annex 8)

PC: Phytosanitary certificate

Pathway	Estimated probability of entry *(with uncertainty)*	Existing regulation	Measures
Natural spread (from Italy)	Moderate-high, although slow *(moderate)*	No	Containment programme (see details in 16.2)
Untreated wood packaging material	Moderate-high *(moderate)*	Not fully	Treatment according to ISPM 15
Round wood (incl. firewood) and sawn wood of conifer host species - with higher likelihood of association from North America - from the infested area in Italy - with lower likelihood of association from North America	Moderate/low *(low)* Moderate/low *(high)* Low/very low *(low)*	No	PC and -Pest Free Area (PFA)[1] officially recognized by the importing country or -Heat treatment (for at least 56°C for at least 30 min, measured at the core[2])
Particle wood of conifers and waste wood (not agglomerated)	Moderate/low *(moderate)*	Not fully	PC and -PFA[1] officially recognized by the importing country or -Heat treatment (for at least 56°C for at least 30 min. applied throughout the profile of the material[2])
Bark of conifer and deciduous host species	Low *(high)*	Not fully	If needed, measures could be similar to those for particle wood and waste wood
Plants for planting (except seeds) of host species	Low *(high)*	Not fully (but prohibited by some countries)	PC and -PFA [1] officially recognized by the importing country or -Grown under complete physical protection throughout their life with sufficient measures to exclude the pest + transported in conditions preventing infestation[3] or -Systems approach[4] (on the basis of bilateral agreement): Plants younger than 5 years + grown in pots in sterilized substrate + wounds should be avoided + at least 20 km from the closest infestation (or, if the proposed containment plan is applied, at least 10 km from the demarcated infested area) + intensive monitoring in the space between the nursery and the closest infestation
Christmas trees of host species	Low/very low *(moderate)*	Not fully (but prohibited by some countries)	If needed, measures could be similar to those for plants for planting
Wood of *Quercus*, *Prunus serotina*, *Arbutus menziesii*, *Artostaphylos* spp.	Low/very low *(high)*	Not fully	Measures could be similar to wood of conifers, and may be needed especially for firewood

Pathway	Estimated probability of entry *(with uncertainty)*	Existing regulation	Measures
Deciduous particle wood	Very low *(low)*	Not fully	Measures not needed
Bark of deciduous host species	Very low *(low)*	Not fully	Measures not needed
Wood packaging material treated by ISPM 15	Very low *(low)*	Yes	Already covered by ISPM 15
Particle wood and waste wood (agglomerated)	Very low *(low)*	No	Measures not needed

Notes on measures:

1. **PFA.** The PFA should be officially recognized by the importing country. In order to establish and maintain a PFA, the following elements should be fulfilled:

- Area isolated by appropriate physical barriers (e.g. absence of hosts or sufficient distance) or minimum distance from the limits of infested areas. Such distance could be 100 km based on current knowledge and models of the spread of spores. The distance of 80 km reflects the spore spread that has happened in the infested area of Italy over about 70 years after its introduction in an area with no continuity of *Pinus* sp. However, there is a need to take into account the possible spread of spores at longer distances, and the EWG proposed that 100 km (increasing as a precautionary approach by circa 20% the length of the buffer zone around an infested area) provides a sufficient precautionary distance to cover for such long-distance spread. *Following a request of the EPPO Working Party on Phytosanitary Regulations, an EPPO Expert Working Group considered in 2020 a scenario of long-distance spread. Outputs of this Expert Knowledge Elicitation (EKE) may help inform decision making by an NPPO about the size of buffer zone required for the establishment of a PFA. The EKE was performed considering a cluster of infected trees, in a homogeneous forest of host trees, the distance being measured after formation of a first fruiting body during the following year. The exercise excluded any human assisted spread. The combined events enabling long distance dispersal include several periods of rain with a moderate ambient temperature, stormy winds, and numerous disturbed forest sites. The experts judged that 1% of the infection events within a year would occur during such conditions of long-distance dispersal. Based on a review of the evidence, experts judged that 1% of the infections will occur after one year at a distance of approximately 11 km (best estimate of the median value), with a 90% uncertainty range from 2 to 32 km. Report of the EKE exercise is made available at https://upload.eppo.int/download/933o02d521b6b*
- A monitoring programme based on visual examination (symptoms on trees, fruiting bodies) and spore trapping in areas where hosts are present. This would require appropriate identification capabilities to avoid misidentifications. Such surveillance should last for at least 3 years, and should be conducted during the period when spore release is the most abundant for the area considered. The density of trap should be high to detect very low population levels.
- Incubation of a cross-section from the top of the stumps after felling at a suitable frequency.
- Measures should be put in place to prevent the entry of the pest into the PFA, i.e requirements on commodities.
- Measures should be taken to avoid infestation of the wood when it is transported outside of the PFA. This is especially important for green wood.

PFA in EPPO PRAs is considered both for countries where the pest occurs and where the pest does not occur ("country freedom"). Due to the limited distribution, the EWG noted that the PFA requirement could be recommended for North America, Italy, the Caribbean, and possibly Central America, but not to countries from other continents.

2. **Schedule for heat treatment.** There is no indication of an effective heat treatment schedules for *H. irregulare* on wood. However, mycelium and spores are reported to be killed at 40°C for 1 h and Allen (2014) indicates a maximum survival temperature for 30 minutes of 46°C for *H. annosum* (the original study is not known; E. Allen coordinates the work of the IFQRG, which looks into issues linked with the efficacy of treatments for ISPM 15). It is likely that the 'common' schedule for heat treatment for wood (core temperature of at least 56°C for 30 min) (incl. in EPPO Standard PM 10/6(1) *Heat treatment of wood to control insects and wood-borne nematodes*) will kill the pest. The same schedule is expected to also be effective for particle wood and waste wood, if applied throughout the profile of the material.

3. **Growing under complete physical protection** is not practical and cost-effective for most plants, with the exception of high value plants (e.g. bonsais). '**Transported in conditions preventing infestation'.** The EWG had recommended that this be added to the systems approach. However, the Panel on Phytosanitary Measures noted that it was more relevant in association with growing under physical isolation (which may happen in an infested area), than for the systems approach (in which plants are younger than 5 year, therefore less likely to be infested, and grown at least 20 km from the closest infestation).

4. **Systems approach**. All plant sizes may be infested. However, provided root infection is prevented, it is considered that spore contamination of young plants at long distance is less likely. For plants younger than 5 years, it is considered that if the other conditions are met, a distance of 20 km from the closest infestation would be sufficient to reduce the risk of spore infestation.

16.2 Eradication and containment in the EPPO region

The EWG agreed with the opinion in Gonthier et al. (2014a) that eradication of *H. irregulare* from the infested area in Italy is not a realistic option given the size of the infested area, the incidence of the disease in individual sites and its presence in roots and wood in the soil. Eradication may be possible only locally, in the presence of small and isolated foci of confirmed *H. irregulare*. This would require removal of the infested tree and surrounding trees within a sufficient radius. This approach may be successful if the fungus is detected early (i.e. before or at early stages of fruiting body production).

Containment would minimize the spread and reduce infection rates in the infested area. Gonthier et al. (2014a) describe a possible containment programme covering an infested area (zone of infestation) and a buffer zone, taking account of:

(1) the ability of *H. irregulare* to establish itself as a saprobe on hosts;
(2) the range of effective dispersal (10 km) of airborne *H. irregulare* spores;
(3) the presumed distance (80 km) at which effective dispersal of *H. irregulare* is minimized;
(4) because the fungus can remain viable for long periods in wood (Gonthier et al., 2004; Garbelotto and Gonthier, 2013; Garbelotto et al., 2013), the need for measures to ensure that wood from the infested area is treated before transport or left on site.

The EWG reviewed the containment programme and made it more general for the EPPO region[1].

Delimitation of an infested area and buffer zone

- The infested area should be defined to extend 10 km beyond known infestations. Stands that include hosts in the infested area are subject to specific measures (see below).
- The buffer zone should extend 80 km beyond the infested area. All host stands are subject to specific measures (see below).
- The infested area and buffer zone should be redefined promptly as soon as *H. irregulare* is detected in new sites.

Remark: It should be noted that the 80 km proposed in Gonthier (2014) is based on the size of the outbreak area in Italy reached after about 70 years of spread in an area with no continuty of *Pinus* sp.. Output of the EKE performed in 2020 may help inform decision making by an NPPO to adapt the size of buffer zone required for a specific outbreak (see Section 16.1).

Mandatory measures in both the infested area and the buffer zone

- Treatment of stump surfaces immediately after felling. For conifers, *Phlebiopsis gigantea* or urea at 30% concentration may be used[2]. *Phlebiopsis gigantea* is not expected to be effective on angiosperms, and the efficacy of urea is not known (however, as the control mechanism of urease is pH increase on the substrate, this treatment may be effective on angiosperms as well).
- Thinning and felling operations conducted at times when spore production is the lowest, e.g. hottest months in the Mediterranean area, winter for other areas. In Italy, although sporulation appears to be constant throughout the year, it may be beneficial to fell trees during the hottest months, as it is routinely done to control *H. irregulare* in pine plantations of the southern USA (lower incidence of primary infection).
- Avoidance of logging injuries, which may also reduce the risk of infection by other root rot pathogens.

Mandatory measures in the infested area

- Green logs and untreated timber of hosts must not be moved outside of the infested area. The same restrictions must be applied for firewood and other wood products made of untreated hosts

Strongly recommended measures only in the infested area

- Uprooting of stumps, left to dry or subject to grinding. The EWG considered that this would be a very effective measure to eliminate a major source of spore production, but recognized that this may not be possible in all circumstances.
- Use of less susceptible tree species in reforestation, afforestation or restoration projects

[1] Standard PM 9/28 *Heterobasidion irregulare: procedures for official control* has been approved in 2019 and recommends more detailed procedures to be implemented to eradicate or contain the pest.

[2] Borates, used in the USA, are not approved in the EU for use as stump treatments (sodium tetraborate decahydrate (borax) and disodium octoborate tetrahydrate (DOT)) http://ec.europa.eu/sanco_pesticides/public/?event=activesubstance.detail

Mandatory measures only in the buffer zone

- Sanitation and local eradication. Any tree found to be infected by *H. irregulare* in the buffer zone should be felled as soon as possible and their stumps removed, including all roots of a diameter above 5 cm. As well as host trees within 10 m of the infested tree (assuming early detection and average growth rates of the pathogen in root systems, with precautionary margin). Requirements on handling of infected logging residues and on the movement of wood and wood products should be applied

Handling of infected logging residues

- After sanitation felling, logs should be debarked and propped up to avoid contact with soil to reduce the risk of formation of *H. irregulare* fruiting bodies.
- Destruction of the infested wood or chips in the infested area, or use in a processing facility provided the material is transported in sealed containers.

Monitoring

Intensive monitoring should be implemented in the buffer zone in host stands, and wherever the presence of *H. irregulare* is suspected. Monitoring can be performed using spore trapping methods (wood disk or Burkhard spore sampler) followed by PCR to distinguish between *H. irregulare* and *H. annosum* (e.g. Gonthier et al., 2007). If systematic spore sampling is performed, traps may be placed every 1 km within host stands. Monitoring efforts could be limited to when the concentration of *Heterobasidion* spores in the air is highest (Garbelotto et al., 2010), and detection more likely. Monitoring programs should be performed periodically (every 1 or 2 years). When suspicious symptoms are observed, one should inspect for the presence of fruiting bodies or wood sample be removed and properly analysed (see EPPO Datasheet).

17. Uncertainty

The main uncertainties in this PRA are as follows:

- *Heterobasidion* species present in the rest of the Americas (especially Caribbean, Central America, Brazil), and their exact distribution.
- Hosts. To what extent species in the EPPO region may be attacked by *H. irregulare* (for example *Pinus sylvestris* and *Picea abies*, but also species not yet identified as hosts such as *P. sibirica* (*P. cembra* var. *sibirica*), *P. nigra*, *Juniperus oxycedrus* etc.)
- *Quercus*: Is *Quercus* a host, and if so is *H. irregulare* a saprobe or pathogenic? Efficacy of stump treatment products (urea and others on *Quercus*)?
- Is the saprophytic capacity of *H. irregulare* and hybrids of *H. irregulare* x *H. annosum* s.s. on conifers others than *Pinus*, and on *Quercus* higher than that of *H. annosum* s.s.
- Pathways. Possibility that plants for planting act as pathway, and whether there is a trade.
- Risk of spore infection on stumps at different seasons in different areas of Europe.
- Impact. How *H. irregulare* would interact with European species of *H. annosum* s.l.? Effects of hybridization (on both *H. irregulare* and *H. annosum* s.s.)?
- In pest risk management: possibility to use heat treatment on plants for planting.

18. Remarks

H. irregulare presents the case of an unusual pathway of introduction in the EPPO region, but this PRA shows that trade pathways also exist. Attention should be paid to the need for measures in Italy to contain the pest. Although natural spread will occur, it will be slow, and there is still a possibility to contain the pest in the current area of infestation, before it spreads to areas with more continuous presence of pines.

Research is needed in the following fields:

- Susceptibility of the main conifer and oak species to *H. irregulare* and to hybrids between *H. irregulare* and *H. annosum s.s.*;
- Presence and ecology of *H. irregulare* on oak stands: pathogenicity vs. saprotrophism, way of infection/establishment, sites of development of fruiting bodies;
- Effectiveness of urea and/or other treatments against *Heterobasidion* on oak stumps;
- Saprobic ability of *H. irregulare* and hybrids between *H. irregulare* and *H. annosum s.s.* on wood of the main European conifer and oak species;
- Use of mild heat treatments to kill *H. irregulare* on plants for planting.
- Studies on spore dispersal.
- Rapid diagnostic methods.

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ANNEX 1- Host list for *H. irregulare*

Tables 1 and 2 list conifer and deciduous hosts of *H. irregulare*. In each table:

- The first part lists hosts mentioned in the literature in relation to *H. irregulare* or the North American "P group" of *H. annosum* (i.e. positively confirmed for *H. irregulare*).
- The second part lists hosts in earlier records for *H. annosum* in North America, but which may be *H. irregulare* because the records refer to: Eastern North America; or *Pinus* and *Juniperus* spp. (even from Western North America); or angiosperms (even from Western North America) (see section 6 of the PRA for further explanation). These records were extracted from:
  - Farr and Rossman (2014) in relation to the distribution of *H. annosum, Fomes annosum*, *Fomitopsis annosa* (as specified in the tables).
  - Grand and Vernia (2007) for hosts records for *H. annosum* in North Carolina.
  - Filip and Morrison (1998) for species mentioned in relation to *H. annosum* for USA and Canada, without positive statement about being identified in relation to the North American "P group".
- When there is information on whether *H. irregulare* is pathogenic or a saprobe, this is indicated (this information is not always available).
- Major forestry species in the EPPO region are in bold (see section 9.1 for details on hosts in the PRA area). The column "Presence in the PRA area" records known forestry species. It is assumed that all other hosts may be used in the PRA area as ornamentals, as this is frequently the case for tree species.

Table 1. Conifers: Confirmed hosts and earlier records

Host	In PRA area as forestry species?	Comments	*Reference*
Confirmed hosts: relate to *H. irregulare* or North American "P group" of *H. annosum*			
Abies balsamea (balsam fir)		Pathogenic	Dumas and Laflamme, 2013; Wisconsin DNR, 2014
Calocedrus decurrens (syn. *Libocedrus decurrens*, incense cedar)	Yes	Pathogenic *In EPPO region: timber production, ornamental?*	Garbelotto and Gonthier, 2013; US Forest Service, ND
Juniperus occidentalis (western juniper)		Pathogenic	Filip and Morrison, 1998; Otrosina and Garbelotto, 2010; US Forest Service, ND
Juniperus spp.			Garbelotto and Gonthier, 2013
Juniperus virginiana (eastern red cedar)		Pathogenic	Filip and Morrison, 1998; Scirè et al. 2011; Wisconsin DNR, 2014; Grand and Vernia, 2007
Larix lyallii (alpine larch)		Host of a hybrid of *H. irregulare* and *H. occidentale*. *H. irregulare* found on *L. lyallii* in 2015 (unpublished)	Lockman et al., 2014 (hybrid); M. Garbelotto, University of California, 2015-01, pers. comm. (*H. irregulare*)
Larix occidentalis (Western larch)			M. Garbelotto, University of California, 2014-12, personal communication
***Picea abies* (Norway spruce)**	**Yes**	**Pathogenic. Susceptibility demonstrated in inoculation studies** ***EPPO region: wild, timber production***	**Lind et al., 2007**
Picea glauca (Canadian spruce, white spruce)		See uncertainties below the table	Juzwik et al., ND; Wisconsin DNR, 2014
Picea sitchensis (sitka spruce)	Yes	Laboratory inoculations suggest *Picea sitchensis* is a possible host but reports from nature are sparse *In EPPO region: timber production, ornamental?*	M. Garbelotto, University of California, 2014-12, pers. comm.
Pinus banksiana (jack pine)	Yes	Pathogenic *In EPPO: timber production*	Filip and Morrison, 1998; Wisconsin DNR, 2014; Dumas and Laflamme, 2013, Laflamme, 2011

Host	In PRA area as forestry species?	Comments	*Reference*
Pinus brutia **(Turkish pine)**	**Yes**	**Pathogenic. In an arboretum in California (Bega, 1962), later shown to be *H. irregulare*.** ***EPPO region: wild, timber production***	**Scirè et al., 2008 citing Bega, 1962; M. Garbelotto, personal communication**
Pinus cembroides var. *monophylla*		Pathogenic. "P group" in interior Western USA	Filip and Morrison, 1998;
Pinus coulteri (Coulter pine)		Pathogenic. "P group" in interior Western USA	Filip and Morrison, 1998, US Forest Service, ND
Pinus edulis (pinyon)		Pathogenic	US Forest Service, ND
Pinus elliottii (slash pine)		Pathogenic	Filip and Morrison, 1998; Garbelotto and Gonthier, 2013;
Pinus halepensis **(Aleppo pine, Jerusalem pine)**	**Yes**	**Pathogenic. Attacked in Italy.** ***In EPPO region: ornamental, wild, timber production?***	**Scirè et al., 2008, 2010**
Pinus jeffreyi (Jeffrey pine)		Pathogenic	Filip and Morrison, 1998; Garbelotto and Gonthier, 2013; US Forest Service, ND
Pinus lambertiana (sugar pine)		Pathogenic	US Forest Service, ND
Pinus pinaster **(maritime pine)**	**Yes**	**Pathogenic in inoculation trials. Also observed in an arboretum in California, later shown to be *H. irregulare*.** ***In EPPO region: timber production, ornamental, wild***	**Scirè et al., 2008 citing Bega, 1962; Lung-Escarmant et al., 2012; M. Garbelotto, personal communication**
Pinus pinea **(stone pine, umbrella pine)**	**Yes**	**Pathogenic. Main species attacked in Italy.** ***In EPPO region: ornamental, wild, fruit***	**Gonthier et al., 2004; D'Amico et al., 2007 ; Scirè et al., 2010**
Pinus ponderosa (ponderosa pine)		Pathogenic	Filip and Morrison, 1998;Otrosina and Garbelotto, 2010; Dalman et al., 2010
Pinus radiata (Monterey pine)	Yes	Pathogenic *In EPPO region: ornamentals?, timber production. Among the most used non-native species in Europe*	Filip and Morrison, 1998;Garbelotto and Gonthier, 2013
Pinus resinosa (red pine)		Pathogenic	Filip and Morrison, 1998; Garbelotto and Gonthier, 2013, Dumas and Laflamme, 2013, Wisconsin DNR, 2014; Dalman et al., 2010
Pinus strobus (white pine)	Yes	Pathogenic *In EPPO region: timber production, considered naturalized in places.*	Filip and Morrison, 1998; Dumas and Laflamme, 2013
Pinus sylvestris **(Scot pine)**	**Yes**	**Pathogenic in inoculation experiments. Also record of *H. annosum* in Eastern USA.** ***In EPPO region: timber production, wild, ornamental***	**Garbelotto et al., 2010; Farr and Rossman, 2014**
Pinus taeda (loblolly pine)	Yes	Pathogenic *In EPPO region: ornamental?, timber production.*	Filip and Morrison, 1998; Otrosina and Garbelotto, 2010
Pseudotsuga menziesii (Douglas fir)	Yes	Pathogenic *In EPPO region: ornamental?, timber production. Among most used non-native species in Europe*	Garbelotto and Gonthier, 2013
Thuja plicata (Western red cedar)		Pathogenic. North American species	Hammett, 2014

Host	In PRA area as forestry species?	Comments	*Reference*
Earlier records of *H. annosum/F. annosus/F. annosa*: from Eastern North America, or *Pinus/Juniperus* from Western USA, or angiosperms			
Abies fraseri		Record from Eastern USA (*H. annosum*, *F. annosus*)	Farr and Rossman, 2014; Grand and Vernia, 2007
Chamaecyparis thyoides		Pathogenic. Record from Eastern USA (*H. annosum, F. annosus*)	Filip and Morrison, 1998; Grand and Vernia, 2007; Farr and Rossman, 2014
Juniperus communis		Record from USA (no details) (*F. annosus*), but Juniperus	Farr and Rossman, 2014
Juniperus conferta		Record from Eastern USA (*H. annosum, F. annosus*)	Farr and Rossman, 2014
Juniperus osteosperma		Record from Western USA (*F. annosus*), but Juniperus	Farr and Rossman, 2014
Larix laricina		Pathogenic. Record of *H. annosum* in SE Canada/NE USA	Filip and Morrison, 1998
Picea rubens		Record from Eastern USA (*F. annosus*, *F. annosa*)	Farr and Rossman, 2014
Pinus albicaulis		Record from Western USA (*F. annosus*), but Pinus	Farr and Rossman, 2014
Pinus clausa		Record from Eastern USA (*H. annosum*)	Farr and Rossman, 2014
Pinus contorta	Yes	Record from Western USA (*H. annosum, F. annosus*), but *Pinus* *In EPPO region: ornamentals? Timber production. Among the most used non-native species in Europe*	Farr and Rossman, 2014
Pinus echinata		Pathogenic. Records from Eastern USA (*H. annosum*, *F. annosus*)	Filip and Morrison, 1998; Farr and Rossman, 2014; Grand and Vernia, 2007
Pinus engelmannii		Record from Western USA (*F. annosus*), but Pinus	Farr and Rossman, 2014
Pinus monticola		Record from Western USA (*F. annosus*), but Pinus	Farr and Rossman, 2014
Pinus occidentale		Record for Dominican Republic	Farr and Rossman, 2014
Pinus palustris		Pathogenic. Record of *H. annosum* in SE USA	Filip and Morrison, 1998
Pinus patula		Record from Western USA (*H. annosum, F. annosus*), but Pinus	Farr and Rossman, 2014
Pinus rigida		Pathogenic. Record from Eastern USA (*H. annosum, F. annosus*)	Filip and Morrison, 1998; Grand and Vernia, 2007; Farr and Rossman, 2014
Pinus virginiana		Record from Eastern USA (*H. annosum, F. annosus*)	Grand and Vernia, 2007; Farr and Rossman, 2014
Thuja occidentalis		Pathogenic. Record of *H. annosum* in SE Canada/NE USA (*H. annosum*, *F. annosus*)	Filip and Morrison, 1998; Farr and Rossman, 2014
Tsuga canadensis		Pathogenic Record of *H. annosum* in SE Canada/NE USA (*H. annosum*, *F. annosus*)	Filip and Morrison, 1998; Farr and Rossman, 2014

Table 2. Deciduous hosts: confirmed and earlier records

Host	Presence in PRA area as forestry species	Comments	*Reference*
Confirmed: relate to *H. irregulare* or P group of *H. annosum*			
Arbutus menziesii (Pacific madrone)			M. Garbelotto, personal communication
Arctostaphylos manzanita (manzanita)		Pathogenic. Mentioned as always P group of *H. annosum* in California on this species	US Forest Service, ND
***Erica arborea* (Mediterranean heath)**		**Saprobe. Found on stumps in Italy.** ***In EPPO region: wild, ornamental***	**Gonthier, 2006 cited in Gonthier et al. (2014a)**
Quercus alba (white oak)			Wisconsin DNR, 2014; Farr and Rossman, 2014
Quercus rubra (red oak)	Yes	Pathogenic? Understorey infections *In EPPO region: timber production*	Wisconsin DNR, 2014
Prunus serotina (black cherry)	Yes	Pathogenic? Understorey infections *In EPPO region, timber production (also invasive)*	Wisconsin DNR, 2014
Rhamnus (buckthorn)		Pathogenic? Understorey infections. Mentioned as "buckthorn", no species indicated	Wisconsin DNR, 2014
Earlier records of *H. annosum/F. annosus/F. annosa*: from Eastern North America, or *Pinus*/*Juniperus* from Western USA, or angiosperms			
Acer macrophyllum		Record from Western North America and Canada, but angiosperm (*H. annosum*, *F. annosus*)	Farr and Rossman, 2014
Acer rubrum		Record from Eastern USA (H. annosum)	Farr and Rossman, 2014
Alnus incana		Record from Western North America (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Alnus rubra		Record from Canada (no details) (*H. annosum*, *F. annosus*), angiosperm	Farr and Rossman, 2014
Arctostaphylos spp.		Record from Western North America (H. annosum), but angiosperm	Farr and Rossman, 2014
Arctostaphylos viscida		Record from Western North America (*H. annosum*, *F. annosus*), but angiosperm	Farr and Rossman, 2014
Artemisia tridentata		Record from Western North America (*H. annosum*, *F. annosus*), but angiosperm	Farr and Rossman, 2014
Camellia		Record from Eastern USA (H. annosum)	Grand and Vernia, 2007
Camellia sasanqua		Record from Eastern USA (F. annosus)	Farr and Rossman, 2014
Carya sp.		Record from Eastern USA (F. annosus)	Farr and Rossman, 2014
Castanea dentata		Record from Eastern USA (F. annosus)	Farr and Rossman, 2014
Cercocarpus sp.		Record from Western North America (F. annosus), but angiosperm	Farr and Rossman, 2014
Diospyros virginiana		Record from Eastern USA (F. annosus)	Farr and Rossman, 2014
Fraxinus Americana		Record from Canada (no details) (H. annosum), but angiosperm	Farr and Rossman, 2014
Kalmia latifolia		Record from Eastern USA (F. annosus)	Farr and Rossman, 2014

Host	Presence in PRA area as forestry species	Comments	*Reference*
Lonicera sp.		Record from Western North America (F. annosus), but angiosperm	Farr and Rossman, 2014
Paxistima myrsinites		Record from Western North America (F. annosus), but angiosperm	Farr and Rossman, 2014
Populus sp.	Yes	Record from Western North America (F. annosus), but angiosperm	Farr and Rossman, 2014
Populus tacamahacca		Record from Western North America (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Populus trichocarpa		Record from Western North America (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Prunus armeniaca		Record from Western North America (*H. annosum*), but angiosperm	Farr and Rossman, 2014
Prunus sp.		Record from Eastern USA (F. annosus)	Farr and Rossman, 2014
Purshia tridentata		Record from Western North America (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Pyrus angustifolia		Record from Eastern USA (*F. annosus*)	Farr and Rossman, 2014
Quercus agrifolia		Record from Western North America (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Quercus gambelii		Record from Western North America (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Quercus montana		Record from Eastern USA (*F. annosus*)	Farr and Rossman, 2014
Rhododendron maximum		Record from Eastern USA (*F. annosus*)	Farr and Rossman, 2014
Rhododendron ponticum		Record from North America (no details) (*F. annosus*), but angiosperm	Farr and Rossman, 2014
Rhododendron spp.		Record from Eastern USA (*H. annosum*, *F. annosus*)	Grand and Verna, 2007; Farr and Rossman, 2014

ANNEX 2. Phytosanitary import requirements of EPPO countries in relation to hosts species

Sources:

- EU Directives
- EPPO collection of summaries of phytosanitary regulations, for non-EU countries, 1999 to 2003 depending on countries.
- Texts of regulations posterior to the EPPO summaries for Israel (2009), Norway (2010), Serbia (2010), Turkey (2007).

✓ indicate when the requirement would imply a measure for the commodity from the USA, Canada, Mexico or other countries where *H. irregulare* occurs.

✗ indicate when the requirement would not specifically apply to that commodity from these countries (i.e. would not have any effect), in particular because the pest targeted by the requirement does not occur in a country where H. irregulare occurs

? indicate an uncertainty (whether the pest covered by the requirement occurs in countries where *H. irregulare* occurs, or whether the requirements would apply to the commodity from countries where *H. irregulare* occurs).

Several markings indicate pests that occur in different countries according to PQR (EPPO, 2014), i.e. if there are requirements from where the pest occurs, they will apply to these countries. Cuba and the Dominican Republic were not taken into account here as no trade was recorded or it is less likely.

* occur in the USA, Canada and Mexico

** occur in the USA and Canada (not Mexico)

*** occur in Canada (not USA nor Mexico)

occur in USA (not Canada nor Mexico).

Mexico and USA (not Canada).

<u>Warning</u>: tables for non-EU countries were developed based on EPPO summaries of phytosanitary regulations (prepared between 1999 and 2003), and for a few countries for regulations (years indicated above). Regulations may have changed in the meantime, but this is only used as an indication of the measures in place.

Table 1. Wood of host species from countries where *H. irregulare* occurs

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	General and specific requirements
Albania		✓ All non-squared or squared wood: import permit, PC
Algeria		✓ All non-squared or squared wood: PC ✓ all non-squared and squared wood free from Bursaphelenchus xylophilus* ✓ Non-squared wood with bark. Free from Dendroctonus and Ips
Belarus		✓ All non-squared or squared wood: import permit, PC
EU, Serbia		✓ Wood of conifers (Coniferales), except that of *Thuja* L. (other than wood chips, wood waste etc., wood packaging material, dunnage, wood ofLibocedrus decurrens processed or manufactured for pencils using heat treatment to achieve a minimum temperature of 82 °C for a seven to eight-day period), 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 Bursaphelenchus xylophilus* (Steiner et Bührer) Nickle et al. is known to occur: Heat treatment or fumigation or

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	General and specific requirements
		chemical pressure impregnation ✓ Wood of Thuja (except wood chips, particles, sawdust, shavings, wood waste and scrap, wood packaging material, dunnage, originating in Canada, China, Japan, the Republic of Korea, Mexico, Taiwan and the USA, where Bursaphelenchus xylophilus*. is known to occur: Bark free, or kiln drying below 20% or heat treatment, or fumigation or chemical pressure impregnation ✗ Wood of conifers from Russia, Kazakhstan and Turkey : various requirements. ✗ Wood of conifers from third countries other than Russia, Kazakhstan and Turkey, European countries, Canada, China, Japan, the Republic of Korea, Mexico, Taiwan and the USA, where Bursaphelenchus xylophilus is known to occur: bark-free and free from grub holes, caused by Monochamus spp. (non-European), or kiln-drying to below 20 % moisture content, or fumigation, or chemical pressure impregnation, or heat treatment. ✓ Wood ofQuercus L., other than in the form of chips etc., casks etc., but including wood which has not kept its natural round surface, originating in the USA : squared so as to remove entirely the rounded surface, or bark-free and water content less than 20 % expressed as a percentage of the dry matter, or bark-free and disinfected by an appropriate hot-air or hot water treatment, or if sawn, with or without residual bark attached, has undergone kiln-drying to below 20 % moisture content., + mark
Israel		✓ Logs with bark: IP. (If originate from Europe or South Africa and PC, vapour treatment and inspection) ✓ Debarked logs: PC, vapour treatment (phosphine or methyle bromide) in accordance with treatment manual ✓ Wood products and railway sleepers, excluding wood logs, wood bark and wood chips; certificate of origin
Jordan		✓ All squared or non-squared wood: IP.
Khirghistan		✓ All squared or non-squared wood: IP, PC, place of production and buffer zone inspected during the last growing season and found free from quarantine pests, fumigation before dispatch.
Moldova		✓ All squared or non-squared wood: PC, IP, disinfection
Morocco		✓ All non-squared wood with bark: PC
Norway	✓ Coniferales. wood with bark (other than wood packaging material from Non-European countries and Portugal	✓ Wood of Coniferales, including wood which has not kept its natural, rounded surface (other than wood in the form of chips and wood packaging material in accordance with ISPM 15) originating from Canada, China, Japan, Korea, Mexico, Portugal, Taiwan and the USA: squared so that all its natural rounded surface is removed, and heat treatment (core temperature of at least 56°C for a period of 30 minutes.) ✓ Wood of Coniferales, including wood which has not kept its natural, rounded surface (other than wood packaging material in accordance with ISPM 15 and wood in the form of chips and shavings which are obtained in whole or part from conifers) originating from non-European countries other than Canada, China, Japan, Korea, Mexico, Taiwan and the USA: stripped of its bark and free from grub holes caused by the genus Monochamus (non-European spp.), or kiln-drying to below 20% moisture content ✓ Wood of Castanea Mill. and Quercus L., including wood that has not kept its natural rounded surface, originating in countries in North America: stripped of its bark and a) either squared so as to remove the rounded surface entirely, or b) moisture content does not exceed 20%, or c) disinfected using an appropriate hot-air or hot-water treatment, or d) in the case of sawn wood, with or without residual bark attached: kiln-drying to below 20% moisture content

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	General and specific requirements
Russia	✓ Pinus non-squared wood from countries where *B. xylophilus** occurs	
Tunisia		✓ All squared or non-squared wood: PC. ✓ Conifer non-squared wood originating in countries outside Europe and the Mediterranean area: debarking
Turkey	✓ Importation of wood from conifers as fuel wood is prohibited	✓ Conifer wood: stripped of theirs barks; free from grub holes, caused by Monochamus spp. which are larger than 3 mm across, or dried to below 20% moisture content ✓ Conifer timber: shall not contain bark pieces; free from grub holes, caused by Monochamus spp. which are larger than 3 mm across, and dried to below 20% moisture content, expressed as a percentage of dry matter, or evidence thereof by a mark “Kiln-dried”, “KD” ✓ Deciduous wood (of angiosperms): stripped from its bark and PC (free from pests) ✓ Deciduous timber(of angiosperms): stripped from its bark and free from pests; and kiln-dried or marked with internationally recognized mark for kiln-drying ✓ Fuel wood (of angiosperms): debarked or fumigated (and PC indicating free from pests)
Ukraine		× No requirements for wood (only packing wood from Asia)

ANNEX 2 - Table 2. Particle wood (wood chips) and waste wood from countries where *H. irregulare* occurs

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	Other general and specific requirements
Albania		? No requirements for wood chips?
Algeria		? No requirements for wood chips?
Belarus		? No requirements for wood chips?
EU, Serbia		✓ Conifer wood chips, particles, sawdust, shavings, wood waste and scrap and wood waste from Canada, China, Japan, the Republic of Korea, Mexico, Taiwan and the USA, where Bursaphelenchus xylophilus* is known to occur : Heat treatment or fumigation and official statement × Conifer wood chips, particles, sawdust, shavings, wood waste and scrap from Russia, Kazakhstan and Turkey, non-European countries other than Canada, China, Japan, the Republic of Korea, Mexico, Taiwan and the USA, where Bursaphelenchus xylophilus is known to occur: PFAs for Monochamus spp. (non-European), Pissodes spp. (non-European),Scolytidae spp. (non-European), or produced from debarked round, or kiln-drying to below 20 % moisture content, or has undergone an appropriate fumigation, or heat treatment✓ Wood chips, particles, sawdust, shavings, woodwaste and scrap from *Quercus* from the USA : kiln-drying to below 20 %, or fumigation, or heat treatment (min core temperature of 56 °C for at least 30 minutes)
Israel		✓ Wood chips: PC. Do not include bark and treated with methyl bromide in accordance with treatment manual
Jordan		? No requirements for wood chips?
Kyrgyzstan		? No requirements for wood chips?

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	Other general and specific requirements
Moldova		? No requirements for wood chips?
Morocco		? No requirements for wood chips?
Norway	✓ Coniferales. All chips from Canada, China, Japan, Korea, Mexico, Portugal, Taiwan and the USA ✓ Coniferales. chips of wood with bark, and wood waste from non-European countries and Portugal ✓ Wood waste of Castanea and Quercus from Non-European countries	? Wood chips derived in whole or part from Castanea, Populus and Quercus, from non-European countries: made from wood stripped of its bark, or from wood which has undergone kiln-drying to 20%, or fumigated ? Wood chips derived in whole or part from Coniferales, originating from non-European countries other than Canada, China, Japan, Korea, Taiwan and the USA: made from wood stripped of its bark, or from wood kiln-dried to 20%, or fumigated
Russia		? No requirements for wood chips?
Tunisia		? No requirements for wood chips?
Turkey		✓ wood chips (angiosperms and conifers): produced from wood that was fumigated or stripped of its bark, or kiln-dried; and carried in sealed containers or equivalent
Ukraine		? No requirements for wood chips?

ANNEX 2 - Table 3. Bark of host species from countries where *H. irregulare* occurs

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	Other general and specific requirements
Albania	✓ All isolated bark: prohibited	
Algeria		✓ All isolated bark: PC
Belarus		? No requirement for isolated bark.
EU		✓ Isolated bark of conifers (Coniferales), from non-European countries : fumigation or heat treatment (56 °C 30 min)
Israel		✓ All isolated bark: PC (treatment with methyl bromide as specified in treatment manual)
Jordan		✓ All isolated bark: IP
Kyrgyzstan		✓ All isolated bark: IP, PC
Moldova		✓ All isolated bark: PC, IP and disinfection
Morocco		✓ Non-dried bark: PC
Norway	✓ Coniferales. Isolated bark from Non-European countries and Portugal ✓ Quercus: isolated bark (other than *Quercus suber*) from non-Europ. countries	
Russia	✓ Isolated bark originating in countries where B. xylophilus* occurs	
Tunisia	✓ Isolated bark of forest trees: prohibited	
Turkey		? No requirement for isolated bark?
Ukraine		? No requirement for isolated bark

ANNEX 2 - Table 4. Plants for planting of host species from countries where *H. irregulare* occurs

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	Other general and specific requirements
Albania		✓ All plants: import permit (IP), PC
Algeria		✓ All plants: PC ✓ Fruit or ornamental plants of species not indigenous or cultivated in Algeria: IP ✓ Conifers: free from Ips spp. ✓ Pinus Free from Atropellis spp.?, Mycosphaerella dearnessii*, Mycosphaerella gibsonii, Mycosphaerella pini** and Thaumetopoea pityocampa ✓ Prunus: IP and free from a number of pests (including Quadraspidiotus perniciosus*, some viruses
Belarus	✓ Plants from countries where *Bemisia tabaci** occurs ✓ Plants with roots from countries where *Popillia japonica*** occurs ✓ Plants from countries where Phymatotrichopsis omnivora## occurs ? Deciduous woody plants from countries where Dialeurodes citri, Icerya purchasi, Lopholeucaspis japonica, Pantomorus godmani or Pseudococcus calceolariae occur ✓ Plants from countries where *Spodoptera littoralis* or *S. litura*# occur ✓ Prunus plants from countries where Quadraspidiotus perniciosus*/Hyphantria cunea*/Grapholita molesta*/Carposina niponensis? Occur	✓ All plants: import permit, PC ✓ Plants with roots: free from soil ✗ Deciduous woody plants originating in countries where Ceroplastes japonicus or Ceroplastes rusci occurs: prohibited
EU	✓ Plants of Abies, Cedrus, Chamaecyparis, Juniperus, Larix, Picea, Pinus, Pseudotsuga and Tsuga, other than fruit and seeds. From non-European countries ✓ Plants of Castanea and Quercus, with leaves, other than fruit and seeds. Non-European countries ✓ Plants Prunus etc for planting, other than dormant plants free from leaves, flowers and fruit. Non-European countries ✓(Cuba and Dom. Rep.) Plants of Prunus stc. for planting, other than seeds, from non-European countries, other than Mediterranean countries, Australia, New Zealand, Canada, the continental states of the USA	✓ Plants of *Quercus* (other than fruit and seeds) from USA : area freedom for Ceratocystis fagacearum# ✓ Plants of *Castanea* and *Quercus* (other than fruit and seeds), from non-European countries : no symptoms of Cronartium spp.** (non-European) at the place of production or immediate vicinity ✓ Plants for pl. of *Castanea* and *Quercus* (other than seeds): area freedom Cryphonectria parasitica**, or no symptoms observed. ✓ Deciduous trees and shrubs for planting (other than seeds and plants in tissue culture), from third countries other than European and Mediterranean countries : plants dormant and free from leaves. ✓ Trees and shrubs, intended for planting, other than seeds and plants in tissue culture, originating in third countries other than European and Mediterranean countries : clean (i.e. free from plant debris) and free from flowers and fruits, grown in nurseries, inspected at appropriate times and prior to export and found free from symptoms/signs and symptoms or treated ✓ Naturally or artificially dwarfed plants intended for planting other than seeds, originating in non-European countries including those collected directly from natural habitats: detailed requirement for plants and their growing media, including bare roots or growing medium replaced with a treated growing medium.

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	Other general and specific requirements
		✓ ? Plants of Prunus, for planting, other than seeds, originating in countries where a number of pests occur (Apricot chlorotic leafroll mycoplasm, Xanthomonas campestris pv. Prunis, non-European viruses and virus-like organisms : no symptoms of diseases caused by them observed on the plants at the place of production since the beginning of the last complete cycle of vegetation. ? Plants of Prunus for planting (a) originating in countries where Tomato ringspot virus is known to occur on Prunus ; (b) other than seeds, originating in countries where a number of viruses and phytoplasma specified) are known to occur ; (c) other than seeds, originating in non-European countries where Little cherry pathogen is known to occur : certification scheme or derived in direct line from material maintained under appropriate conditions and tested, and no symptoms observed
Israel	✓ Vegetative propagation material (excluding seeds), cut flowers and branches : Pinaceae	✓ All plants: IP
Jordan		✓All plants: IP, PC; free from soil.
Khirghistan		✓ All plants: IP, PC, free from soil, PFA for quarantine pests, place of production and buffer zone inspected during the last growing season and found free from quarantine pests); ✓ Plants with growing medium: growing medium free from *Globodera pallida***, *Globodera rostochiensis** and *Meloidogyne chitwood*##
Morocco		✓ All plants: PC; ✓ Plants with soil: pest free ? Prunus: IP and requirements for a number of viruses
Moldova		✓ All plants: PC, IP, disinfection; ✓ Plants with roots: free from soil.
Norway	✓ Coniferales. Plants and parts of plants (other than seeds and fruit) from Non-European countries and Portugal ✓ Quercus plants (other than seeds and fruit) from non-European countries	? Also some requirements for *Prunus* regarding specific pests
Russia	✓ All plants: prohibition from countries where some specific pests occur (e.g. *Thrips palmi*##, *Bemisia tabaci**, *Liriomyza trifolii**, *Frankliniella occidentalis**); ? Plants of deciduous trees originating in countries where Lymantria dispar (Asian form) occurs ✓ Pinus plants originating in countries where Bursaphelenchus xylophilus* occurs ✓ Quercus Plants originating in countries where Ceratocystis fagacearum# occurs	✓ All plants: import permit, PC, ✓ Plants with roots: free from soil
Tunisia	✓ Forest trees: prohibited	✓ All plants: PC, free from *F. occidentalis**

Country	Prohibitions or requirements implying prohibition from USA, Canada or Mexico	Other general and specific requirements
		✓ *Prunus*: from countries where *Q. perniciosus** occurs: free from or fumigation
Turkey		✓ Plants with roots gown in the open air: PFA for Clavibacter michiganensis subsp. sepedonicus**, Globodera pallida**, G. rostochiensis* and Synchytrium endobioticum***; ✓ Trees and shrubs originating in third countries other than European and Mediterranean countries: free from plant debris, flowers and fruit; grown in nurseries, inspected and found free or treated. No requirements for plants of conifers Quercus. no symptoms of Cryphonectria parasitica** at place of production or PFAfor Cryphonectria parasitica and Ceratocystis fagacearum#. ✓ Prunus: originating from areas where Quadraspidiotus perniciosus* is not known to occur or, no infestation at the place of production or immediate vicinity (last two complete cycles of vegetation) or treated to eradicate the relevant harmful organism. Also requirements on a number of viruses
Ukraine		✓ All plants: import permit, PC; free from quarantine pests or disinfested at the point of entry.

ANNEX 3 – TRADE OF CONIFER WOOD INTO THE EPPO REGION FROM COUNTRIES WHERE *H. IRREGULARE* OCCURS

Table 1. CONIFER ROUNDWOOD – Imports by EPPO countries. FAOStat Roundwood of conifers Ind Rwd Wir (C) m^3

There were no imports from Cuba

	USA							Canada							Mexico			Dominican Rep.
	2004	2006	2008	2009	2010	2011	2012	2004	2006	2008	2009	2010	2011	2012	2006	2010	2012	2008
Albania		1003	528	127	393	562					9							
Algeria			46	284	393													
Austria		58	4000	1000	1000	51			2696	2000	2000		1000					
Belgium	97300	2035	22000	17000	14000	12000	9000			231	378			2000				
Bosnia and Herzegovina			511															
Bulgaria		4273				169												
Croatia					11	3			5				12					
Cyprus	1393	15030	8659	6437	3803	3051	2580											
Czech Republic		16	1000	1000	8000		373	93			2000							
Denmark	67	10532	1119	1388	1000	1094	691		292	605		277		286				
Estonia			309	10000	6600	2000							129000					
Finland	4	1	19	57	291	289	95					8	179	16				
France	4746	1184	24000	129000	27000	10000	28000		60	1000	1047	869	867	23			2327	295
Georgia							555											
Germany	20223	25129	111000	59000	75000	88000	17	208		271	16							
Greece	363	472	12477	6810	2241	393	787											
Hungary	27	38	33	492		98												
Ireland	464	14508	21000	7000	2000	1319	3298	2265	5973	45000	57000	96799	112488	44408				
Israel	326		5144	16	213	1444	263			1605				182				
Italy	67065	8380	160000	95000	1000	36000	1000	100	812	432			1000					
Jordan	841	9717					188	22										
Lithuania			164															
Malta	83	455	549	451	239	474	556											
Morocco		547	544	475	546	5560	2896			179								
Netherlands	7907	38805	30000	21000	22065	34000	1000				1000		1000				3	
Norway		2288	5000	4000	369	419	1000										25	
Poland			1	1000		153	1000			2000								
Portugal	1243	30	19262	1468	315	5665	499			170								
Republic of Moldova	27																	
Romania			294									62						
Russian Federation			2000		1546	7018	529		50				270					
Slovakia			89	91000			107											

	USA							Canada							Mexico			Dominican Rep.
	2004	2006	2008	2009	2010	2011	2012	2004	2006	2008	2009	2010	2011	2012	2006	2010	2012	2008
Slovenia	22	752	1293	2352	1766		1					1475						
Spain	63131	71787	104000	126000	46000	35000	18000		602		79		2000		4			
Sweden		53	1000	2	44		104									128		
Switzerland	14	39126	1000		9	6	10			70	8						5	
Tunisia	151		43															
Turkey	76497	731	20000	30000	27991	21000	98000					32988						
Ukraine		2				46												
United Kingdom	134202	165642	1000	120000	593	92000	2000	74	6688	1000	13603	1000	314	5000				
Total	**476096**	**413664**	**592439**	**801856**	**286124**	**362607**	**212392**	**2762**	**17178**	**54565**	**77140**	**133478**	**248130**	**51915**	**4**	**128**	**2360**	**295**

ANNEX 3. Table 2. CONIFER WOOD IN THE ROUGH – Imports by EU countries. Eurostat Coniferous wood in the rough 440320

	USA						CANADA						MEXICO	
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013	2012	2013
AUSTRIA	:	:	227	231	:	238	392	446	:	215	:	4 152	:	:
BELGIUM	:	:	:	482	:	0	:	:	:	:	:	:	:	:
CROATIA	:	:	0	0	:	:	3	:	:	4	:	:	:	:
CZECH REP.	3	:	:	:	0	:	:	:	:	:	:	:	:	:
DENMARK	:	636	:	:	:	:	:	225	:	:	:	:	:	:
FINLAND	:	72	:	:	:	:	:	:	0	:	:	:	:	:
FRANCE	805	330	:	:	:	:	:	671	150	158	:	:	1 394	3 184
GERMANY	33	520	:	:	10	514	:	:	:	:	:	:	:	:
IRELAND	12 597	10 692	1 402	512	1 549	2 022	11 032	6 339	:	:	:	115	:	:
ITALY	15 105	16 109	6 950	12 147	1 986	915	726	448	:	549	:	:	:	:
NETHERLANDS	0	:	:	:	249	0	:	:	:	:	:	77	:	:
PORTUGAL	:	:	499	:	1 314	:	:	:	:	:	:	:	:	:
SLOVAKIA	:	14	:	:	:	:	:	:	:	:	:	:	:	:
SLOVENIA	:	195	:	:	1	:	:	:	1 258	:	:	210	:	:
SPAIN	:	23	:	:	:	:	:	:	:	:	:	:	:	:
SWEDEN	13	:	:	:	7	:	:	:	:	:	:	:	:	:
UNITED KINGDOM	794	4 151	274	1 552	1 548	1 349	2 447	8 448	1 000	:	1 638	969	:	:
Total	**29350**	**32742**	**9352**	**14924**	**6664**	**5038**	**14600**	**16577**	**2408**	**926**	**1638**	**5523**	**1394**	**3184**

ANNEX 3. TableS 3. CONIFER WOOD DETAILED CATEGORIES – Exports from the USA to EPPO countries USDA-FAO (2014). (subcategories of 440320). Details of categories are from https://www.census.gov/foreign-trade/schedules/b/2011/c44.txt

Table 3.1. Conifer pulpwood 4403200005 (m3)

	2008	2009	2010	2011	2012	2013
Italy	16,012.0	0.0	0.0	0.0	62,679.0	576,277.0
Germany	481.0	0.0	0.0	67,324.0	146,299.0	131,147.0
Morocco	685.0	116.0	134.0	353.0	429.0	216.0
Greece	0.0	59.0	0.0	0.0	0.0	0.0
Spain	1,283.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	213.0	227.0	0.0	0.0	0.0	0.0
Total	**18674**	**402**	**134**	**67677**	**209407**	**707640**

Table 3.2. Logs and timber : Southern yellow pines (4403200020 - SW LOGS, SY PINE, m3) : Pinus taeda, Pinus palustris, Pinus rigida, Pinus echinata, Pinus elliottii, Pinus virginiana)

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Spain	7,944.0	6,369.0	6,099.0	3,987.0	1,710.0	2,247.0
Turkey	0.0	591.0	788.0	669.0	9,254.0	1,441.0
Norway(*)	53.0	514.0	0.0	34.0	90.0	1,312.0
France(*)	1,631.0	3,156.0	2,439.0	805.0	668.0	854.0
Germany(*)	1,517.0	2,008.0	1,026.0	479.0	327.0	829.0
Jordan	327.0	0.0	346.0	1,976.0	615.0	714.0
United Kingdom	1,510.0	642.0	359.0	452.0	64.0	469.0
Greece	1,201.0	845.0	369.0	68.0	141.0	324.0
Belgium(!)	1,654.0	1,789.0	1,095.0	507.0	272.0	322.0
Algeria	0.0	31.0	72.0	0.0	0.0	267.0
Italy(*)	12,341.0	12,022.0	4,874.0	1,819.0	1,586.0	207.0
Portugal	505.0	945.0	571.0	108.0	12.0	127.0
Tunisia	1.0	0.0	0.0	0.0	0.0	109.0
Albania	38.0	0.0	74.0	0.0	0.0	0.0
Austria	0.0	72.0	0.0	0.0	0.0	0.0
Denmark(*)	37.0	101.0	35.0	32.0	39.0	0.0
Ireland	243.0	35.0	35.0	0.0	35.0	0.0
Estonia	0.0	1,182.0	975.0	34.0	0.0	0.0
Georgia	0.0	0.0	0.0	0.0	79.0	0.0
Israel(*)	683.0	1,627.0	102.0	117.0	0.0	0.0
Latvia	0.0	0.0	0.0	36.0	0.0	0.0
Malta	33.0	0.0	0.0	0.0	0.0	0.0
Netherlands	188.0	334.0	223.0	0.0	15.0	0.0
Slovenia	3,440.0	193.0	0.0	0.0	0.0	0.0
Sweden	146.0	0.0	0.0	0.0	0.0	0.0
Total	**33492,00**	**32456,00**	**19482,00**	**11123,00**	**14907,00**	**9222,00**

Table 3.3. Logs and timber. Ponderosa pine (Pinus ponderosa) - 4403200025 - SW LOGS, PNDROSA

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Jordan	192.0	393.0	0.0	100.0	2,319.0	302.0
Germany(*)	54.0	41.0	0.0	103.0	0.0	46.0
Netherlands	0.0	50.0	0.0	0.0	0.0	0.0
United Kingdom	0.0	0.0	0.0	45.0	0.0	0.0
Total	**246**	**484**	**0**	**248**	**2319**	**348**

Table 3.4. Logs and timber. Other pine, excl. Southern yellow pines (3.2 above) and ponderosa pine (3.3 above) 4403200030- Sw Logs,Pine,Oth

	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Turkey	0.0	0.0	1,267.0	474.0	370.0	114.0
Italy(*)	1,062.0	4,787.0	0.0	0.0	373.0	35.0
Albania	290.0	0.0	0.0	0.0	0.0	0.0
Belgium(!)	182.0	1,455.0	0.0	0.0	0.0	0.0
Denmark(*)	0.0	0.0	215.0	0.0	0.0	0.0
Ireland	0.0	136.0	0.0	0.0	0.0	0.0
France(*)	676.0	1,075.0	0.0	0.0	0.0	0.0
Greece	0.0	187.0	0.0	0.0	0.0	0.0
Israel(*)	0.0	0.0	0.0	428.0	0.0	0.0
Jordan	0.0	269.0	608.0	251.0	0.0	0.0
Norway(*)	885.0	0.0	0.0	0.0	0.0	0.0
Poland	0.0	0.0	0.0	0.0	202.0	0.0
Spain	263.0	2,090.0	233.0	0.0	0.0	0.0
United Kingdom	693.0	3,192.0	215.0	0.0	0.0	0.0
Total	**4051**	**13191**	**2538**	**1153**	**945**	**149**

Table 3.5. Logs and timber Douglas-fir (Pseudotsuga menziesii) 4403200040 - SW LOGS, D-FIR (m3)

	2008	**2009**	**2010**	**2011**	**2012**	**2013**

United Kingdom	252.0	760.0	2,326.0	5,047.0	8,475.0	3,101.0
Netherlands	215.0	347.0	1,211.0	4,048.0	4,089.0	1,552.0
Belgium(!)	104.0	400.0	1,280.0	2,336.0	1,789.0	1,007.0
Poland	0.0	0.0	0.0	0.0	0.0	307.0
Albania	32.0	0.0	0.0	0.0	0.0	0.0
Cyprus	0.0	0.0	0.0	0.0	42.0	0.0
Ireland	172.0	0.0	0.0	0.0	0.0	0.0
France(*)	0.0	0.0	0.0	0.0	155.0	0.0
Germany(*)	659.0	692.0	1,771.0	1,047.0	937.0	0.0
Italy(*)	0.0	0.0	0.0	193.0	345.0	0.0
Jordan	0.0	0.0	0.0	877.0	0.0	0.0
Latvia	258.0	0.0	0.0	0.0	0.0	0.0
Morocco	0.0	0.0	0.0	164.0	148.0	0.0
Romania	103.0	0.0	0.0	0.0	0.0	0.0
Spain	0.0	1,660.0	377.0	103.0	416.0	0.0
Switzerland(*)	5,200.0	0.0	0.0	0.0	0.0	0.0
Total	**6995**	**3859**	**6965**	**13815**	**16396**	**5967**

Table 3.6. Logs and timber. Spruce (Picea spp.) 4403200035 - SW LOGS, SPRUCE Logs and timber. Spruce (Picea spp.)

	2008	2009	2010	2011	2012	2013
United Kingdom	0.0	0.0	0.0	246.0	467.0	857.0
Spain	0.0	0.0	0.0	311.0	0.0	551.0
Belgium(!)	52.0	170.0	0.0	449.0	0.0	0.0
Netherlands	260.0	35.0	0.0	0.0	0.0	0.0

Table 3.7. Logs and timber : Western red cedar (Thuja plicata) (m3)4403200055 - SW LOGS, WR CEDR.

	2008	2009	2010	2011	2012	2013
Germany(*)	0.0	504.0	754.0	625.0	1,359.0	631.0
United Kingdom	0.0	0.0	0.0	648.0	813.0	365.0
Russia	446.0	0.0	307.0	1,185.0	103.0	279.0
Netherlands	382.0	0.0	0.0	344.0	708.0	209.0
Belgium(!)	427.0	0.0	0.0	0.0	0.0	169.0
Ireland	99.0	0.0	0.0	0.0	0.0	0.0
Italy(*)	0.0	0.0	0.0	259.0	0.0	0.0
Spain	0.0	301.0	0.0	0.0	0.0	0.0
Switzerland(*)	618.0	0.0	0.0	0.0	0.0	0.0

	2008	2009	2010	2011	2012	2013
Total	**1972**	**805**	**1061**	**3061**	**2983**	**1653**

Table 3.8. Logs and timber, coniferous, except all others mentioned above, Chamaecyparis lawsonia and Tsuga heterophylla. 4403200060

	2008	2009	2010	2011	2012	2013
Germany(*)	9,907.0	3,440.0	7,203.0	299.0	1,282.0	2,269.0
Italy(*)	3,289.0	1,958.0	2,790.0	1,325.0	747.0	263.0
Portugal	2,390.0	2,305.0	621.0	178.0	1,599.0	131.0
Poland	0.0	0.0	0.0	0.0	0.0	126.0
Spain	3,053.0	873.0	66.0	20.0	0.0	101.0
Turkey	2,748.0	3,837.0	4,525.0	4,678.0	1,348.0	66.0
Jordan	0.0	0.0	0.0	0.0	5.0	14.0
Belgium(!)	620.0	0.0	0.0	0.0	0.0	7.0
United Kingdom	2,912.0	5,950.0	162.0	32.0	0.0	6.0
Austria	24.0	18.0	0.0	0.0	0.0	0.0
Denmark(*)	78.0	108.0	16.0	22.0	21.0	0.0
Ireland	167.0	49.0	0.0	0.0	0.0	0.0
Estonia	33.0	35.0	26.0	0.0	0.0	0.0
Czech Republic	0.0	0.0	1,129.0	0.0	0.0	0.0
Finland	33.0	0.0	0.0	0.0	0.0	0.0
France(*)	1,214.0	61.0	26.0	142.0	0.0	0.0
Greece	257.0	32.0	0.0	0.0	0.0	0.0
Israel(*)	52.0	0.0	75.0	0.0	0.0	0.0
Lithuania	25.0	0.0	0.0	0.0	0.0	0.0
Netherlands	903.0	36.0	0.0	0.0	0.0	0.0
Norway(*)	0.0	9.0	0.0	0.0	0.0	0.0
Russia	29.0	0.0	0.0	0.0	0.0	0.0
Slovenia	573.0	210.0	168.0	0.0	0.0	0.0
Sweden	25.0	0.0	0.0	0.0	0.0	0.0
Switzerland(*)	614.0	0.0	0.0	23.0	0.0	0.0
Total	**28946**	**18921**	**16807**	**6719**	**5002**	**2983**

Table 3.9. Other coniferous wood 4403200065 - ROUGH SW,OTH,N/T.

	2008	2009	2010	2011	2012	2013
United Kingdom	536.0	200.0	105.0	31.0	40.0	126.0
Portugal	0.0	0.0	0.0	0.0	796.0	114.0
France(*)	264.0	471.0	457.0	105.0	327.0	67.0

	2008	2009	2010	2011	2012	2013
Israel(*)	144.0	0.0	113.0	0.0	0.0	40.0
Belgium(!)	101.0	134.0	60.0	0.0	0.0	37.0
Italy(*)	433.0	934.0	864.0	281.0	0.0	36.0
Morocco	0.0	0.0	0.0	0.0	22.0	21.0
Jordan	0.0	0.0	0.0	0.0	0.0	10.0
Finland	30.0	9.0	28.0	39.0	16.0	9.0
Czech Republic	52.0	34.0	181.0	0.0	45.0	4.0
Norway(*)	274.0	33.0	13.0	0.0	0.0	4.0
Albania	0.0	19.0	0.0	0.0	0.0	0.0
Austria	66.0	0.0	0.0	0.0	0.0	0.0
Denmark(*)	352.0	401.0	116.0	0.0	0.0	0.0
Ireland	1,079.0	317.0	0.0	0.0	0.0	0.0

	2008	2009	2010	2011	2012	2013
Germany(*)	178.0	104.0	69.0	37.0	82.0	0.0
Greece	14.0	36.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	112.0	0.0	0.0	0.0
Latvia	0.0	33.0	0.0	0.0	0.0	0.0
Netherlands	0.0	0.0	19.0	0.0	0.0	0.0
Poland	0.0	28.0	0.0	0.0	0.0	0.0
Spain	249.0	195.0	64.0	0.0	0.0	0.0
Sweden	0.0	6.0	0.0	0.0	0.0	0.0
Turkey	0.0	0.0	0.0	18.0	0.0	0.0
	3772	**2954**	**2201**	**511**	**1328**	**468**

ANNEX 3. Table 4. FIREWOOD - Eurostat – imports by EU countries- 440110 FUEL WOOD, IN LOGS, BILLETS, TWIGS, FAGGOTS OR SIMILAR FORMS (in 100 kg)

EU countries without imports were deleted

	USA						CANADA						MEXICO	
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013	2012	2013
Austria	:	:	:	:	2	:	:	:	1	3	:	:	0	1
Belgium	:	1	:	:	:	:	:	:	:	:	:	:	:	:
Bulgaria	:	:	:	:	:	0	183	:	:	:	:	:	:	:
Cyprus	:	:	:	:	:	0	:	:	:	:	:	:	:	:
Czech rep	:	28	:	:	:	:	:	:	:	:	86	:	:	:
Denmark	:	68	:	:	73	8	:	:	:	:	:	:	:	:
Estonia	:	:	:	:	:	660	:	:	:	:	:	:	:	:
Finland	:	:	:	:	2	0	:	:	:	:	:	:	:	:
France	:	:	:	:	0	2	120	:	:	:	:	1 003	:	:
Germany	:	:	28	50	277	25	:	:	:	:	:	:	:	:
Hungary	:	:	:	17	:	186	:	:	:	:	:	:	:	:
Ireland	6	850	3	1	0	0	:	1	8	:	:	:	:	:
Italy	:	408	:	:	:	:	4 779	:	:	:	:	209	:	:
Netherlands	:	:	:	:	5	:	:	:	:	:	:	:	:	:
Poland	:	:	:	:	:	0	:	:	:	:	6	:	:	:
Portugal	822	440	:	1 519	75	:	:	:	:	:	:	:	:	:
Romania	:	:	:	:	:	0	:	:	:	:	:	:	:	:
Spain	:	130	:	0	:	:	:	:	:	:	:	:	:	:
Sweden	37	7	11	6	0	31	:	:	:	1	:	:	:	:

	USA						CANADA						MEXICO	
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013	2012	2013
UK	6 808	8 737	6 334	222	268	716	:	:	:	:	:	:	:	:
Total	**7673**	**10669**	**6376**	**1815**	**702**	**1628**	**5082**	**1**	**9**	**4**	**92**	**1212**	**0**	**1**

ANNEX 3. Table 5. CONIFEROUS POLES, PILES AND POSTS – exports to EPPO countries - USDA-FAO (2014). 4403200010 SW POLES, UNTRTD (in number)

	2008	2009	2010	2011	2012	2013
Italy	0.0	0.0	0.0	0.0	0.0	12,350.0
Russia	0.0	0.0	0.0	0.0	0.0	1,737.0
Morocco	0.0	0.0	0.0	0.0	0.0	200.0
Israel	0.0	0.0	0.0	0.0	108.0	50.0
Bulgaria	0.0	0.0	0.0	388.0	0.0	0.0
Czech Republic	0.0	0.0	1,970.0	0.0	0.0	0.0
France	0.0	0.0	0.0	40.0	15.0	0.0
Germany	2,693.0	0.0	0.0	0.0	0.0	0.0
Croatia	0.0	0.0	1,592.0	0.0	0.0	0.0
Hungary	0.0	1,130.0	0.0	0.0	0.0	0.0
Netherlands	473.0	0.0	0.0	0.0	0.0	0.0
Poland	143.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	24.0	491.0	9.0	128.0	7,506.0	0.0
Total	**3333**	**1621**	**3571**	**556**	**7629**	**14337**

ANNEX 3. Table 6. POSTS AND BEAMS OF WOOD – imports by EU countries. Eurostat 441860 (100 kg)

There were no imports from Dominican Republic, Cuba and Mexico

EU countries without imports were deleted

	USA						CANADA					
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013
BELGIUM	:	:	:	0	91	:	:	:	751	:	404	25
BULGARIA	:	8	:	:	:	:	:	:	:	:	:	:
CYPRUS	:	:	8	:	:	:	:	:	:	:	:	:
CZECH REP	:	:	:	:	283	508	:	:	:	:	:	:
GERMANY	:	:	10	1 556	40	:	:	:	192	405	:	3
DENMARK	:	:	203	656	:	:	:	:	:	:	:	:
SPAIN	:	1 388	:	:	504	:	:	:	:	:	:	:
FINLAND	:	0	:	:	:	:	:	:	:	0	:	:
FRANCE	:	298	:	215	273	0	:	:	156	1	:	:
UNITED KINGDOM	:	200	545	389	49	143	:	626	19	:	:	:
IRELAND	:	373	:	:	0	:	:	:	6	:	:	:
ITALY	:	:	177	:	23	:	:	:	372	:	:	:
LITHUANIA	:	:	:	21	:	:	:	:	:	:	:	:
NETHERLANDS	:	29	515	11	:	:	:	106	:	250	:	:
POLAND	:	90	3	35	:	1	:	:	:	:	:	:

	USA						CANADA					
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013
ROMANIA	:	22	16	15	8	:	:	:	:	:	:	2
SWEDEN	:	:	:	:	159	:	:	:	:	:	:	:
SLOVENIA	:	:	:	:	:	:	:	0	:	:	187	:
SLOVAKIA	:	:	:	:	3	3	:	:	:	:	:	:
CROATIA	:	23	10	41	:	:	:	139	1	:	:	:
	0	2431	1487	2939	1433	655	0	871	1497	656	591	30

ANNEX 3. Table 7. 440410 Eurostat HOOPWOOD; SPLIT POLES; PILES, PICKETS AND STAKES OF WOOD, POINTED BUT NOT SAWN LENGTHWISE; WOODEN STICKS, ROUGHLY TRIMMED BUT NOT TURNED, BENT OR OTHERWISE WORKED, SUITABLE FOR THE MANUFACTURE OF WALKING-STICKS, UMBRELLAS, TOOL HANDLES OR THE LIKE; CHIPWOOD AND THE LIKE, OF CONIFEROUS WOOD (EXCL. HOOPWOOD SAWN LENGTHWISE AND CARVED OR NOTCHED AT THE ENDS; BRUSHMOUNTS, LASTS)

	UNITED STATES						CANADA					MEXICO	
	2006	2008	2010	2011	2012	2013	2008	2010	2011	2012	2013	2010	2011
AUSTRIA	0	:	:	:	:	:	:	:	:	:	:	:	:
DENMARK	:	:	:	:	:	:	:	172	:	200	200	:	:
FINLAND	0	:	:	:	:	:	:	:	:	:	:	:	:
FRANCE	:	:	:	:	:	0	:	0	:	:	:	:	:
HUNGARY	79	52	:	13	:	:	:	:	:	:	:	:	:
IRELAND	24	5	:	:	:	:	13 734	46 987	55 726	23 311	14 470	:	:
LATVIA	:	:	0	:	:	:	:	:	:	:	:	:	:
NETHERLANDS	:	:	:	:	0	:	:	:	:	:	:	:	:
POLAND	:	:	0	:	:	:	:	:	:	:	:	:	:
PORTUGAL	45	:	:	:	:	:	:	:	:	:	:	:	:
SWEDEN	:	:	:	1	0	0	:	:	:	:	:	139	:
SLOVAKIA	:	:	:	0	:	0	:	:	:	:	:	:	0

ANNEX 3. Table 8. **RAILWAY OR TRAMWAY SLEEPERS 'CROSS-TIES' OF WOOD, NOT IMPREGNATED 440610Eurostat**

	USA			Canada				
	2006	2008	2012	2008	2010	2011	2012	2013
Belgium	:	12 795	:	:	:	:	:	:
Germany	:	9 510	:	:	:	:	:	:
France	:	:	0	:	:	:	:	:
UK	:	:	:	21 020	14 735	11 190	8 543	12 696
Ireland	:	:	:	143	:	:	:	:
Netherlands	30	:	:	:	:	:	:	:
Poland	:	4 588	:	:	:	:	:	:

ANNEX 3. Table 9. Ties, Wood, Not Impregnated USDA FAS-440610 - (m3)

	2008	2009	2010	2011	2012	2013
Belgium(!)	5.0	0.0	0.0	0.0	0.0	0.0
Germany(*)	0.0	0.0	2.0	0.0	0.0	0.0
Israel(!)	34.0	0.0	0.0	1.0	174.0	0.0
Italy(*)	0.0	0.0	79.0	1.0	0.0	0.0
Latvia	0.0	22.0	0.0	0.0	0.0	0.0
Russia	0.0	0.0	0.0	0.0	0.0	174.0
Switzerland(*)	0.0	0.0	18.0	0.0	0.0	0.0
Turkey	0.0	0.0	0.0	1.0	0.0	0.0
United Kingdom	0.0	0.0	39.0	0.0	2.0	0.0

ANNEX 4 – TRADE OF OAK WOOD INTO THE EPPO REGION FROM COUNTRIES WHERE *H. IRREGULARE* OCCURS

Table 1. OAK WOOD – Imports by EU countries. Eurostat 440391

	UNITED STATES						CANADA					
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013
AUSTRIA	:	4 062	955	1 083	570	481	:	:	:	:	:	:
BELGIUM	596	1 047	408	:	:	:	:	:	:	:	:	:
CYPRUS	:	:	:	:	218	479	:	:	:	:	:	:
CZECH REP.	78	409	62	:	1 707	3 470	:	:	:	:	:	:
DENMARK	1 071	220	:	:	:	:	369	:	:	:	:	:
FINLAND	:	1	:	:	:	:	:	:	:	:	:	:
France	:	6 888	2 360	5 751	4 145	:	410	:	:	:	:	:
GERMANY	49 724	19 012	31 621	6 196	16 762	18 797	125	:	:	:	:	:
GREECE	:	1 033	:	:	:	:	:	:	:	:	:	:
HUNGARY	:	:	:	:	:	:	:	:	:	:	:	:
IRELAND	43 481	15 892	5 334	2 860	1 322	1 917	1 788	:	:	:	:	:
ITALY	203	853	:	210	200	405	:	:	:	:	:	:
LATVIA	3 665	1 837	:	:	:	:	:	:	:	:	:	:
MALTA	0	0	:	200	:	:	0	:	:	:	:	:
NETHERLANDS	:	1 410	:	111	0	:	:	:	:	:	:	:
POLAND	202	200	:	239	:	281	:	:	:	:	:	:
PORTUGAL	65 730	88 226	82 974	49 799	39 533	38 241	:	:	:	:	:	:
SLOVENIA	4 115	1 080	812	:	:	:	:	:	:	:	:	:
SPAIN	59 553	65 167	23 214	27 547	30 439	28 251	97	:	:	:	:	:
SWEDEN	3 925	17 834	26 964	30 733	27 654	29 483	0	235	166	1 314	174	206
UNITED KINGDOM	91 426	125 632	12 881	14 469	17 354	8 988	7 144	3 470	0	549	659	219
	323769	350803	187585	139198	139904	130793	9933	3705	166	1863	833	425

Table 2. OAK LOGS - US exports to EPPO countries. USDA-FAS oak logs -440391 - Logs, Oak (m3)

	2008	2009	2010	2011	2012	2013
Albania	0.0	0.0	0.0	0.0	28.0	29.0
Algeria	56.0	135.0	204.0	296.0	211.0	99.0
Austria	48.0	0.0	55.0	26.0	20.0	0.0
Azerbaijan	19.0	17.0	0.0	0.0	0.0	23.0
Belgium(!)	5,611.0	2,474.0	2,862.0	2,672.0	2,534.0	3,269.0
Bulgaria	0.0	0.0	0.0	60.0	0.0	253.0
Croatia	53.0	0.0	0.0	0.0	0.0	0.0
Cyprus	572.0	85.0	146.0	35.0	117.0	116.0

	2008	2009	2010	2011	2012	2013
Czech Republic	192.0	295.0	185.0	26.0	194.0	245.0
Denmark(*)	1,490.0	174.0	955.0	658.0	1,496.0	1,532.0
Estonia	128.0	107.0	272.0	410.0	268.0	81.0
Finland	1,933.0	1,056.0	1,168.0	641.0	633.0	629.0
France(*)	2,764.0	1,852.0	2,447.0	1,359.0	2,027.0	1,036.0
Georgia	0.0	0.0	0.0	23.0	0.0	0.0
Germany(*)	17,833.0	11,466.0	12,358.0	9,325.0	8,291.0	10,545.0
Greece	4,887.0	2,330.0	961.0	414.0	242.0	295.0
Ireland	6,974.0	2,065.0	3,054.0	1,202.0	1,616.0	1,203.0
Israel(*)	716.0	442.0	1,173.0	1,231.0	804.0	1,128.0
Italy(*)	15,404.0	8,258.0	9,656.0	5,192.0	2,800.0	2,072.0
Jordan	1,871.0	2,334.0	2,552.0	2,081.0	1,813.0	919.0
Latvia	103.0	0.0	27.0	0.0	0.0	0.0
Lithuania	0.0	0.0	97.0	779.0	262.0	132.0
Malta	934.0	292.0	173.0	132.0	57.0	116.0
Moldova	29.0	0.0	0.0	0.0	0.0	0.0
Morocco	144.0	30.0	81.0	124.0	403.0	363.0
Netherlands	2,556.0	320.0	464.0	392.0	205.0	689.0
Norway(*)	1,933.0	1,550.0	1,142.0	1,194.0	2,176.0	2,106.0
Poland	7,138.0	1,786.0	639.0	244.0	700.0	523.0
Portugal	15,623.0	9,629.0	11,617.0	7,651.0	7,718.0	5,515.0
Romania	113.0	29.0	0.0	0.0	0.0	0.0
Russia	662.0	144.0	146.0	228.0	252.0	330.0
Slovenia	212.0	35.0	70.0	0.0	0.0	0.0
Spain	36,937.0	10,650.0	17,118.0	8,022.0	5,825.0	6,823.0
Sweden	4,867.0	4,989.0	6,023.0	4,093.0	3,151.0	1,624.0
Switzerland(*)	53.0	47.0	51.0	0.0	0.0	0.0
Tunisia	0.0	29.0	0.0	0.0	0.0	0.0
Turkey	6,861.0	3,265.0	3,509.0	1,950.0	2,240.0	2,402.0
Ukraine	27.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	31,620.0	18,057.0	24,809.0	17,901.0	20,982.0	14,501.0
Total	**170363**	**83942**	**104014**	**68361**	**67065**	**58598**

ANNEX 5 - TRADE OF WOOD CHIPS AND WASTE WOOD INTO THE EPPO REGION FROM COUNTRIES WHERE *H. IRREGULARE* OCCURS

Table 1. FAO Stats Chips and particles (m3). (Years and countries without imports were deleted, There were no imports from the Dominican Republic and Cuba)

	USA							Canada							Mexico			
	2004	2006	2008	2009	2010	2011	2012	2004	2006	2008	2009	2010	2011	2012	2004	2009	2010	2011
Algeria			2013	1514	2669													
Austria	47	5	1	3	7	13	5000							17				
Azerbaijan				10	5	3	16				4							
Belarus							20					10						
Belgium	351	757	1526	2000	2000	1000	1000			1	4	4	2	1				
Bulgaria		636			111	10	2596											
Cyprus		456										77						
Czech Republic	368	1	2		1	3	5						3	1				
Denmark			1	7	1000	1000	2000		2		13	1						
Finland	524			1						53342	118000	119000	20					
France	898	7337	26	11000	14000	25000	21000		34	29	6	15	21	1				
Germany	288	3894	56	3000	9000	13000	38000	6	59632	2		1	5	26	41	89	107	25
Greece	9			1000		1				3			1	1				
Hungary	3	32	9	1	2					2	1	3		2				
Ireland	240	11	22	9	2				35		49							
Israel	91	491		6	39		267						28	2				
Italy	86074	6103	23	15000	13000	13000	20000	7	159546	1	25	154	263	133				
Libya				72	163													
Malta				1														
Morocco	5	3																
Netherlands	23	164	10	3000	3000	54	42			5	11	19						
Norway		2		17			11000			60		152000						
Poland					1	33	20			1		13	1	2				
Portugal	3	654	47	1000	1000	3000				3								
Republic of Moldova		1					50											
Romania	1																	
Russian Fed			17	11	15	17	21	57		352		5						
Slovenia	2682										20			9000				
Spain	780	4294	264	4000	5000	4000	5000			1		2	1	119				
Sweden	1	3	3	3	31	8	1000		1	16741			3	2	18	16		
Switzerland		270					24			2	1	3	1					
Turkey	27418	78626	5	510000	588000	1958000	2096000			146964	38000	76000	422000	873000				

	USA							Canada							Mexico			
	2004	2006	2008	2009	2010	2011	2012	2004	2006	2008	2009	2010	2011	2012	2004	2009	2010	2011
Ukraine			80		2				9402					1				
United Kingdom	247	360	44	1000	69	78	105	1711	1229	1401	133000	39264	14	4				
Total	120053	104100	4149	552655	639117	2018220	2203166	1781	229881	218910	289134	386571	422363	882312	59	105	107	25

ANNEX 5. Table 2. Eurostat. 440121. Coniferous wood chips CONIFEROUS WOOD IN CHIPS OR PARTICLES (EXCL. THOSE OF A KIND USED PRINCIPALLY FOR DYING OR TANNING PURPOSES)

	USA						Canada				
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2012	2013
Austria	:	:	:	2	:	:	:	:	:	:	2
Belgium	195	:	:	:	:	:	:	:	:	:	:
Czech Rep.	:	:	:	0	0	0	:	:	:	:	:
Denmark	:	14	:	1	:	9 066	14	:	:	:	:
Finland	:	:	:	:	2	:	:	1	:	:	:
France	:	:	:	:	33	:	:	218	:	:	:
Germany	231	86	162	441	151	189	:	:	:	:	1
Ireland	:	:	:	:	0	:	253	:	:	:	:
Italy	426 911	:	:	:	:	:	1 212 330	:	:	:	:
Lithuania	:	10	:	:	:	:	:	:	:	:	:
Netherlands	2	:	28	:	:	0	:	:	:	:	:
Poland	:	:	:	326	190	101	:	:	:	:	:
Spain	:	418	:	:	254	:	:	:	:	:	:
Sweden	8	1	294	:	:	:	:	167 412	:	1	8
UK	13 026	11	116	38	291	55	8 630	13 564	392 480	:	:
	440373	540	600	808	921	9411	1221227	181195	392480	1	11

ANNEX 5. Table 3. Imports to EU. Eurostat. 440122. Non coniferous wood chips WOOD IN CHIPS OR PARTICLES (EXCL. THOSE OF A KIND USED PRINCIPALLY FOR DYING OR TANNING PURPOSES, AND CONIFEROUS WOOD)

	USA						Canada						Mexico		
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013	2008	2010	2011
AUSTRIA	4	:	0	4	0	186	:	:	0	:	:	2	:	:	:
BELGIUM	:	:	:	182	175	:	:	:	:	:	:	:	:	:	:
BULGARIA	41	:	:	100	:	302	:	:	:	:	:	:	:	:	:
CROATIA	1	:	0	0	2	0	:	:	:	:	:	:	:	:	:

	USA						Canada						Mexico		
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013	2008	2010	2011
CYPRUS	:	1	:	1	:	:	:	:	:	:	:	:	:	:	:
CZECH REP	:	:	:	:	0	0	:	:	:	32	20	16	:	:	:
DENMARK	:	:	59	33	645	1 599	:	:	:	:	:	:	0	:	:
ESTONIA	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
FINLAND	0	:	6	:	:	113	:	533 421	985 107	:	:	:	:	:	:
FRANCE	0	253	256	822	2 361	3 012	:	67	:	:	:	3	:	:	:
GERMANY	182	472	1 223	1 580	1 565	2 576	:	:	:	:	:	:	:	1 067	252
GREECE	:	:	0	12	:	:	:	:	:	:	:	:	:	:	:
HUNGARY	231	91	19	5	3	7	5	:	1	0	2	:	:	:	:
IRELAND	10	215	18	:	:	6	:	:	:	:	:	:	:	:	:
ITALY	140	225	768	835	194	143	:	:	:	:	:	:	:	:	:
NETHERLAND	122	99	386	661	424	176	:	:	:	2	5	68	:	:	:
POLAND	:	9	:	0	2	7	:	:	:	:	:	:	:	:	:
PORTUGAL	108	471	56	330	:	0	:	:	:	:	:	:	:	:	:
SLOVAKIA	:	:	:	:	0	:	:	:	:	:	:	:	:	:	:
SPAIN	597	947	378	885	1 062	1 230	:	:	:	:	:	:	:	:	:
SWEDEN	15	:	17	16	251	465	:	:	:	2	:	:	:	:	:
UK	1 889	430	573	741	757	1 687	152	449	162	145	40	62	:	:	:
Total	**3340**	**3213**	**3759**	**6207**	**7441**	**11509**	**157**	**533937**	**985270**	**181**	**67**	**151**	**0**	**1067**	**252**

ANNEX 5. Table 4. Exports from the USA to EPPO countries (USDA-FAS 440121 - Wood In Chips, Conif (metric tonnes)

	2008	2009	2010	2011	2012	2013
Algeria	1,890.0	1,514.0	2,669.0	0.0	0.0	0.0
Azerbaijan	0.0	0.0	70.0	0.0	0.0	0.0
Belgium(!)	1,435.0	2,450.0	1,284.0	1,249.0	962.0	1,164.0
Czech Republic	98.0	95.0	0.0	0.0	38.0	0.0
Denmark(*)	0.0	0.0	905.0	1,351.0	1,660.0	3,236.0
Finland	0.0	0.0	0.0	0.0	121.0	0.0
France(*)	0.0	849.0	7,386.0	14,318.0	8,657.0	3,843.0
Germany(*)	504.0	0.0	1,264.0	3,264.0	4,006.0	4,672.0
Greece	0.0	21.0	12.0	0.0	0.0	0.0
Ireland	0.0	0.0	39.0	0.0	41.0	5.0
Israel(*)	0.0	0.0	222.0	168.0	3,625.0	39.0
Italy(*)	705.0	1,328.0	1,628.0	947.0	17,415.0	39,074.0
Netherlands	197.0	454.0	610.0	1,074.0	701.0	1,370.0
Norway(*)	0.0	0.0	0.0	0.0	0.0	56.0

	2008	2009	2010	2011	2012	2013
Poland	0.0	0.0	0.0	32.0	18.0	18.0
Russia	17.0	0.0	0.0	0.0	0.0	0.0
Spain	248.0	434.0	0.0	0.0	0.0	0.0
Sweden	0.0	38.0	0.0	84.0	0.0	0.0
Switzerland(*)	0.0	0.0	0.0	0.0	0.0	217.0
Turkey	205,951.0	509,642.0	588,044.0	741,864.0	983,571.0	541,899.0
Ukraine	15.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	104.0	141.0	956.0	1,051.0	784.0	1,931.0
Total	**211164**	**516966**	**605089**	**765402**	**1021599**	**597524**

ANNEX 5. Table 5. US exports to EPPO countries (USDA-FAS, 2014) - 440122 - Wood In Chips, non-coniferous (metric tonnes)

	2008	2009	2010	2011	2012	2013
Belgium(!)	664.0	0.0	609.0	0.0	0.0	0.0
Bulgaria	813.0	813.0	111.0	813.0	2,596.0	2,461.0
Czech Republic	65.0	0.0	0.0	0.0	0.0	0.0
Denmark(*)	2,088.0	0.0	0.0	0.0	183.0	4,676.0
Finland	44.0	0.0	0.0	0.0	0.0	637.0
France(*)	15,341.0	10,075.0	6,738.0	11,119.0	11,849.0	23,207.0
Germany(*)	3,309.0	3,470.0	7,930.0	9,641.0	14,470.0	12,279.0
Israel(*)	1,319.0	2,181.0	1,674.0	2,518.0	2,827.0	1,981.0
Italy(*)	8,318.0	13,364.0	11,741.0	12,403.0	2,772.0	1,906.0
Moldova	473.0	0.0	0.0	0.0	50.0	0.0
Netherlands	5,642.0	2,745.0	2,025.0	63.0	130.0	2,192.0
Portugal	4,005.0	1,373.0	513.0	2,800.0	0.0	0.0
Spain	4,016.0	4,065.0	5,423.0	4,212.0	4,941.0	5,111.0
Sweden	965.0	0.0	0.0	70.0	875.0	3,240.0
Switzerland(*)	0.0	476.0	0.0	194.0	0.0	532.0
Turkey	0.0	45.0	0.0	0.0	12,184.0	122,441.0
United Kingdom	128.0	223.0	130.0	334.0	7,209.0	2,758.0
Total	**47190**	**38830**	**36894**	**44167**	**60086**	**183421**

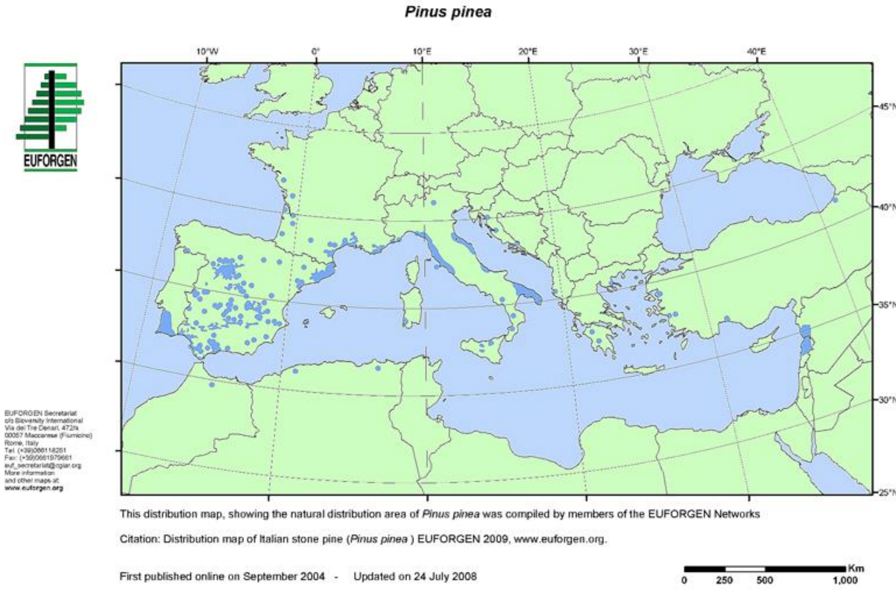
ANNEX 5. Table 6. EUROSTAT. 440130 - 2006-2011 : sawdust and waste wood and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms
440139 - 2012-2013 : sawdust and waste wood and scrap, whether or not agglomerated in logs, briquettes or similar forms (excl. Pellets)

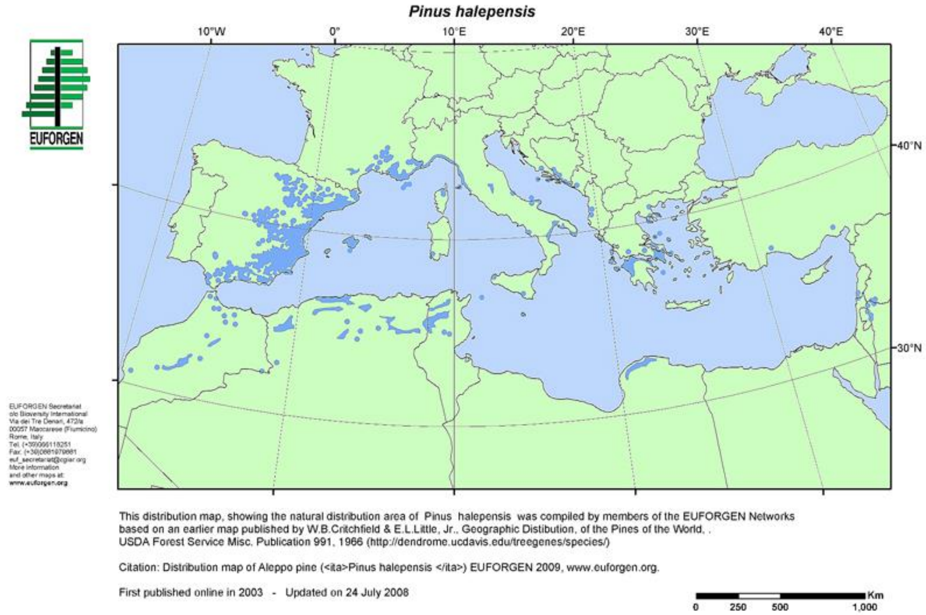
	USA						Canada						Cuba	Mexico	
	2006	2008	2010	2011	2012	2013	2006	2008	2010	2011	2012	2013	2012	2010	2011
Austria	0	17	108	34	0	:	:	9	1	5	0	:	:	0	1
Belgium	2 344	642	914 098	2 147 977	1 007 326	48 405	1 841 411	1 799 701	753 303	1 948 143	202 445	13 145	:		:
Bulgaria	12	:	10	:	17	107	:	:	:	:	:	:	:		:
Cyprus	:	:	:	:	:	:	:	:	:	:	:	:	:		:
Czech Rep.	145	1	0	82	91	49	152	3	149	:	1	8	:		:
Germany	2 596	21 555	125 341	10 318	13 089	19 948	2 727	1 382	108 387	11 700	:	:	:		:
Denmark	342	1 192	800 931	383 835	204	1	255 083	77 314	374 961	182 428	0	0	:		:
Estonia	:	:	0	:	:	:	:	:	67	7	:	:	:		:
Spain	837	120	762	151	:	:	:	:	3	2	:	:	:		:
Finland	41	2	5	14	0	:	:	:	:	:	:	:	:		:
France	3 371	3 360	1 037	1 988	1 041	13 148	1 621	377	41	0	2	230	:		:
Uk	4 504	170 074	1 888 211	2 762 224	5 062	5 741	82 413	394 334	3 079 005	5 918 567	507	481	5		:
Greece	526	488	343	:	:	43	:	180	197	:	:	348	:		:
Hungary	71	:	:	:	:	:	:	:	:	:	:	:	:		:
Ireland	978	3 446	281	91	3	1 599	31 817	16 461	:	:	:	:	:		:
Italy	12 624	1 810	36 257	208 901	0	200	108 100	1 820	125 074	660 521	4	4 398	:		:
Lithuania	:	:	:	:	:	:	:	7	:	:	:	:	:		:
Luxembourg	:	:	:	:	:	:	:	:	:	:	:	:	:		:
Latvia	:	:	:	0	:	:	0	0	:	:	:	:	:		:
Malta	:	:	15	90	0	:	161	:	:	:	:	:	:		:
Netherlands	322	680 469	3 459 897	4 234 601	2	3 269	1 704 318	4 418 811	5 170 661	2 753 841	:	:	:		:
Poland	:	0	7	80 425	1	:	:	:	:	:	:	:	:		:
Portugal	:	:	143	37	:	:	12	15	:	:	6	:	:		:
Romania	:	:	:	:	:	0	:	:	:	:	:	5	:		:
Sweden	707	57 956	488 939	454 286	119 018	25	1 305 972	317 512	219 987	264 662	:	:	:		:
Slovenia	:	:	0	:	:	0	10	12	2	5	3	:	:		:
Slovakia	:	:	:	:	:	0	:	:	:	:	:	:	:		:
Croatia	:	:	:	:	:	:	:	:	0	:	:	:	:		:

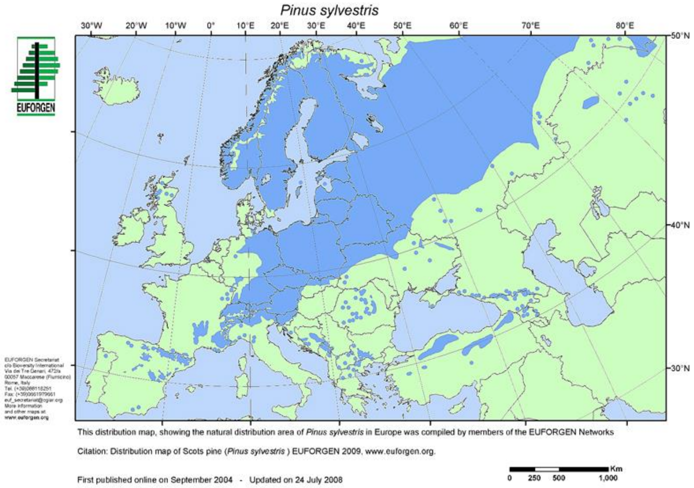
ANNEX 5. Table 7. Waste wood - Export from the USA to EPPO countries of "sawdust and wood waste and scrap, whether or not agglomerated in logs, briquettess or similar forms (other than pellets" (4401300000 in 1998-2011; 4401390000 in 2012-2013) (unit: metric tonnes) (source USDA-FAS, 2014)

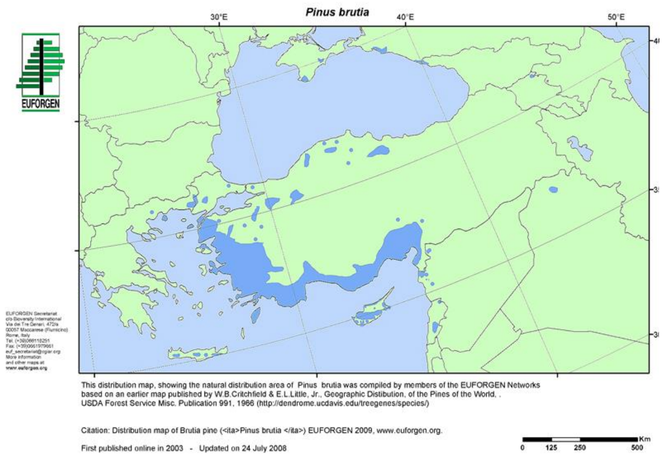
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Algeria																33.1
Belgium						32.6	65	31.1	18.7	18.9	121121.7	259030.8	85225.8	3478.3	16.4	26.8
Bulgaria			1		6.5											
Denmark		2.9							2.6	31.7	16.1	26	46	54.4	54.1	
Ireland			.9				61.8	78.3		100.3	211.7	30.9				
Czech Rep.						1.2								19.1		
Finland											307.8			4.6		
France	55	16.7	1.8	3.1	17.4	48.9	75.5	118.5	148.3		3.8	7.8	29	1.1	2.2	
Germany	0.8		78	19.5		2.4	5.3		4.6	1015	865.6	61.8	250.7	22.1	148.8	260.6
Greece	49.2		17		85.6	97.8	105	104.4	81.7	66	66	40.1	15.9			
Israel			17.2		3.6	19.4				24.2	37	22.9		34.3		
Italy				20.2	72.3	74.1	40587.4	211725.6	36.2	4111.3	2.1	3.3	4633.6	19540.5	790.6	
Jordan								6		68.6						
Kazakhstan						37.8	19.2									
Latvia						2.2										
Malta												16.8		42.3	0.0	13.0
Netherlands	164.6	1.2	2.6		0.5				8.4		49782.7	235221.9	222979.8	90548.3	98.3	279.9
Norway					17.2				6			2.4				
Poland											4.3	2.8				
Portugal		20				16		7.9								
Russia	26.3							17.6	13	14.3	45.1	28.1	68	47	27.9	4.6
Spain	16.2	120.7	149.2	232	413.5	876	1041	148.7	1007.3	1177.3	812.9	242.7				
Sweden				1.1				6.7			778.2	68.9	90.7		734.8	
Switzerland			4.1			16.6	22.9		11.6			16.7		7.4	0.4	
Turkey							15.7		22.7	273.9		15.9	55.5	35.8	0.1	42.3
UK	57.8	164.6	47.9	88.9	321	2105.4	2969.8	4658.8	1903.3	1108.3	1212.5	852.5	133116.9	161584.3	616.9	511.9
Total	**369,9**	**326,1**	**319,7**	**364,8**	**937,6**	**3330,4**	**44968,6**	**216903,6**	**3264,4**	**8009,8**	**175267,5**	**495692,3**	**446511,9**	**275419,5**	**2490,5**	**1139,1**

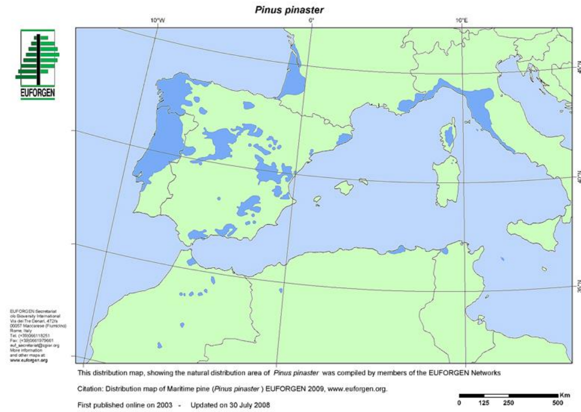
ANNEX 6 – Maps of distribution of certain *Pinus* species in the the PRA area (all from EUFORGEN, 2009)



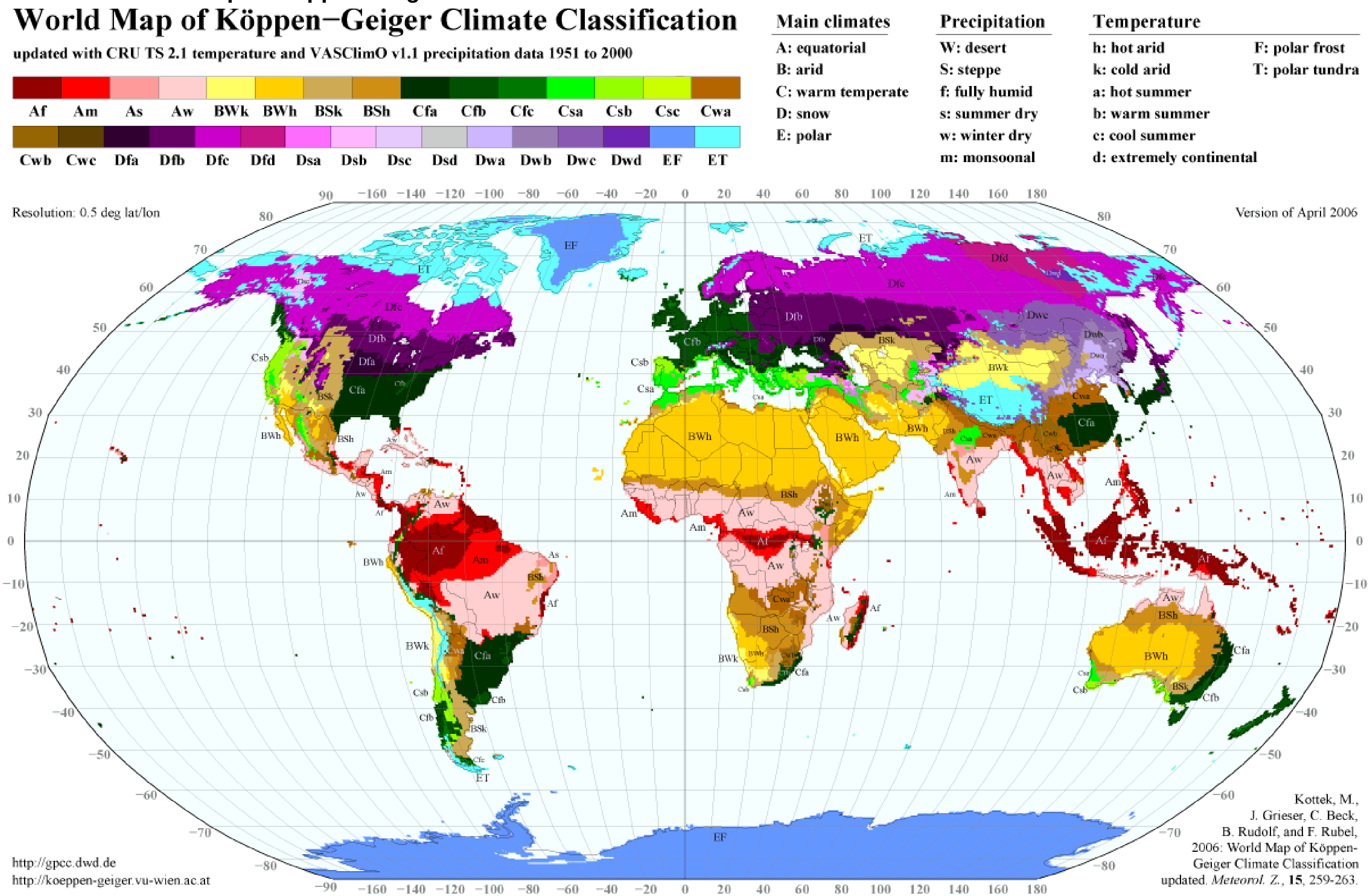








ANNEX 7 - World Map of Köppen Geiger Climate classification



ANNEX 8 – Detailed consideration of pest risk management

Stage 3: Pest Risk Management

7.01 - Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?

no

The risk is not considered acceptable for wood of conifers, conifer wood chips and waste wood , plants for planting of host species and untreated wood packaging material. Untreated wood packaging is not detailed here as treatment according to ISPM 15 would make the risk acceptable.

Measures for Christmas trees and bark of hosts are not studied in detail but can be adapted from those for plants for planting and for wood chips.

7.02 - Is natural spread one of the pathways?

yes

H. irregulare is expected to spread from its current distribution in Italy (see section 11).

7.03 - Is the pest already entering the PRA area by natural spread or likely to enter in the immediate future?

The answer to question 4.01 was:

no

H. irregulare occurs in Italy, but its spread to other countries will be extremely slow and it is not likely to reach another country in the immediate future (see section 11). The spread may be further slowed down by application of containment measures (see section 16.2).

Pathway 1: Round wood (incl. firewood) and sawn wood of conifer hosts

7.06 - Is the pathway that is being considered a commodity of plants and plant products?

yes

7.09 - If the pest is a plant, is it the commodity itself?

no (the pest is not a plant or the pest is a plant but is not the commodity itself)

7.10 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? (if yes, specify the measures in the justification)

no

Level of uncertainty: low

H. irregulare is not a quarantine pest in the PRA area. At the scale of the whole PRA area, there are no measures that would completely prevent its introduction.

Requirements in EPPO countries are presented in Annex 2 (Table 1). This annex is based on current requirements for the EU, but on older EPPO summaries of phytosanitary regulations for most other countries. However, it may give an indication of the current requirements in place, and overall the pathway seems to be open from all origins for most hosts, categories of wood and countries of the PRA area. A number of countries in the PRA area (such as the EU) have regulations in place targeting some hosts. The EU has requirements in place against *Bursaphelenchus xylophilus* and if heat treatment is applied, it would be effective against *H. irregulare*. General requirements are also in place for some countries. A few commodities of wood seem prohibited to a few individual countries (conifer wood with bark; Pinus non-squared wood, conifer fuel wood).

Options at the place of production

7.13 - Can the pest be reliably detected by visual inspection at the place of production (if the answer is yes specify the period and if possible appropriate frequency, if only certain stages of the pest can be detected answer yes as the measure could be considered in combination with other measures in a Systems Approach)?

No

Level of uncertainty: low

H. irregulare is more likely to be initially detected when symptoms are expressed in the crown of the tree. Symptoms and disease gaps are only likely to appear after several years. Fruiting bodies are also most likely to appear after some time. Early infestations may not be detected. *H. irregulare* is difficult to detect especially at low levels of infestation. Symptoms are also not specific, and may be overlooked. This measure is not sufficient on its own but may be used a part of a PFA.

Spore trapping can be done, followed by identification. This is considered as a sensitive method and could detect low population levels. However, it is not considered as a possible phytosanitary measure.

Samples can also be collected at thinning and subjected to fungal isolation. However, sampling needs to target suspected material, i.e. from trees with crown symptoms.

7.14 - Can the pest be reliably detected by testing at the place of production? (if only certain stages of the pest can be detected by testing answer yes as the measure could be considered in combination with other measures in a Systems Approach)

no

Level of uncertainty: low

There are a number of detection methods that are available to detect rot in standing trees, but they are not species-specific and are damaging to the trees (and increase the possibilities of entry of other pests). The pest may also not affect all trees in a particular stand.

7.15 - Can infestation of the commodity be reliably prevented by treatment of the crop?

no

Level of uncertainty: low

There is no treatment available. Spread may be slowed down by treating stumps at harvest, but this will not eliminate the pest when already present in living trees or in remaining stumps.

7.16 - Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)

no

Level of uncertainty: low

There is currently no information on resistant cultivars/provenances.

7.17 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?

no

Level of uncertainty: low

Not relevant for wood.

7.18 - Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?

no

Level of uncertainty: low

The fungus may be present in the tree at any time of the year and any age.

7.19 - Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?

no

Level of uncertainty: low

Not relevant.

7.20 - Based on your answer to question 4.01 (with uncertainty), select the rate of spread.

low rate of spread

Level of uncertainty: low

Possible measure: pest-free place of production or pest free area

See section 11.

7.21 - The possible measure is: pest-free place of production or pest free area
Can this be reliably guaranteed?

yes

Level of uncertainty: low

A pest free production site is not considered an option as the pest may already have spread beyond the limits of known infestation and a neighbouring production site may be already infested. Pest-free area is a suitable option.

In order to establish and maintain a PFA, the following elements should be fulfilled:

- Area isolated by appropriate physical barriers (e.g. absence of hosts or sufficient distance) or minimum distance from the limits of infested areas. Such distance could be 100 km based on current knowledge and models of the spread of spores. The distance of 80 km reflects the spore spread that has happened in the infested area of Italy over about 70 years after its introduction in an area with no continuity of pine. However, there is a need to take into account the possible spread of spores at longer distances, and the EWG proposed that 100 km (increasing as a precautionary approach by circa 20% the length of the buffer zone around an infested area) provides a sufficient precautionary distance to cover for such long-distance spread. Following a request of the EPPO Working Party on Phytosanitary Regulations, an EPPO Expert Working Group considered in 2020 a scenario of long-distance spread. Outputs of this EKE may help inform decision making by an NPPO about the size of buffer zone required for the establishment of a PFA. The EKE was performed considering a cluster of infected trees, in a homogeneous forest of host trees, the distance being measured after formation of a first fruiting body during the following year. The exercise excluded any human assisted spread. The combined events enabling long distance dispersal include several periods of rain with a moderate ambient temperature, stormy winds, and numerous disturbed forest sites. The experts judged that 1% of the infection events within a year would occur during such conditions of long-distance dispersal. Based on a review of the evidence, experts judged that 1% of the infections will occur after one year at a distance of approximately 11 km (best estimate of the median value), with a 90% uncertainty range from 2 to 32 km. Report of the EKE exercise is made available at https://upload.eppo.int/download/933o02d521b6b

- A monitoring programme based on visual examination (symptoms on trees, fruiting bodies) and spore trapping in areas where hosts are present. This would require appropriate identification capabilities to avoid misidentifications. Such surveillance should last for at least 3 years, and should be conducted during the period when spore release is the most abundant for the area considered. The density of trap should be high to detect very low population levels.
- Incubation of a cross-section from the top of the stumps after felling at a suitable frequency.
- Measures should be put in place to prevent the entry of the pest into the PFA, i.e requirements on commodities.
- Measures should be taken to avoid infestation of the wood when it is transported outside of the PFA. This is especially important for green wood.

The PFA should be officially recognized by the importing country.

Due to the limited distribution of the pests,the EWG noted that the PFA requirement only need to be applied to North America, Italy, the Caribbean, and possibly Central America, but not to countries from other continents.

Options after harvest, at pre-clearance or during transport

7.22 - Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?

no

Level of uncertainty: low

Although fruiting bodies and stem rot may be detected, they are not characteristic and may be absent at early stage of the disease. Visual inspection will not easily detect early infestation because of the size of wood consignments.

However, visual inspection could be used as part of a systems approach to ensure that consignments are free from the pathogen, but this would only be effective in association with other very specific measures.

7.23 - Can the pest be reliably detected by testing of the commodity (e.g. for pest plant, seeds in a consignment)?

no

Level of uncertainty: low

The fungus may have an irregular distribution in logs, and this would require a high intensity of testing, which is not relevant in practice.

7.24 - Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?

yes as standalone measure

Level of uncertainty: low

Possible measure: specified treatment of the consignment

No methods are currently used in North America to destroy the pest in wood. However, the following methods are considered to be effective:

Heat treatment. Heat treatments have proven to be highly effective for subcortical insects and pathogens. The EPPO Standard PM 10/6(1) *Heat treatment of wood to control insects and wood-borne nematodes*, contains a schedule of heat-treatment until the core temperature reaches at least 56°C for at least 30 min. There is no indication of an effective heat treatment schedules for *H. irregulare* on wood. However, mycelium and spores are reported to be killed at 40 C for 1 h and Allen (2014) indicates a maximum survival temperature for 30 minutes of 46°C for *H. annosum* (the original study is not known; E. Allen coordinates the work of the IFQRG, which looks into issues linked with the efficacy of treatments for ISPM 15). It is likely that the "common" heat treatment recommended for wood of a core temperature of at least 56 C for 30 min will kill the pest.

Kiln-drying that fulfills the heat treatment conditions above is considered effective (kiln-drying is otherwise not considered as a suitable measure – there is no data showing that kiln-drying at 20% would be effective and kiln-drying is normally done on boards).

The following treatments were not considered effective:

Processing into sawn wood will remove part of the bark and outer surface of the wood, and eliminate part of the inoculum. The wood will dry out more quickly. Fruiting bodies are not likely to develop, and such wood is less likely to be stored on soil for the long periods necessary for the fruiting bodies to develop). However, this is not considered as being effective to destroy the pest.

Chipping. The wood dries more quickly. However, *H. irregulare* could survive, especially in bigger chips where bark is present.

Irradiation. There is an EPPO Standard PM 10/8(1) Disinfestation of wood with ionizing radiation but it relates to infesting wood (including Scolytidae). The effect on H. irregulare is unknown, and this option has not been retained.

Methyl bromide fumigation of wood. Methyl bromide would be an option but there is not yet a documented effective concentration to eliminate *H. irregulare*. A fumigation schedule is not yet available. In addition, in the EPPO region, this measure is not recommended because methyl bromide will be phased out in 2015 and its use is not favoured in many EPPO countries because of its environmental consequences, see IPPC Recommendation *Replacement or reduction of the use of methyl bromide as a phytosanitary measure* (FAO, 2008)

Chemical pressure impregnation. There is no indication of effectiveness on *H. irregulare*. In addition, this is not effective in the presence of bark, on big logs. Chemical pressure impregnation requires a wood surface clean from dirt and bark (as bark is impermeable to liquid chemicals), small wood thickness, and wood moisture below 25-30%.

7.25 - Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)

no

Level of uncertainty: low

The fungus does not occur on the stem of all species. On species where the fungus does not grow high in the stem (e.g. *Pinus*), a requirement could be made that trees are cut at 2.5 m above the stem base (this is the height recommended in Wisconsin DNR, 2014). However this would reduce the value of the product, and may favour build up of populations on site.

Making the wood bark-free or squaring to entirely remove the wood surface is not considered to reduce the risk adequately.

Debarking will eliminate fruiting bodies and part of the mycelum associated to the tree, but would not be sufficient to remove all colonized tissues. Small areas of bark would be sufficient to shelter viable mycelium.

7.26 - Can infestation of the consignment be reliably prevented by handling and packing methods?

No

Level of uncertainty: low

Complementary answer: specific handling/packing methods

The logs could be stored without contact with the soil, for a sufficient period in conditions that do not prevent the development of fruiting bodies (combined with inspection, so that if fruiting bodies develop, they are detected). If fruiting bodies have not formed during this period, it could be concluded that the pathogen is not present or has disappeared. However, it is difficult to decide the length of the period after which there is sufficient confidence that fruiting bodies are not going to form, as this depends on many parameters, and may range from several weeks to several years.

Reinfestation is not considered an issue. Although some spores may be deposited on trees when cut, they are not likely to lead to infection.

Options that can be implemented after entry of consignments

7.27 - Can the pest be reliably detected during post-entry quarantine?

no

Level of uncertainty: low

Not relevant for wood.

7.28 - Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?

no

Level of uncertainty: low

The wood could be accepted for immediate processing, with appropriate measures relating to disposal of bark and waste. However, the risk attached to the disposal of waste is too high, and it is difficult to control that the wood will be processed immediately.

7.29 - Are there effective measures that could be taken in the importing country (surveillance, eradication, containment) to prevent establishment and/or economic or other impacts?

no

Level of uncertainty: low

Surveillance can be put in place at the vicinity of facilities using the wood, using spore traps (however, this would only detect spores released by fruiting bodies, and not mycelium). Eradication is not considered possible in most cases (see section 16 of the PRA).

7.30 - Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?

Q.	Standalone	System Approach	Possible Measure	Uncertainty
7.20	X		pest-free place of production or pest free area	low
7.24	X		specified treatment of the consignment	low

yes

7.31 - Does each of the individual measures identified reduce the risk to an acceptable level?

no

Level of uncertainty: low

The following individual measures reduce the risk to an acceptable level:
PFA
or
Treatment (heat treatment)

7.34 - Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.

Level of uncertainty: low

The measures would interfere with trade :
- from the USA and Canada: but there are already some measures in place for various wood species to certain EPPO countries.
- from other countries where the pest occurs: trade is probably very limited.
- from countries where the pest does not occur, as these would need to demonstrate the absence of *H. irregulare* (especially if Central America or South America, where there is uncertainty regarding the presence of *H. irregulare*, were covered by regulation).

Measures are not likely to interfere much with trade from the infested area of Italy, as this is not a major area of production.

7.35 - Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.
Level of uncertainty: low
The measures create additional costs. Heat treatment may not be cost effective for some wood commodities (e.g. firewood).

Importing countries would have costs of inspection related to the requirement for a PC. There would be costs of identification following inspection, but such costs are currently incurred under current measures in countries where wood of conifer is already regulated.

The disease is already under some surveillance in the USA in many areas where it occurs. Any requirements for PFA would have costs and there would possibily be costs for countries where the pests are not present.

H. irregulare would be impossible to eradicate in most cases if introduced, and is likely to have a high impact. Therefore measures preventing introduction will be cost effective. Measures will be as cost-effective if *H. occidentale* is also covered.

7.36 - Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?
yes
PFA
or
Treatment (heat treatment)

Pathway 2: Conifer particle wood and waste wood

7.06 - Is the pathway that is being considered a commodity of plants and plant products?
yes

7.07 - Is the pathway that is being considered the entry with human travellers?
no

7.08 - Is the pathway being considered contaminated machinery or means of transport?
no

7.09 - If the pest is a plant, is it the commodity itself?
no (the pest is not a plant or the pest is a plant but is not the commodity itself)

7.10 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? (if yes, specify the measures in the justification)
no
Level of uncertainty: low
H. irregulare is not a quarantine pest in the PRA area. At the scale of the whole PRA area, there are no measures that would completely prevent its introduction.

Requirements in EPPO countries are presented in Annex 2 (Table 2). This annex is based on current requirements for the EU, but on older EPPO summaries of phytosanitary regulations for most other countries. However, it may give an indication of the current requirements in place, and overall the pathway seems to be open from all origins for most hosts, categories of wood and countries of the PRA area. A number of countries in the PRA area (such as the EU) have regulations in place. General requirements are also in place for some countries.

Turkey, which imports large quantities of wood chips, seems to have some measures in place (produced from wood that was fumigated or stripped of its bark, or kiln-dried; and carried in sealed containers or equivalent), but not all of these may be effective against *H. irregulare*.

Options at the place of production

7.13 - Can the pest be reliably detected by visual inspection at the place of production (if the answer is yes specify the period and if possible appropriate frequency, if only certain stages of the pest can be detected answer yes as the measure could be considered in combination with other measures in

a Systems Approach)?
no
Level of uncertainty: low
As for wood.

7.14 - Can the pest be reliably detected by testing at the place of production? (if only certain stages of the pest can be detected by testing answer yes as the measure could be considered in combination with other measures in a Systems Approach)
no
Level of uncertainty: low
As for wood.

7.15 - Can infestation of the commodity be reliably prevented by treatment of the crop?
no
Level of uncertainty: low
As for wood.

7.16 - Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)
no
Level of uncertainty: low
As for wood.

7.17 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?
no
Level of uncertainty: low
Not relevant for wood.

7.18 - Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?
no
Level of uncertainty: low
As for wood.

7.19 - Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?
no
Level of uncertainty: low
Not relevant.

7.20 - Based on your answer to question 4.01 (with uncertainty), select the rate of spread.
low rate of spread
Level of uncertainty: low
Possible measure: pest-free place of production or pest free area
As for wood

7.21 - The possible measure is: pest-free place of production or pest free area
Can this be reliably guaranteed?
yes
Level of uncertainty: low
As for wood.

Options after harvest, at pre-clearance or during transport
7.22 - Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?
no
Level of uncertainty: low
The pest would be difficult to detected in wood chips and waste wood.

7.23 - Can the pest be reliably detected by testing of the commodity (e.g. for pest plant, seeds in a consignment)?

no
Level of uncertainty: low
Possible measure: specified testing of the consignment
As for wood

7.24 - Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?
yes as standalone measure
Level of uncertainty: low
Possible measure: specified treatment of the consignment
Heat treatment could be used. There has not been specific studies on heat treatment of wood chips. The schedule recommended for wood (i.e. core temperature of at least 56°C for 30 min) is expected to be effective if applied throughout the profile of the material.

Methyl bromide fumigation. Methyl bromide would be an option but the effective concentration to eliminate *H. irregulare* is unknown. A fumigation schedule is not available. In addition, in the EPPO region, this measure is not recommended because methyl bromide will be phased out in 2015 and its use is not favoured in many EPPO countries because of its environmental consequences, see IPPC Recommendation *Replacement or reduction of the use of methyl bromide as a phytosanitary measure* (FAO, 2008)

7.25 - Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)
no
Level of uncertainty: low
Wood chips could be produced from wood which is bark-free and not produced from the lower part of the stems or roots. However this does not correspond to current practice.

This is probably not applicable to waste wood.

7.26 - Can infestation of the consignment be reliably prevented by handling and packing methods?
no
Level of uncertainty: low
Possible measure: specific handling/packing methods
As for wood.

Options that can be implemented after entry of consignments
7.27 - Can the pest be reliably detected during post-entry quarantine?
no
Level of uncertainty: low
Not relevant

7.28 - Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?
no
Level of uncertainty: low
The consignments could be accepted for immediate processing. However, such measures are difficult to implement and control (ensuring immediate processing, mixing consignments of wood chips, etc.).

7.29 - Are there effective measures that could be taken in the importing country (surveillance, eradication, containment) to prevent establishment and/or economic or other impacts?
no
Level of uncertainty: low
As for wood.

7.30 - Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?

Q.	Standalone	System Approach	Possible Measure	Uncertainty
7.20	X		pest-free place of production or pest free area	low

7.24	X		specified treatment of the consignment	low

yes

7.31 - Does each of the individual measures identified reduce the risk to an acceptable level?
yes
Level of uncertainty: low
The following measures reduce the risk to an acceptable level:
PFA
Or
Treatment (heat treatment)

7.34 - Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.
Level of uncertainty: low
Similar to wood. In addition, for conifer wood chips and wood waste, the pathway is already regulated in some countries with some general measures, and the measures will not interfere more with trade. The PFA requirement for countries where the pest is not known to occur will also interfere with trade.

7.35 - Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.
Level of uncertainty: low
The measures create additional costs. Heat treatment may not be cost effective.

Importing countries would have costs of inspection related to the requirement for a PC. There would be costs of identification following inspection, but such costs are currently incurred under current measures.

The disease is already under some surveillance in the USA in many areas where it occurs. Any requirements for PFA would have costs, also for countries in which the pest is not present.

H. irregulare would be impossible to eradicate in most cases if introduced, and is likely to have a high impact. Therefore measures preventing introduction will be cost effective. Measures will be as cost-effective if *H. occidentale* is also covered.

7.36 - Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?
yes
PFA
Or
Treatment (heat treatment).

Pathway 3: Plants for planting of host species

7.06 - Is the pathway that is being considered a commodity of plants and plant products?
yes

7.09 - If the pest is a plant, is it the commodity itself?
no (the pest is not a plant or the pest is a plant but is not the commodity itself)

7.10 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest? (if yes, specify the measures in the justification)
No, except for some countries (including the EU)
Level of uncertainty: low
Plants for planting of conifers are prohibited in a number of countries, including the EU.

Requirements in EPPO countries are presented in Annex 1 (Table 4). This annex is based on current requirements for the EU, but on older EPPO summaries of phytosanitary regulations for most other countries. However it gives an indication of the requirements in place, and overall the pathway seems to be open for most countries in the PRA area from all origins. A PC is usually required for plants for planting in EPPO countries, but this does not guarantee the absence of all pests. General requirements (e.g. import permit or phytosanitary certificate) may ensure that inspections are carried out, but detection of *H. irregulare* would be difficult.

Options at the place of production

7.13 - Can the pest be reliably detected by visual inspection at the place of production (if the answer is yes specify the period and if possible appropriate frequency, if only certain stages of the pest can be detected answer yes as the measure could be considered in combination with other measures in a Systems Approach)?

no

Level of uncertainty: low

As for wood, *e*arly infestations may not be detected. Symptoms are also not specific, and may be overlooked. This measure is not sufficient on its own but may be used a part of a PFA.

Spore trapping can be done, followed by identification. This requires the presence of an actively sporulating population; the threshold for detection is not clear.

Samples cannot be collected as this would damage the plants.

If living plants are infected, they are likely to have been in contact with infested roots. If this is the case, their roots may show signs of rot (especially when changing the growing medium to fulfill the requirements in some EPPO countries) and the rot could then be identified. However, such signs may be overlooked.

7.14 - Can the pest be reliably detected by testing at the place of production? (if only certain stages of the pest can be detected by testing answer yes as the measure could be considered in combination with other measures in a Systems Approach)

no

Level of uncertainty: low

Testing is possible on symptomatic material (although time consuming) but there is currently no testing method that would allow detection of the pest reliably and without damage to asymptomatic plants.

7.15 - Can infestation of the commodity be reliably prevented by treatment of the crop?

no

Level of uncertainty: low

There is no treatment available.

7.16 - Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)

no

Level of uncertainty: low

As for wood.

7.17 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?

yes as a stand-alone measure

Level of uncertainty: low

Possible measure: specified growing conditions of the crop

Plants for planting can be grown under complete physical protection throughout their life with sufficient measures to exclude the pest. Guidelines for growing under complete physical protection are being developed in EPPO. This is not common practice for nurseries of forest trees and this will not be practical for large plants, but it may be relevant for some plants. Bonsais can be subject to similar measures.

The conditions for such facilities are very stringent because they should prevent entry of spores, which have a very small size. The draft guidelines currently provide for either positive pressure inside the place/site of production or a suitable physical structure complemented by other measures (such as inspections, testing, hygienic measures or preventive treatments).

7.18 - Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth stages?

no

Level of uncertainty: low

All plant sizes may be infested. However, provided root infection is prevented, it is considered that spore contamination of young plants at long distance is less likely. The EWG proposed that for the production of plants younger than 5 years, and provided that other conditions (below) are met, a distance of 20 km from the closest infestation would be sufficient to reduce the risk of spore infestation. The plants should be grown in pots in sterilized substrate, and wounds should be avoided. Intensive monitoring should be conducted to verify absence of the pathogen in the space between the nursery and the closest infestation. The plants should be transported in conditions preventing infestation.

Note: in the case of Italy, because the infested area (in the proposed containment plan, see 16.2) is demarcated to extend 10 km beyond the closest known infestation, the requirement above would mean that plants younger than 5 years may be grown at minimum 10 km from the limit of the demarcated infested area.

7.19 - Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production of healthy plants for planting)?
no
Level of uncertainty: low
Not relevant.

7.20 - Based on your answer to question 4.01 (with uncertainty), select the rate of spread.
low rate of spread
Level of uncertainty: low
Possible measure: pest-free place of production or pest free area
as for wood.

7.21 - The possible measure is: pest-free place of production or pest free area
Can this be reliably guaranteed?
yes
Level of uncertainty: low
As for wood.

The EWG discussed the possibility to establish pest-free places of production for plants for planting, but concluded that this would not be sufficient to ensure absence of the pathogen.

Options after harvest, at pre-clearance or during transport

7.22 - Can the pest be reliably detected by a visual inspection of a consignment at the time of export, during transport/storage or at import?
no
Level of uncertainty: low
Possible measure: visual inspection of the consignment
The pest would be difficult to detect in a large consignment of plants for planting, although signs of the pest may be detected on individual plants. Early infestations may be overlooked.

7.23 - Can the pest be reliably detected by testing of the commodity (e.g. for pest plant, seeds in a consignment)?
no
Level of uncertainty: low
The fungus occurs under the bark and in roots, and any sampling for testing would damage the trees.

7.24 - Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?
no
Level of uncertainty: low
No treatments are available to eliminate the fungus.

7.25 - Does the pest occur only on certain parts of the plant or plant products (e.g. bark, flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)
no
Level of uncertainty: low
The fungus may be in the root or at the base of the stem.

7.26 - Can infestation of the consignment be reliably prevented by handling and packing methods?
no
Level of uncertainty: low
Possible measure: specific handling/packing methods

The plants may be infested by root contact. However, handling and packing methods may be used to prevent the infestation by spores during transport (see 7.18).

Options that can be implemented after entry of consignments

7.27 - Can the pest be reliably detected during post-entry quarantine?

No

Level of uncertainty: low

Possible measure: import of the consignment under special licence/permit and post-entry quarantine

This would require keeping the plants in post-entry quarantine for a sufficient time in conditions favourable to the development of fruiting bodies. This duration would depend on the species and the age of the plants, but is highly variable. It is not possible to recommend a sufficient duration for post-entry quarantine.

7.28 - Could consignments that may be infested be accepted without risk for certain end uses, limited distribution in the PRA area, or limited periods of entry, and can such limitations be applied in practice?

no

Level of uncertainty: low

Plants for planting are destined to be planted. Infested roots may come in contact with healthy trees, and spores may be released by conidiophores or fruiting bodies.

7.29 - Are there effective measures that could be taken in the importing country (surveillance, eradication, containment) to prevent establishment and/or economic or other impacts?

no

Level of uncertainty: low

Plants for planting could be destined to all areas of use (forest, nurseries, parks, gardens) and would be widely distributed. Surveillance is possible but would be difficult to target.

7.30 - Have any measures been identified during the present analysis that will reduce the risk of introduction of the pest?

Q.	Standalone	System Approach	Possible Measure	Uncertainty
7.17	X		specified growing conditions of the crop (complete physical isolation)	low
		X	Specific crop ages	low
7.20	X		pest free area	low

yes

7.31 - Does each of the individual measures identified reduce the risk to an acceptable level?

yes

Level of uncertainty: low

PFA

Or

Grown under complete physical protection throughout their life with sufficient measures to exclude the pest

7.32 - For those measures that do not reduce the risk to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?

yes

Level of uncertainty: low

The following measures reduce the risk to a sufficient level:

Plants younger than 5 years + grown in pots in sterilized substrate + wounds should be avoided + at least 20 km from the closest infestation (or, if the proposed containment plan is applied, at least 10 km from the demarcated infested area) + intensive monitoring in the space between the nursery and the closest infestation + transported in conditions preventing infestation.

7.34 - Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.

Level of uncertainty: low

Requirements for import of plants for planting already exist for import to many EPPO countries (e.g. the EU). For other countries, measures may interfere to a certain extent with trade, but it is thought that trade is limited.

Measures may have an effect on trade of plants for planting of hosts from the infested area of Italy (if any, not known). If the pest reaches major production nurseries in Italy, there may be serious interference with trade.

7.35 - Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.
Level of uncertainty: low
The measures create additional costs. The disease is already under some surveillance in the USA in many areas where it occurs. Any requirements for PFA would have costs, and there would possibily be costs for countries where the pest is not present, but need to demonstrate their pest-free status.

Growing under complete physical protection is not practical and cost-effective for most plants, with the exception of high value plants (e.g. bonsais).

Importing countries would have costs of inspection related to the requirement for a PC. There would be costs of identification following inspection, but such costs are currently incurred under current measures in countries where conifer plants for planting are regulated.

H. irregulare would be impossible to eradicate in most cases if introduced, and is likely to have a high impact. Therefore measures preventing introduction will be cost effective. Measures will be as cost-effective if *H. occidentale* is also covered.

7.36 - Have measures (or combination of measures) been identified that reduce the risk for this pathway, and do not unduly interfere with international trade, are cost-effective and have no undesirable social or environmental consequences?
yes
PFA
Or
Grown under complete physical protection throughout their life with sufficient measures to exclude the pest
Or
Plants younger than 5 years + grown in pots in sterilized substrate + wounds should be avoided + at least 20 km from the closest infestation (or, if the proposed containment plan is applied, at least 10 km from the demarcated infested area)+ intensive monitoring in the space between the nursery and the closest infestation + transported in conditions preventing infestation.

7.41 - Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment

The pathways considered are listed in the conclusion of Section 8.

7.45 - Conclusions of the Pest Risk Management stage.
Conclusions are given in the main text of the PRA, section 16.