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

21- 26635

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

Pest Risk Analysis for

Thousand cankers disease (Geosmithia morbida and Pityophthorus juglandis)

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 Thousand cankers disease (Geosmithia morbida and Pityophthorus juglandis)*. EPPO, Paris.
Available at http://www.eppo.int/QUARANTINE/Pest_Risk_Analysis/PRA_intro.htm

Photo Superficial cankers caused by Geosmithia morbida on Juglans nigra and insect holes (Pityophthorus juglandis). Courtesy: Prof. Lucio Montecchio, Universita di Padova, IT.

21- 26635 (21-26451 20-26115, 15-21058, 15-20694, 15-20353 14-20219 14-20142 14-19823, 14-19733)

Pest Risk Analysis for Thousand cankers disease (*Geosmithia morbida* and *Pityophthorus juglandis*)

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

PRA area: *EPPO region*
Prepared by: *Expert Working Group on Thousand cankers disease*
Date: 2014-08-26/29.

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The PRA was further reviewed by core members (José Maria Guitian Castrillon, Salla Hannunen, Roel Potting, Robert Steffek, Arild Sletten, Nursten Üstün, Dirk Jan van der Gaag) between 2014-12-18 and 2015-01-20, and by the Panel on Phytosanitary Measures and the Panel on Quarantine Pests for Forestry on 2015-03-11/13.

Summary of the Express Pest Risk Analysis for thousands canker disease			
PRA area: *EPPO region*			
Endangered area: *P. juglandis* and *G. morbida* have the potential to establish throughout the EPPO region where *Juglans* species occur. They are likely to be more damaging (more generations of *P. juglandis*) in the Southern and Eastern parts of the EPPO region, where walnuts are also grown more widely.			
Main conclusions *Overall assessment of risk:* The likelihood of entry is estimated as high, especially on wood (with or without bark) of *Juglans* and *Pterocarya* and untreated wood packaging material. Plants for planting are also a very suitable entry pathway, if there is a trade. Establishment is likely where *Juglans* is grown in the EPPO region, and there is no factor that would limit the spread until the entire endangered area is colonized. The EWG considered that the potential impact in the absence of phytosanitary measures would be high in the long term. *Phytosanitary Measures:* Risk management options were determined for wood of *Juglans* and *Pterocarya,* particle wood and waste wood of deciduous species, and plants for planting of *Juglans* and *Pterocarya*. Wood packaging material should be treated according to ISPM 15. Scion wood of *Juglans* and bark of *Juglans* and *Pterocarya* were considered together with, respectively, plants for planting and particle wood and waste wood. Containment measures are in place in Veneto, Italy (Regione del Veneto, 2014a,b, 2015).			
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: Given that the pests have been found in Italy (Veneto and Lombardia), and that several commodities that may carry the pest are imported (especially from the USA), more extensive surveys in other areas of Italy and the EPPO region would be useful. Survey and trapping may be considered in EPPO countries, even more intensively in those countries importing large quantities of walnut wood and wood chips from the USA. In particular, trapping could be performed at points of entry (e.g. ports) and facilities (e.g. mills) receiving *Juglans* wood and plants, and in areas where *Juglans* are grown close to such facilities. Finally, there are gaps in the knowledge about these pests, and research on their biology and management is critical to developing better management measures (including susceptibility trials including hybrids, better detection and monitoring tools, cultural controls, chemical and biological control). However there is no doubt that they can establish in most of the EPPO region where *Juglans* are present and have the potential to cause damage.			

Content

Stage 1. Initiation

Reason for performing the PRA: Thousand cankers disease (TCD) is caused by the fungus *Geosmithia morbida* in association with the bark beetle *Pityophthorus juglandis*. In the USA, widespread dieback and mortality of *Juglans nigra* (black walnut) has occurred since the mid-1990s. The cause of the disease was determined only in 2008, as the combination of feeding damage by *P. juglandis* and canker development by *G. morbida*. *G. morbida* and *P. juglandis* are spreading in the USA, and the disease has caused extensive mortality on *J. nigra* and other *Juglans* species. In 2013, *P. juglandis* and *G. morbida* were detected in the EPPO region for the first time in Italy (Veneto region) on *J. nigra*, and was also detected in 2014 in the same region on *J. regia*. Thousand cankers disease was added to the EPPO Alert List of pests possibly presenting a risk to the EPPO region in January 2014.

The EPPO Panels on Phytosanitary Measures and on Forest Quarantine supported that thousand cankers disease was a priority for PRA. The EPPO Panel on Phytosanitary Measures decided that PM 5/5 *Decision-Support Scheme for an Express Pest Risk Analysis* could be used. This PRA addresses *G. morbida* and *P. juglandis* together, but specific elements are developed separately as needed under the different sections. Pest risk management was conducted according to the EPPO Decision-support scheme for quarantine pests PM 5/3(5) (detailed in Annex 8).

The present PRA uses and refers to elements in other recent PRAs, especially that for the bark beetle *Polygraphus proximus* (EPPO, under development).

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

Note: In order to be consistent with some previous PRAs, this PRA uses 5 rating levels 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. It uses throughout the levels of uncertainty of PM 5/5(1) (low, moderate, high).

Stage 2. Pest risk assessment

1. Taxonomy

Taxonomic classification

Geosmithia morbida	Fungi; Ascomycota; Eurotiales; Trichomaceae; *Geosmithia morbida* (M. Kolarík, E. Freeland, C. Utley & N. Tisserat, 2011)
Pityophthorus juglandis	Animalia; Insecta; Coleoptera; Curculionidae; Scolytinae; *Pityophthorus juglandis* Blackman, 1928

G. morbida was described by Kolařík et al. (2011) as *Geosmithia morbida* sp. nov. M. Kolarik, E. Freeland, C. Utley & N.Tisserat sp. nov. (Mycobank MB518713). It has no known teleomorph. Many haplotypes of *G. morbida* have been described (57 in Zerillo et al., 2014). Several haplotypes may be present on the same tree, and haplotypes are not correlated with phenotypic characters, geographic origin of the isolates or their host plants (Kolarik et al., 2011; Freeland et al., 2012). Zerillo et al. (2014) demonstrated the existence of four genetically distinct groups of isolates of *G. morbida* in three geographical regions of the USA. They conclude that the variations do not necessarily mean that *G. morbida* is a species complex, although they mention the need for further studies to investigate the potential that some isolates may be a cryptic species related to *G. morbida*.
All known isolates of *G. morbida* are currently considered as one species.

Synonyms. none found.

Common names

Geosmithia morbida	None
Pityophthorus juglandis	Walnut twig beetle (EPPO PQR, 2014)

The name "Thousand cankers disease" is given to the disease caused by the combined action of *P. juglandis* and *G. morbida*.

Origin and history of thousand cankers disease

Mortality of *J. nigra*, now presumed to be the result of thousand cankers disease, is thought to have occurred in the Western USA by the early 1990s (Idaho, Utah; Cranshaw and Tisserat 2008, Utley et al., 2013). Association of dying *J. nigra* with *P. juglandis* was first noted in New Mexico in 2001 and shortly after in Colorado. In the original reports, attacks by *P. juglandis* were considered secondary, incidental to drought, with the pest attacking stressed trees. Drought stress was also originally thought to be the cause of *Juglans* decline in Washington in 2008 and when such decline was first observed in eastern North America (Tennessee) in 2010. However, it was later observed that decline did not have any consistent association with drought, as affected trees were commonly present on well-irrigated sites.

A pathogenic fungus, subsequently described as *G. morbida*, was found in 2008 to be consistently associated with *P. juglandis* and cankers that developed around wounds made by the insect during feeding and gallery production. Ultimately, in 2008, mortality of *J. nigra* in Colorado was determined to result from the combined action of aggressive feeding by *P. juglandis* and subsequent canker development by *G. morbida* (Cranshaw and Tisserat, 2008; Utley et al., 2013). This led to the original description of the disease and suggestion of the common name "thousand cankers".

Recent studies in Italy show uncertainties regarding the role of *F. solani* species complex in the epidemiology of thousand cankers disease (see EPPO Data Sheet; Montecchio *et al*., 2015). However, there is no uncertainty that *G. morbida* and *P. juglandis* together cause thousand cankers disease.

2. Pest overview

Thousand cankers disease is caused by the combined activity of *G. morbida* and *P. juglandis* (Newton and Fowler, 2009). Adults of *P. juglandis* carry spores of *G. morbida* on their body and deposit them in the wounds and galleries they create in the bark of branches or trunks of *Juglans*. *G. morbida* grows within and around the feeding sites and galleries where it was introduced, killing tissues and producing cankers. Each canker is initiated by a wound created by *P. juglandis*, and multiple transmission of *G. morbida* to a same tree leads to numerous cankers, which ultimately coalesce and destroy phloem function, often leading to tree death. Immature stages of *P. juglandis* develop under the bark, and emerging adults carry the fungus, subsequently transmitting it to other parts of the tree or other trees (Cranshaw and Tisserat, ND; Utley et al., 2013).

P. juglandis does not show some characteristics typical of most bark beetles: there does not seem to be a close relationship between tree health and susceptibility, and there is no evidence of a strong aggregation pheromone nor the need of critical numbers to establish in a tree to overwhelm tree defences. Its rapid spread in the USA is likely to be due to many founding populations of very small original size.

The EWG recognized there are cases, not fully understood yet, where *G. morbida* cankers has been found in absence of *P. juglandis* infestations, or where *G. morbida* was associated to another insect (see under Distribution); however, from the evidence available, it is believed that the development of the disease "thousand cankers" needs the combined presence of *P. juglandis* and *G. morbida*. No other insect is known to date that could play the same vector role as *P. juglandis* (i.e. frequent probing behaviour and multiple boring wounds on live trees).

Details on the biology, as well as on detection (including trapping with pheromone-baited traps) and identification (including on possible confusion with other species), can be found in the EPPO datasheet (in preparation).

Note: this PRA considers the risk of introduction of *P. juglandis* and *G. morbida*, separately and together, and both questions 3 and 4 are therefore relevant.

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

P. juglandis can be considered as a "vector" as it carries spores of *G. morbida* on its body when emerging from trees, and transmits the fungus to other branches or trees. There is no evidence that *P. juglandis* transports other fungi in the same way.

F. solani was isolated in Italy from *P. juglandis* emerging from *J. nigra* (Montecchio et al. 2015). However, there is insufficient data on the role of *P. juglandis* in the transmission of *F. solani* is not known, the role of *F. solani* in thousand cankers disease, as well as on the members of the *F. solani* species complex involved (see EPPO Data Sheet).

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

G. morbida needs a vector able to transmit it naturally at sufficient numbers of sites on a tree to cause thousand cankers disease. *P. juglandis* is the only such vector known so far. In the EPPO region it is reported only in Italy.
It is not known if insects other than *P. juglandis* are capable of (or significant in) the natural transmission of *G. morbida*. The only instance to date where any other species had documented association with the fungus is an observation that the fungus was recoverable from the body of *Stenomimus pallidus* (Coleoptera: Curculionidae) in Indiana (USA) (more details in Annex 1). The EWG considered from the evidence available that *S. pallidus* is not likely to be important in the epidemiology of the disease.
Other insects are found associated in trees affected by thousand cankers disease. So far, no organisms other than *P. juglandis* and *G. morbida* acting together have been shown to cause thousand cankers disease. Although there is a possibility that other insects carry *G. morbida*, the disease thousand cankers requires multiple infestations of the same tree by an insect that consistently carries the fungus. Research is being conducted in the USA on associated insects, and details are provided in Annex 1. In the EPPO, region, there is no information on whether some species could act as a vector, behaving similarly to *P. juglandis*. 17 other species of *Pityophthorus* have been recorded in Europe (list in Annex 1), but they are all on conifer trees. One *Hylesinus* species (*H. orni* on *Fraxinus*) is a known vector of *Geosmithia* species in Europe (Kolarik et al., 2008). Although the particular biology of *P. juglandis* (multiple woundings inflicted to the host and generation of a large number of cankers) might make it the only insect able to efficiently transmit *G. morbida* in a manner that can produce symptoms associated with thousand cankers disease, there are examples in the literature of local Platypodidae or Scolytinae beetles picking up an exotic pathogen and becoming its major vector in a newly invaded area. In Japan, the native *Platypus quercivorus* became associated to a fungus of probable exotic origin, *Raffaelea quercivora*, pathogenic to Japanese oaks (Hulcr and Dunn 2011); Carrillo et al. (2014) experimentally showed that six species of ambrosia beetles indigenous to Florida were able to transmit the Asian laurel bay pathogen *Raffaelea lauricola*, normally vectored by the introduced Asian beetle, *Xyleborus glabratus*. Conversely, Sun et al. (2013) report a new association between a bark beetle exotic in China, *Dendroctonus valens*, and Chinese species of potentially pathogenic fungi.

5. Regulatory status of the pest

P. juglandis and *G. morbida* are not listed as quarantine pests by EPPO countries according to the EPPO collection of phytosanitary regulations and summaries (www.eppo.int). Both are on the EPPO Alert List.

Pityopththorus juglandis is a quarantine pest for the Republic of Korea (www.ippc.int), which has recently started implementing measures for thousand cankers disease on various walnut commodities from the USA (at least from Pennsylvania, Robertson, 2014) and as of February 2014 from Italy (ICE, 2014). Within the USA, interstate and intrastate quarantine measures have been developed by some states (details in section 8). In Italy, a regional decree describing both delimited area and containment measures in the Veneto region was published on 14 August 2014, and revised with updated delimited areas on 6 November 2014 and 6 February 2015 (Regione del Veneto, 2014 a, b, 2015).

6. Distribution

P. juglandis and *G. morbida* are recorded only from the USA, Mexico and Italy.

Continent	*Distribution*	*Comments on the pest status (see explanation below)*	*Reference*
Americas	**Present in North America**		
	Mexico	Chihuahua (*P. juglandis*, native; *G. morbida* not recorded (see Notes on the distribution and Uncertainties below)	Wood and Bright (1992 – *P. juglandis*)

Continent	*Distribution*	*Comments on the pest status (see explanation below)*	*Reference*
	USA	Arizona (*P. juglandis* native; *G. morbida* present)	Wood and Bright (1992 - *P. juglandis*); Kolarik et al. (2011 – G. morbida); Seybold et al. (2012a - P. juglandis)
		California (first record of *P. juglandis* in 1959; *G. morbida* present)	Bright and Stark (1973); Graves et al. (2010, 2011); Seybold et al. (2012a), Kolarik et al. (2011 – *G. morbida*)
		Colorado (*P. juglandis* record 2004, *J. nigra* mortality since 2001, *G. morbida* identified 2008)	Cranshaw and Tisserat (2008 *P. juglandis*, *G. morbida*), Tisserat et al. (2009; *P. juglandis*, *G. morbida*); Kolarik et al. (2011 – *G. morbida*)
		Idaho (*P. juglandis* recorded in 2003; *G. morbida* present)	Cranshaw and Tisserat (2008 *P. juglandis*); Kolarik et al. (2011 – *G. morbida*); Seybold et al. (2012a - *P. juglandis*)
		Indiana (*G. morbida* only, recorded in 2013, associated to *Stenomimus pallidus; P. juglandis* not yet recorded – see Notes on the distribution below)	Indiana Department of Natural Resources (2014), thousandcankers.com (2014), Warmund and van Sambeek (2014)
		Maryland (*P. juglandis* first collected in 2013); *G. morbida* confirmed in 2014)	USDA (2014), Maryland Department of Agriculture (2014)
		Nevada (*P. juglandis* first collected in 2011; *G. morbida* confirmed in 2011)	Seybold et al. (2012a – *P. juglandis*), ThousandCankers (2014 *G. morbida*); USDA (2014 *G. morbida*)
		New Mexico (*P. juglandis* native; *G. morbida* present)	Wood and Bright (1992 - *P. juglandis*); Freeland et al. (2012 - *G. morbida*)
		North Carolina (*G. morbida* recorded in 2012; *P. juglandis* first collected in 2013 – see notes below). Recent map in NCFS (2014)	NCFS (2013a, b *G. morbida*), NCFS (2014), Wiggins et al. (2014)
		Ohio (*P. juglandis* trapped in 2012, *G. morbida* first recorded in 2013)	Conrad et al. (2013 *P. juglandis*), Seybold et al. (2013 *P. juglandis*); Fisher et al. (2013)
		Oregon (*P. juglandis* recorded in 1997; *G. morbida* present)	Cranshaw and Tisserat (2008 *P. juglandis*), Kolarik et al. (2011 – *G. morbida*) Pscheidt and Ocamb (2014 *P. juglandis G. morbida*)
		Pennsylvania (*P. juglandis* and *G. morbida* recorded in 2011)	Pennsylvania Department of Agriculture (2011 *G. morbida*); Seybold et al. (2012a *P. juglandis*)
		Tennessee (*P. juglandis* and *G. morbida* recorded in 2010). Recent map in NCFS (2014)	Grant et al. (2011 *P. juglandis*, *G. morbida*); Randolph et al. (2013 *P. juglandis*, *G. morbida*), Seybold et al. (2013 *P. juglandis*, *G. morbida*)
		Utah (*P. juglandis* first recorded in 1988; *G. morbida* present)	Kolarik et al. (2011 – *G. morbida*); Nischwitz and Murray (2011 *P. juglandis*, *G. morbida*); Seybold et al. (2012a - *P. juglandis*)
		Virginia (*P. juglandis* and *G. morbida* recorded in 2011). Recent map in NCFS (2014)	Hansen et al. (2011 *P. juglandis G. morbida*), Seybold et al. (2012a); NCFS (2014)
		Washington (*P. juglandis* and *G. morbida* recorded in 2008)	Kolarik et al. (2011 – *G. morbida*), Cranshaw and Tisserat (2008)
	Absent in Central America, South America, Caribbean		
Europe	Italy (North)	Veneto (Vicenza, Treviso, Padova provinces)	Montecchio and Faccoli (2014), Montecchio et al. (2014), Regione del Veneto (2014a&b, 2015)
		Lombardia (Mantova province) (*P. juglandis* trapped in 2014; *G. morbida* not recorded – see Notes on the distribution below)	Italian NPPO (2014)
Africa	Absent		
Asia	Absent		
Oceania	Absent		

The distribution records above are based on information available to 15 December 2014. Results of 2014 summer surveys may not be all available yet.

<u>Origin</u>

- The original collections (1898) of *P. juglandis* were made in Mexico (Chihuahua), New Mexico and Arizona (Wood and Bright, 1992; Cranshaw and Tisserat, 2012b) in association with *Juglans major*

(Arizona walnut), a native plant. *P. juglandis* was first recorded in southern California in 1959 (Bright and Stark, 1973) and there is strong evidence (e.g. Seybold et al., 2012a) that *P. juglandis* is also native to that state, where it was originally associated with *J. californica*.

- *G. morbida* has a complex genetic structure and Kolarik et al. (2011) suggested that it had not been introduced recently, and that *G. morbida* and *P. juglandis* might have been established for some time outside the original reported range of *P. juglandis* in the USA (see above). A project is underway to study the population structure and possibly origin of *G. morbida* in North America (Tisserat, 2010-2014). Recent studies indicate a wide genetic variation of *G. morbida* in the USA, which is one factor that provides support to the idea that the fungus has a long history in North America, and is likely native to the southwestern USA and parts of northern Mexico (Hadziabdic et al., 2014; Zerillo et al. 2014). The most extensive study of the genetics of *G. morbida* (Zerillo et al. 2014) concludes that: thousand cankers disease does not result from a new association between the insect and the fungus; *G. morbida* populations found outside Arizona, New Mexico and parts of Colorado are related to Californian populations; the diversity of isolates indicate that *G. morbida* was not introduced recently and is likely native. This study did note that data still are lacking from *G. morbida* collections made in the southern part of the range of *J. major* (e.g. Mexico) and are needed to better understand origin populations of the fungus..
- Cranshaw and Tisserat (2012b) reflect the hypothesis that thousand cankers disease resulted from the movement of *P. juglandis* and its associated *G. morbida* from native hosts (*J. major*, *J. californica*) to other *Juglans* species that are more susceptible, and from its dispersion in Western USA on susceptible *Juglans* species introduced within the past century (no *Juglans* species are native to most of the States where thousand cankers was first identified).

<u>Notes on the distribution</u>

- *P. juglandis* and *G. morbida* were both recorded at the locations listed above, except in three cases:
  - <u>Mexico (Chihuahua)</u>: only *P. juglandis.* The captures in Mexico are solely of *P. juglandis* and pre-date by many decades the discovery of thousand cankers disease and description of *Geosmithia morbida* (as reported in Wood and Bright, 1992); there are no known recent attempts to make dedicated collections of either organisms in Mexico
  - <u>Indiana</u>: only *G. morbida*. Collections involved surveys of trees that had been girdled and killed. Subsequently *G. morbida* was found at one site and reported at the end of 2013 (Indiana Department of Natural Resources, 2014). The fungus was associated with *Stenomimus pallidus* (Coleoptera: Curculionidae) (see section 4). *P. juglandis* has not yet been found at this site to date, but expanded surveys, including trapping, are in progress.
  - <u>Lombardia, Italy</u>. only *P. juglandis*. Seven adults were trapped at one site in July 2014 (Italian NPPO, 2014). *G. morbida* was not found. Symptoms of the disease were not observed.

  For the purpose of this PRA, it was assumed that both pests occur in all USA States where one of them has been recorded; this assumption is also made for Mexico in the absence of contrary evidence from suitable surveys. In the Western USA, *P. juglandis* and *G. morbida* are consistently associated. There are few cases where *P. juglandis* or *G. morbida* were found on their own, but in most cases, it is likely that the other pest has not yet been found due to insufficient sampling.
- The case of Maryland possibly illustrates an early detection in the absence of symptoms. In 2013, adults of *P. juglandis* were caught in one trap, and *G. morbida* had not been identified through search for visual symptoms and random sampling of branches. In 2014, adults were trapped again in that same trap, and *G. morbida* was also identified from a log baited with *P. juglandis* pheromone (Maryland Department of Agriculture, 2014).
- *P. juglandis* and *G. morbida* were not detected in a number of USA States, such as Missouri (as of June 2014, Warmund and van Sambeek, 2014), Iowa (as of February 2013, Jesse, 2013), Kansas, Illinois (Illinois Department of Agriculture, 2013) and others. However, Cranshaw (2011) noted that, following the introduction of *P. juglandis* into Eastern USA, there were no ecological or geographic barriers preventing the spread throughout the entire range of *J. nigra* in the USA. It was speculated that natural spread will likely be slow, and may be further slowed down by containment through restrictions on movement of walnut wood products and aggressive management at edges of infestation.
- In Italy, *G. morbida* and *P. juglandis* were identified near Vicenza (Veneto region) in *J. nigra* of different ages in September 2013 (80-year-old plants in a garden and 17-year-old trees in a nearby walnut plantation for wood production). The outbreak was detected due to symptoms (yellowing, wilting, twig and branch dieback) and a high number of small bark cankers were present (Montecchio and Faccoli, 2014). Both pests and symptomatic *J. regia* were detected in the same area in 2014 (Montecchio et al.,

2014). Five more sites were detected in the same area in winter 2013-2014. According to the results of surveys in summer 2014 in the Veneto region, *P. juglandis* and *G. morbida* occur in the provinces of Vicenza, Treviso and Padova (12 sites in total). In 2014, *P. juglandis* was trapped in Lombardia in a nature reserve (Marmirolo, Mantova province – Italian NPPO, 2014). In Lombardia region, no symptoms of thousand cankers disease have been observed and *G. morbida* has not been found. Surveys were also conducted in 2014 in the regions Piemonte and Friuli-Venezia-Giulia and did not find the pests (M. Vettorazzo, pers. comm.).

Uncertainties

Distribution data raise a number of general uncertainties regarding the exact distribution of *P. juglandis* and *G. morbida*, and these are important in the framework of this PRA.

- Mexico**.** Due to the absence of recent surveys, it is not clear if *G. morbida* is present in Mexico. It is also not clear if *P. juglandis* is present in states other than Chihuahua. As both species have been recorded within a few kilometres of the Mexican border and the distribution of *J. major* extends South into Mexico, it is likely that both pests are present in other Mexican states. Zerillo et al. (2014) mentions that data is lacking regarding the presence of *G. morbida* on *J. major* in Mexico (southern extension of the natural range of *J. major*).
- USA. It is not known whether *P. juglandis* and *G. morbida* are already present, but not detected, in other USA States. Surveys have been conducted in several States, with increasing survey intensity since the report from Tennessee in 2010, and the development of a lure for use in traps. However, surveys have often detected infestations that are well established. Furthermore, given the relatively short history of survey for this insect, and the large number of new detections in recent years, it seems reasonable to assume in this PRA that *P. juglandis* and *G. morbida* may be present at other locations where they have not been detected, especially in states neighbouring those where the pest is now well established or have history of importing walnut wood from known infested areas.
-
- How long have the pests be present in the EPPO region? There is no information at present. If there is a high certainty that *P. juglandis* and *G. morbida* would have been detected if they were present before, the outbreak may still be limited to the area found infested. If *P. juglandis* and *G. morbida* have been present for some years before symptoms first appeared in the Veneto region, some natural or human-assisted spread may have occurred (even if it may take a few years for a population to build and start spreading). Given the general understanding in the USA that symptoms appear only after a certain level of *P. juglandis* attacks, and after some years, it seems reasonable to assume in this PRA the scenario according to which *P. juglandis* and *G. morbida* have been present in the outbreak area in Italy for at least a few years. In the Veneto region, surveys are ongoing at the commercial companies and sawmills located in the demarcated areas, which have possibly imported wood of *J. nigra* from the USA in the recent past (last 10 years) (M. Vettorazzo, personal communication).
- Situation in other EPPO countries? There is regular trade of *Juglans* material that may carry both pests, from the USA into many EPPO countries, but no specific phytosanitary measures are in place (see section 8). It cannot be excluded that, as happened in Italy, the pests have already been introduced into other EPPO countries and have not yet been detected. In Northern Spain (Basque Country), a survey was carried out in 2012 using the pheromone of *P. juglandis* in *J. regia* trees at four sites, and the pest was not trapped (only *P. solus* was trapped, a species attacking *P. radiata*) (Goldarazena et al., 2014). The EWG was not aware of other surveys conducted in other EPPO countries to detect *P. juglandis* and *G. morbida*.

7. Host plants and their distribution in the PRA area

The host species of *P. juglandis* and *G. morbida* are indicated in the Table below. All belong to the family Juglandaceae, genera *Juglans* and *Pterocarya*. Based on observations in the *Juglans* collection of the USDA-ARS National Clonal Germplasm Repository in California, Hishinuma et al. (2014, in press) note that *P. juglandis* is considered to have the capacity to develop in all species of *Juglans* that it may encounter.

Major species in the EPPO region are in bold. PPP-Index (2014) was used to verify the availability of species in nurseries in the EPPO region. It is not excluded that other species may be used as ornamentals (indicated with "?"). Details on the presence of hosts in the EPPO region are given in section 9.1. Of the species positively known to occur in the EPPO region, at least *J. ailantifolia*, *J. californica*, *J. cinerea*, *J. hindsii*, *J. major*, *J. mandshurica*, *J. microcarpa*, *J. nigra*, *J. regia* and several hybrids are known to be susceptible, to various degrees, to thousand cankers disease.

Host Scientific name	Presence in PRA area	Comments	*Reference*
Juglans ailantifolia (Japanese walnut)	Yes	syn. *J. mandshurica* var. *sieboldiana, J. sieboldiana.* Asian species. Found susceptible to *G. morbida* in inoculation studies. Host of *P. juglandis* in collection (Seybold, ND) *In EPPO region: ornamental, wild. Probably minor*	Utley et al. (2013)
Juglans californica (southern California black walnut)	Yes	North American species. Probable native host of *P. juglandis*. Found infested in the field. Original distribution overlaps that of *J. major.* *In EPPO region: ornamental*	Wood and Bright (1992), Utley et al. (2013), Serdani et al. (2013), Graves et al. (2011)
Juglans cinerea (butternut, white walnut)	Yes	North American species. Found infested in the field. *In EPPO region: timber production (occasional), ornamental.*	Serdani et al. (2013)
Juglans hindsii (northern California black walnut)	Yes	North American species. Found infested in the field. *In EPPO region: ornamental*	Cranshaw and Tisserat, 2008, Utley et al., 2013, Serdani et al. (2013)
Juglans major (Arizona walnut)	Yes	North American species. Native host of *P. juglandis* (Utley et al., 2013). *In EPPO region: ornamental*	Wood and Bright (1992), Utley et al. (2013), Serdani et al. (2013)
Juglans mandshurica	Yes	Asian species. Found infested in a collection in California. *In EPPO region: ornamental, wild*	Graves et al. (2011), Utley et al. (2013)
Juglans microcarpa (little walnut)	Yes	North American species. *In EPPO region: ornamental*	Cranshaw and Tisserat (2008); Graves et al. (2011); Utley et al. (2013)
Juglans mollis	Yes?	Native to Mexico. Found infested in a collection in California. *In EPPO region: ornamental?*	Graves et al. (2011)
***Juglans nigra* (black walnut)**	**Yes, major**	**North American species. Found infested in the field, the most susceptible species to the disease.** ***In EPPO region: major and widespread (introduced XVIIth century). Timber production, ornamental***	**Wood and Bright, 1992, Utley et al., 2013**
***Juglans regia* (Persian, English or Common walnut)**	**Yes, major**	**Asian species, possibly also native to southeast Europe. Found infested in the field.** ***In EPPO region: major and widespread. Fruit, ornamental, timber production, wild***	**Serdani et al. (2013), Utley et al. (2013)**
Hybrids *Juglans hindsii* x *regia* (Paradox rootstock), *J. cinerea* x *J. ailantifolia*, *J. nigra* × *regia, J. nigra x J. hindsii*	Yes	Some of many walnut hybrids. Found infested in the field, in collections or found susceptible to *G. morbida* in inoculation studies *In EPPO region: ornamental, timber production*	Seybold et al. (2012a), Utley et al. (2013), Yaghmour et al. (2014, in press)
Pterocarya fraxinifolia	Yes	Isolates of *G. morbida* cultured from the margins of stem or branch cankers surrounding *P. juglandis* galleries	Zerillo et al. (2014)
Pterocarya rhoifolia	Yes	Found infested in a collection, arboretum and botanic garden in California	Hishinuma et al. (2014, in press)
Pterocarya stenoptera	Yes	Isolates of *G. morbida* cultured from the margins of stem or branch cankers surrounding *P. juglandis* galleries	Zerillo et al. (2014), Hishinuma et al. (2014, in press)

More details on hosts are given in EPPO datasheet (in preparation), and only elements of relevance for the PRA are indicated here. It is worth noting that *Carya* species (also Juglandaceae) are not hosts of *P. juglandis* and *G. morbida* (never found infested in the field, no cankers observed on *Carya* trees situated close to infected *Juglans* trees, no cankers on *Carya illinoiensis* (pecan), *C. aquatica* and *C. ovata* in inoculation studies in Utley et al., 2013).

Susceptibility of hosts

- Susceptibility to thousand cankers disease varies between species and between trees in a same species. It also varies for hybrids. In some trees and species, the disease is slowed or halted. Some trees may not be affected in areas of intensive mortality. The susceptibility of the different *Juglans* species depends both on their susceptibility to *G. morbida* and on the ability of *P. juglandis* to find, colonize and breed on the trees (Utley et al., 2013).

- *J. major* and *J. nigra* consistently appear as the least and most susceptible host species respectively (many publications, incl. Cranshaw and Tisserat, 2008; Utley et al., 2013). On *J. major*, the disease is limited to overshaded or injured branches (Cranshaw and Tisserat, 2008). It rarely, if ever, progresses to kill trees or even major limbs (Cranshaw and Tisserat, 2012b). In inoculation studies (Utley et al., 2013), *J. major* presented little canker formation. Conversely, infestation on *J. nigra* generally leads to death and in inoculation studies (Utley et al., 2013), *J. nigra* generally developed the largest cankers.
- All other known *Juglans* hosts infested in the field or in collections seem to fall in an intermediate category, and this is also the case in inoculation studies (Utley et al., 2013). In these species or hybrids, the effects of the disease may be limited to scattered dieback rather than death of the tree, and the course of disease may be substantially slower (Cranshaw and Tisserat, 2012b).
- There is an uncertainty on the susceptibility level of *J. regia*, the most important *Juglans* species in the EPPO region. It is known to be susceptible, but seems to present a wide intraspecific variation. Mortality, although not extensive, has been observed in the USA. *P. juglandis* has been present in Southern California, but historically has not been an issue in cultivated *J. regia* until recent years. Pscheidt and Ocamb (2014) note that *J. regia* is not as susceptible as *J. nigra*, but the disease is easily found in *J. regia* orchards. Potential impact on *J. regia* is unknown according to Utley et al. (2013). In addition, *J. regia* is often grafted, for example on the rootstock 'Paradox' (hybrid of *J. hindsii* and *J. regia*), and there may be considerable variation in susceptibility depending on the rootstock (Utley et al., 2013). It is not clear if *J. regia* that is not grafted (or grafted on *J. regia*) is less susceptible to *P. juglandis* and *G. morbida* than *J. regia* grafted on *J. nigra* (or other susceptible species).

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.

The main biological considerations for the pathways are:

- *P. juglandis* forms galleries in the phloem and bark (and not the sapwood). All stages may be present in and under the bark. At their greatest depth, galleries only slightly imprint the surface of the sapwood (Mayfield et al., 2014). Consequently, no life stage of *P. juglandis* is found in the sapwood. *P. juglandis* is likely to survive if bark is present (even if data is lacking on possible survival of eggs or young larvae when exposed to desiccation).
- *G. morbida* is located in the phloem and cambium, and can occur in the extreme outer sapwood. *G. morbida* produces localized cankers in and around the galleries of *P. juglandis* (Cranshaw and Tisserat, 2012b). It does not produce deep staining, but it may reach the sapwood (superficially) at advanced stages of the disease, and may result in a brown to black discoloration of the sapwood (Cranshaw and Tisserat, 2012a, b). Results of a debarking experiment (Mayfield et al., 2014), in which *G. morbida* was recovered from the sapwood surface of one log, suggest that *G. morbida* can occur in the extreme outer sapwood and can survive, at least temporarily, on the surface of a freshly debarked walnut log. *G. morbida* does not develop in the vascular system of the tree and is not systemic in the tree (Cranshaw, 2009 draft; Jesse, 2013).
- When infested, individual logs may carry large numbers of *P. juglandis* individuals. Densities of 30 insects per square inch of bark (ca. 5 per cm^2) were recorded (Cranshaw and Tisserat, 2012b). Cranshaw (2011) mention 23040 beetles for 2 logs of *J. nigra* in an extreme case in Colorado (circa 6/cm^2). In Tennessee, densities of 0.1-0.5 beetles per cm^2 were observed (Nix, 2013; Mayfield et al., 2014).
- Both pests are not present in roots and nuts.

This PRA focuses on the introduction of *P. juglandis* and *G. morbida* together, as in most cases they are associated and both are necessary to cause the disease (see section 4). The introduction of either species alone is theoretical at this stage. However, if *G. morbida* is present on its own on a pathway, it cannot be excluded that another insect in the EPPO region acts as a vector (see section 5), and for this reason this PRA also covers this case.

Pityophthorus spp. are known to move in trade. Newton and Fowler (2009, citing others) report 1015 interceptions (almost all from Mexico) in the USA, on raw timber, wood packaging material, wood and woodware, and *P. juglandis* was intercepted in New Zealand at least once in a *Juglans* log from the USA.

In the USA, Cranshaw and Tisserat (2012b) noted that isolated infestations in Eastern USA are clearly due to human transfer. Newton and Fowler (2009) list the following possible pathways for *P. juglandis* and *G. morbida* from Western to Eastern USA: raw timber, firewood, wood packaging material, nursery stock, scion wood for grafting. Presently, there is no national quarantine in the USA (Cranshaw and Tisserat, 2012b). However, several US States (Missouri, Arkansas, Indiana, Iowa, Illinois, Kansas, Michigan, Nebraska, North Carolina, Oklahoma, Wisconsin) implement quarantines that prevent movement of *Juglans* material originating from states where the pests occur and there are also internal quarantines in Eastern states with known infestations (Pennsylvania, Tennessee, Virginia). Existing quarantine regulations all regulate raw walnut wood material with bark (incl. wood chips) with differences regarding accepted means of disinfestation). Most allow transport of wood that has been milled to remove all bark (some with kiln-drying) and wood that had been incorporated into finished products; nuts are not regulated (Tisserat and Cranshaw, 2012).

8.1 Possible pathways

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

Wood of *Juglans* and *Pterocarya* from countries where *P. juglandis* or *G. morbida* occurs

Pathway prohibited in the PRA area?: No
Pathway subject to a plant health inspection at import?: Yes for *J. mandshurica* and *P. rhoifolia* (in the EU and some other countries). No for others
Pest already intercepted on the pathway?: Yes (within USA, in New Zealand)

This pathway covers wood with or without bark, sawn or round, as well as firewood (wood packaging material, particle wood and wood waste are covered separately below). Wood with bark may carry all stages of *P. juglandis* and *G. morbida*. *G. morbida* may also be present in the sapwood (superficially). Wood is the main pathway suspected for the movement of the pest within the USA (Newton and Fowler, 2009).

Biological considerations
The following elements of biology are important:

- *P. juglandis* attacks standing living trees, including healthy trees. Although *P. juglandis* was shown to infest logs in certain conditions (e.g. reinfesting treated logs – see below), no information was found in the literature on whether fallen or cut trees are preferentially colonized if there are standing trees around (e.g. in a forest).
- Several experiments have shown that logs can be reinfested by *P. juglandis* (Peachey, 2012; Sitz, 2013; Mayfield et al., 2014). Cranshaw (2009 draft) mention that drying ultimately makes the wood unsuitable, but because of the small size of the beetles, development may occur in small pockets within drying logs. Under conditions where drying is slow, logs may remain suitable for breeding for 2-3 years after felling (i.e. until reinfestation is not possible anymore) (Cranshaw, 2009 draft). In addition, wood that has been suitably heated to kill *P. juglandis* and *G. morbida* can still support survival for several months of adult beetles that are allowed access to heat treated wood. It is unclear whether larval development can occur in heat-treated logs, but studies of this are in progress (W. Cranshaw, R. Sitz, E. Luna, N. Tisserat, Colorado State University, 08-2014, unpublished data). Logs that were steam heated or fumigated with methyl bromide can be infested after treatment. Beetles can infest the bark on kiln-dried boards (bringing moisture content to 8%, but reproduction in bark this dry is not suspected (J. Audley, University of Tennessee, unpublished).
- *P. juglandis* and *G. morbida* may occur in branches or trunks, even if attacks seem to start on branches. Overwintering adults may carry *G. morbida* to the trunk and may also stay on the trunk at the end of the winter. *P. juglandis* rarely attacks twigs (unlike its common name indicates). On *J.* nigra, it was observed attacking mostly branches over 2-cm diameter, as well as large branches and trunks (Cranshaw and Tisserat, 2008; Tisserat, 2009), on *J. hindsii*, branches over 1,5-cm diameter (Newton and Fowler, 2009, citing others). Attacks on 1-cm diameter branches were also observed (Newton and Fowler, 2009, citing others). On *J. nigra*, *P. juglandis* prefers to colonize the underside of branches in rough areas of bark and prefers branches generally larger than 1.5-cm diameter (Seybold et al., 2012b. It is considered here that trunks, from which most walnut products are derived, are likely to carry *P. juglandis* and *G. morbida*, even in areas of low population or at the start of an outbreak.

Where *P. juglandis* and *G. morbida* occur, they are likely to be associated with walnut trees. There is an uncertainty on whether traded walnut wood from the USA presently comes from areas where the pests occur. There are no data on origin, but both pests are present in Eastern USA and at least some wood may come from Western USA.

J. nigra is the main species grown for wood and the most susceptible host. At present, the areas in which thousand cankers disease is known to occur in the USA are not in the primary timber production areas of *J. nigra*, but this may change in time as the pests are spreading in Eastern USA. There is little if any management for these pests in forests or plantations for the production of wood. If trapping is conducted, adults may be trapped but low levels of population may be overlooked. Detection is very difficult at early stages of infestation (few entry or exit holes, very small cankers under the bark). Symptoms may be observed late in the development of a population of *P. juglandis*. Furthermore *P. juglandis* will generally not be noticed if bark is present.

Trees are generally not debarked on site since the value of the wood is degraded by this practice as it produces excessive cracking.

It is expected that a log would normally be transported with bark to maintain wood quality. *P. juglandis* could become associated to the bark on the living tree, or the bark may be infested/reinfested during extraction, transport or storage (Newton and Fowler, 2009). If adults emerge in transport and storage, they will be able to colonize other logs and reproduce, provided sufficient bark is present on the logs. As populations of *P. juglandis* in a tree are generally high (see above), it is likely that one lot would contain several individuals. *G. morbida* may be able to survive for some time on bark-free wood.

In the EPPO region, few requirements apply to wood of *Juglans* and *Pterocarya* (see Table 1 in Annex 2). None of these measures would prevent entry into the whole PRA area. The EU and several other countries have requirements for wood of *J. mandshurica* and *P. rhoifolia* (PFA for *Agrilus planipennis*, or squared so as to remove entirely the round surface). Entirely removing the wood surface would eliminate *P. juglandis* and *G. morbida*. However, these two species are not the most likely hosts to be traded from the USA, nor to be attacked. Some countries have general requirements for phytosanitary certificates, import permits or inspection, but *P. juglandis* is not easy to detect and cankers may be due to many causes. Their presence can be easily overlooked. In addition, inspection of wood consignments is difficult and detection would depend on the intensity of inspection. If a log is infested after the tree is cut (in transport or storage), there may be only entry holes. On debarked wood or wood without bark, the galleries and cankers may be visible. However, detection would depend on the level of infestation.

Once at destination, wood is often stored at processing facilities frequently in the vicinity of forests, and adult *P. juglandis* may fly to suitable hosts, as walnuts are grown in most parts of the EPPO region, for example in forests, orchards, urban areas, parks or private gardens (see 9.1). If the wood is imported and processed during the winter, transfer to a suitable host will only be possible if wood and bark waste is not properly disposed of. However, it is not clear whether adults could emerge at any season in parts of the PRA area.

Different types of wood can be imported as commodities:
- *wood with bark* (including firewood, as well as debarked wood, which may retain some bark). All life stages of *P. juglandis* and *G. morbida* may be present. The likelihood of association of the pests is highest for this type of wood. If *G. morbida* is present alone in wood with bark (because all *P. juglandis* adults have emerged or died or in the not-yet-understood cases where this may occur), the likelihood of entry is equivalent but with a higher uncertainty, as transfer to a suitable host would require that either *P. juglandis* is already present at destination and colonizes the logs, or another insect has the possibility to transmit *G. morbida* efficiently, or *G. morbida* has another mechanism to transfer to trees.
Regarding firewood, there is no information on the tree species that compose firewood for export from areas where thousand cankers is known to occur. However Newton and Fowler (2009) note that walnut is utilized as firewood (in particular trees that are not valuable for other wood production). In its native range in Eastern USA, *J. nigra* may comprise 25% of a load of 'mixed hardwood'. In Western USA, walnut is sold as firewood either mixed or separately.
- *bark-free wood*. According to ISPM 5 definition, such wood may include ingrown bark around knots and bark pockets between rings of annual growth. Due to the small size of *P. juglandis*, individuals may be present in such bark. The likelihood of association of the pests would be smaller, but the pests may still be present. The US States that apply quarantine generally exempt processed wood, but wood free from bark may still be imposed requirements (e.g. kiln-drying).
- *squared wood*. Such wood is squared to eliminate completely the round surface (according to EU Directive 2000/29). Only *G. morbida* may be present in the superficial sapwood. However, transfer to a host would be very unlikely as *P. juglandis*, even if present at destination, would not feed on squared wood. The US States that apply quarantine generally exempt processed wood, but wood free from bark (as squared wood would be) may still be imposed requirements (e.g. kiln-drying).

Trade

By total quantities, *Juglans* is not one of the major deciduous species traded as raw wood. FAO Stat provides only data for all deciduous roundwood and sawnwood, and was not considered relevant as *Juglans* is not the main traded deciduous wood species. No specific data is given in EU trade statistics (Eurostat) for imports of walnut roundwood, but Eurostat provides data on firewood, poles and similar products, and walnut veneer. Data on exports from the USA is available in the USA trade statistics for 1998-2013 (USDA-FAS, 2014). No information was found on exports of *Juglans* wood from Italy, but most production plantations were established in the 1990s and the trees are far from commercial dimensions. No specific data were found on the trade of *Pterocarya* from Mexico or the USA, which is not native to North America nor grown commercially for timber.

From the data available, the broad categories below were traded. Where data specific to walnut is not available, there is no indication that the commodities would include *Juglans* or *Pterocarya*, but *Juglans* are widespread in the USA, and known to be traded.

Roundwood of walnut is commonly imported from the USA (USDA-FAS, 2014 – walnut wood in the rough, whether or not stripped of bark or sapwood, or roughly squared, not treated - 4403990070) (see Table 1 in Annex 3). It was exported to 25 EPPO countries in 2013 and 35 over 1998-2013. Importing countries are spread throughout the PRA area, including North Africa, Near East, Europe and eastwards to Russia. Approximately 23.200 m^3 were exported in 2013, with quantities that seem to be decreasing since 2011 (54.900 m^3), although it is difficult to assess as quantities vary considerably depending on years. The main importing countries (in order of volume) were Italy, Germany, Portugal and Turkey (2000-7100 m^3), with also significant imports (over 1000 m^3) to Russia, Slovenia, UK, Portugal, Belgium. No data was available for exports from Mexico.

Firewood (44011000). No export of firewood to the PRA area was registered in USDA-FAS (2014), but some imports were registered in Eurostat from the USA and (very minor) from Mexico (100 kg for 2 years and 2 countries) (Table 2 in Annex 3). From the USA, UK was the only EPPO country with imports for all years in 1998-2013. In 2013, imports were registered to UK and Estonia (over 60 t), Hungary (over 10 t) and smaller quantities to Sweden, Germany, Denmark and France. Italy imported 408 t of firewood in 2008 and

4238 t in 2007. From Italy, firewood was exported to several EPPO countries in 2013, mostly Austria (over 7000 t), Hungary, France and Switzerland (over 2000 t each) and minor quantities to others (Table 3 in Annex 3) (Eurostat).

Sawn wood of walnut. In 1998-2013, sawn wood of walnut was exported from the USA to 38 EPPO countries (Table 5a and 5b in Annex 3 – USDA-FAS). Exports to many countries were irregular. In 2013 (Table 5b), imports were mostly to Germany and UK (3000-6000 m^3), Italy, the Netherlands and Turkey (over 1300-2400 m^3), and smaller quantities to Belgium, Denmark, Ireland, Israel, Jordan, Lithuania, Romania, Spain Sweden and 15 other EPPO countries. These may have bark attached.

In 2013, exports of walnut logs from the USA were spread throughout the year (Table 7 in Annex 3 – USDA-FAS, 2014). Germany, Italy and Turkey received walnut wood throughout the year, while some imported only once or twice a year. The largest volume was imported in January-June.

In conclusion, major EPPO countries where walnut is cultivated and grows in the wild import walnut logs and products that may contain walnut wood. This is especially the case of Germany, Italy and Turkey, but also a wide variety of other EPPO countries.

Conclusion. The probability of entry of *P. juglandis* and *G. morbida* is considered as "very high" for wood with bark (with low uncertainty) and " moderate" for wood without bark (bark-free) (with moderate uncertainty), and "very low" for wood squared to entirely remove the natural rounded surface (with low uncertainty).

From the biological point of view, this pathway is very favourable for entry of the pest, also because *P. juglandis* can reinfest logs in storage and transport, and populations may increase. There is trade of walnut roundwood and sawn wood, and also firewood, to a large number of EPPO countries where Juglans species are grown.

There is a general uncertainty on whether wood would come from the main walnut wood-producing States in Eastern USA (which may not all be infested yet), but the likelihood of entry will become higher if (once) *P. juglandis* and *G. morbida* have spread to those states.

Likelihood of entry on the pathway:	**Uncertainty**:
- wood with bark: very high	- low
- wood without bark (bark-free): moderate	- moderate (presence of *P. juglandis*, whether *G. morbida* could be transferred to trees)
- squared wood: very low	- low

Wood packaging material (including dunnage)

Pathway prohibited in the PRA area?: No
Pathway subject to a plant health inspection at import?: Possibly
Pest already intercepted on the pathway?: Not known

P. juglandis and *G. morbida* can be present in wood packaging material especially if it still has some bark attached. Dunnage has also been shown as a major source of introduction of Scolytinae worldwide (for example in New Zealand, 34.7 % of interceptions of Scolytinae are made on dunnage, 10.4 % on pallets; Brockerhoff et al., 2003). Wood packaging material could be a major pathway. However, it is not assessed in details here, as treatments in ISPM 15 *Regulation of wood packaging material in international trade* (FAO, 2009) should be effective in destroying *P. juglandis* and *G. morbida*, if they are properly applied (even more as all stages of *P. juglandis* and *G. morbida* are at most in the superficial sapwood). ISPM 15 requires that all wood packaging material moved in international trade should be debarked and heat treated or fumigated with methyl bromide, and stamped or branded with a mark of compliance. These treatments are internationally considered as adequate to destroy insects (including Scolytinae) and nematodes that are present in wood packaging material at the time of treatment (e.g. results of the PEKID project, 2009 for other bark beetles). Wood packaging material is not likely to be a pathway for *G. morbida* when the vector is not present (as transfer to a suitable host is unlikely).

In the USA, *J. nigra* is valuable as timber, but very low-grade trees or small diameter material have little commercial value and may be diverted to pallet manufacturers (Newton and Fowler, 2009).

Conclusion. This pathway is already regulated in some instances, but presents a major risk for the spread of *P. juglandis* and *G. morbida* if ISPM 15 treatments of the wood packaging material are not applied. This would be the case for part of the wood packaging material moving within countries and between EU countries.

Likelihood of entry on the pathway:	**Uncertainty**:
- High if ISPM 15 treatments are not applied	- low
- Very low if ISPM 15 treatments are applied	- low

Natural spread

Natural spread of *P. juglandis* and *G. morbida* from North America to the PRA area is not possible due to the distance and geographical barrier. This pathway covers natural spread from the outbreak in Italy. *P. juglandis* is expected to spread naturally from areas within the EPPO region where it becomes established. No mechanism is currently known for the spread of *G. morbida* in the absence of *P. juglandis*. Natural spread would also be possible if the pest establishes in other part of the PRA area, and this is covered in the "*Spread*" section (section 11.1). It is likely that the pest will start spreading only after a few years.

Any containment measures are likely to slow down natural spread. The *Juglans* species present may also influence the

spread.However it is likely that human-assisted spread will occur before that, especially because there is a trade of several commodities that may carry the pests, at least from the USA (especially walnut roundwood and deciduous wood chips). **Conclusion.** The probability of entry by natural spread is rated as high, and with a moderate uncertainty (flight capacity of the adult, number of generations, suitability of hosts, speed of spread). The probability will increase if new outbreaks appear in the EPPO region.	
Likelihood of entry on the pathway: - high	**Uncertainty**: - moderate (flight capacity of the adult, number of generations, suitability of hosts, speed of spread)

Plants for planting (including scion wood) of *Juglans* and *Pterocarya* from countries where *P. juglandis* or *G. morbida* occurs. Pathway prohibited in the PRA area?: No Pathway subject to a plant health inspection at import?: Yes (in many countries) Pest already intercepted on the pathway?: Not known	
Because *P. juglandis* has been shown to occur on all the native *Juglans* at origin, and to also infest exotic species, this pathway covers all species of *Juglans*. It also covers all *Pterocarya*. It covers plants for planting with roots. Scion wood is also covered because, if imported, it may be so in quantities to graft trees for nut production, and this pathway was therefore not discarded (note: it is not known if scion wood of *Pterocarya* is used). There have been no reports of thousand cankers disease infecting nursery stock (Newton and Fowler, 2009). No later publication mentioning this was found. However, there is some evidence that material of small diameter is suitable for both pests. In caged experiments in the USA, *P. juglandis* entrance holes were observed in *J. nigra* seedlings with basal diameter as small as 0.55 cm (A. Mayfield, USDA Forest Service, USA, 08-2014, personal communication). The minimum diameter for breeding and reproduction of *P. juglandis* is currently not known, but *G. morbida* could be present in small material resulting from feeding by the beetle. In Italy, cankers and holes were observed on 1.5-2 cm material in the field; *G. morbida* could be artificially inoculated in 5-10 mm diameter plants (2-year old), both for *J. nigra* and *J. regia* (L. Montecchio, Università di Padova, Italy, 08-2014, personal communication). Consequently, the EWG considered that all plant sizes should be considered. Older larger plants present a higher risk. Newton and Fowler (2009) note that, for nut production, *J. regia* scion wood (cuttings from branch tips) is commonly grafted onto seedling rootstocks. Growers graft the cuttings onto their own rootstock or purchase grafted trees. It is not known if *P. juglandis* and *G. morbida* would be associated to scion wood. Newton and Fowler (2009) mention that nurseries graft seedling rootstocks at the beginning of the second-leaf stage and sell them the following fall. There are breeding and selection programs for *J. nigra* in the USA, and Newton and Fowler (2009) note that scientists, due to the potential threat from the movement of infected walnut, had not shipped walnut scion material for almost two years, and the very small amounts that were shipped overseas were checked very carefully to ensure healthy material, and that there may be undocumented trade and movement of scion wood by individuals. This may indicate a precautionary approach or a possibility that such material is infested. **Biological considerations.** All life stages could be associated to the plants, including overwintering adults. All life stages of *P. juglandis* are likely to survive and complete development. *G. morbida* would also survive. It is unlikely that *P. juglandis* completes its development and infests other trees within the consignment as transport is likely to be quite rapid. However, in infested areas, other adults from outside could be attracted to the trees if they are stored or transported in open facilities. Import of plants for planting of *Juglans* and *Pterocarya* is allowed but trade of plants for planting is subject to measures in many EPPO countries (Table 4 in Annex 2). Early stages of infestation would be difficult to detect as there will be few signs of the pest presence (e.g. only few entry holes). Transfer to a suitable host is considered likely, because plants for planting will be planted within a few weeks in a suitable environment and suitable host plants may be present in the vicinity. **Trade.** No detailed data were found on trade of *Juglans* or *Pterocarya* plants for planting, but there seems to be a small trade to the EPPO region. Over 2001-2010, at least 34 plants of *Juglans* spp. and 4 of Pterocarya spp. were imported into the EU from the USA (J.C. Grégoire, pers. comm). *J. regia* and *J. nigra* are grown extensively in the EPPO region, and it seems more likely that these species would be traded from within the EPPO region. No precise data was found on this trade, but some nurseries in the EPPO region offer different *Juglans* species for sale (PPP-Index, 2014). No specific data was found regarding scion wood. However, even a very limited number of infested plants may allow the entry of a sufficient number of individuals to build a population. **Conclusion.** Plants for planting would be a very favourable pathway, and there is a trade (although probably of a small volume into the EPPO region). The EWG considered that the risk is lower for scion wood because it would be small pieces, carefully examined during the process of grafting allowing detection of infested material, and unlikely to produce a successful graft if infested. The probability of entry on plants for planting was rated as moderate with a high uncertainty.	
Likelihood of entry on the pathway: - moderate (plants for planting) - low (scion wood)	**Uncertainty**: - high (volume of trade, whether nursery stock is infested) - moderate (whether there is trade, and its volume)

Particle wood and waste wood of deciduous species from countries where *P. juglandis* or *G. morbida* occurs

Pathway prohibited in the PRA area?: No
Pathway subject to a plant health inspection at import?: No
Pest already intercepted on the pathway?: Not known

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

In areas where the pests occur, they are likely to be associated with walnut trees in forests. The species used to produce deciduous wood chips in the USA are not known, but deciduous wood chips from North America are expected to contain many species due to the high diversity of forests (VKM, 2013). Both branches and trunks can carry *P. juglandis* and *G. morbida*, and may be used to produce such material. The EWG supported that walnut is unlikely to ever constitute a high percentage of any load of wood chips, and this creates a major difference in terms of risk compared to other deciduous species such as e.g. birch.

There is little if any management for these pests in forests or plantations for the production of wood, nor have effective management methods been developed. Wood chips are produced by grinding or chipping, which may damage some individual insects and hasten desiccation. *P. juglandis* can survive even in small wood chips, and is able to complete development in larger pieces following chipping; *G. morbida* can also survive (Cranshaw and Tisserat, 2012b). Chipping will make the wood unsuitable for continued breeding in a shorter time (i.e. weeks-months) than for logs (i.e. months-years) (Cranshaw and Tisserat, 2012b). see 12.5 “disposal on infested branches or trees”.

The European Standard on solid fuel (CEN, 2010) identifies four classes of wood chips according to particle size (i.e. passing through round hole sieve of the specified size), with a fraction (3 to 6%) being allowed to be above the class size. Wood chips in the smallest class have a minimum size of 3-15 mm. In the largest class, 75% of wood chips should be comprised in the range 16-100 mm, and 6% can measure 200-350 mm (Alakangas, 2010). In the Netherlands, the common maximum size of wood chips (in any direction) is 200 mm (Kopinga et al., 2010). Because all life stages of *P. juglandis* are very small (1.5-1.9 mm for adults), remaining individuals would survive in wood chips of any size.

Waste wood may be produced as a result of sawing or squaring logs. Waste wood resulting from squaring will contain a large proportion of bark and is more likely to contain the pests. Wood waste may contain large pieces of wood, which could probably be infested as logs are. However, particle wood and waste wood may also be agglomerated in pellets, logs or briquettes, and agglomeration would further damage the pest. Pellets are also treated at high temperature to agglomerate the particles and sealed in plastic bags. The probability of survival in these commodities is very low.

Chips are usually stored in big piles prior to processing. The outer part of the pile may be too dry, and the temperature in the core of the bulk may be too 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. As a conclusion, part of the wood chips consignment/pile is likely to present the appropriate conditions of moisture and temperature for the survival and development of the pest. Young larvae may survive if the size of the wood chips is sufficient to accomplish the life cycle (sufficient space for larval galleries). Survival of later stage of larvae, pupae and adults does not depend on the size of wood chips. *P. juglandis* may complete its development, if the period of storage is long enough. Waste wood is likely to be of bigger size than wood chips and the pest will be less subjected to desiccation than in wood chips.

There is no indication on whether wood chips could become infested after processing. Apart from large size wood chips, wood chips rapidly become unsuitable for breeding and are unlikely to support further generations. However, during transport and storage in the open, adults may be attracted to the wood chips if bark is present. Only the outside layer of the bulk may be infested, if it is not too dry.

Where phytosanitary import requirements are in place, inspections would be carried out at origin and at destination. There are few requirements applying to deciduous wood chips in the EPPO regions, and most apply to other deciduous trees (Table 2 in Annex 2); however, they would probably be applied in case of mixed consignments. Detection of *P. juglandis* and *G. morbida* would be difficult for the same reasons as for the wood pathway. It would also be complicated by the fact that 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 of inspection. Inspection is therefore unlikely to detect *P. juglandis* and *G. morbida*.

Transfer to a suitable host would require that the wood chips/waste are stored in the open in the proximity of walnut trees. The main importers of deciduous wood chips in the PRA area are also countries where *Juglans* species are widely grown. The intended use of the wood chips would also influence transfer, which would be facilitated where wood chips are used outdoors. In this type of use, the wood chips may be too dry to allow development of *P. juglandis*. Where wood chips are intended for energy or processing (e.g. fibreboards), transfer to a suitable host would be possible only if the wood chips reached their destination within 3 months after chipping, and provided a sufficient period prior to processing to allow completion of development and emergence. The likelihood of transfer to a suitable host is on the whole considered much lower than for wood with or without bark.

Trade
VKM (2013) stated that a rapid increase in import of wood chips is expected due to the targets of the EU energy policy towards 2020. Data on trade of wood chips and wood waste were available in USA and EU trade statistics (USDA-FAS, 2014; Eurostat). USDA-FAS (2014) indicate increased imports of deciduous wood chips (4401220000) to the PRA area in 1998-2013, with over 180.000 metric tonnes in 2013 (Table 1 in Annex 4). Turkey was by far the largest importer (ca. 120.000 metric tonnes) followed by France (23.000 metric tonnes) and Germany (12.000 metric tonnes). Spain and Denmark imported over 4000 metric tonnes each, and there were also imports by Sweden, the UK, Bulgaria, the Netherlands, Israel, Italy, Finland and Switzerland. Exports to 10 other EPPO countries are registered in previous years.

Imports seem to have increased considerably between 2012 and 2013 for some countries: x25 for Denmark, x16 for the Netherlands, x10 for Turkey, x4 for Sweden, x2 for France. Imports were however irregular depending on years. In January-March 2014, Turkey had already imported over 90.000 metric tonnes of deciduous wood chips.

EU trade statistics (Eurostat) for 1998-2013 indicate similar trends from the USA, with Austria also listed as importing deciduous wood chips. Germany is the only country that imported deciduous wood chips from Mexico over the same period, but such exports seem to have stopped after 2011 (Table 2, Annex 4).

From Italy, there were exports of small quantities to several EPPO countries, including Austria (over 2000 t), France (over 200 t) and others in smaller quantities (Table 3 in Annex 4).

Regarding waste wood, USDA-FAS (2014) indicates a trade of waste wood (including sawdust) (Table 4 in Annex 4 - 4401300000 in 1998-2011; 4401.39.0000 in 2012-2013) in relatively small quantities mainly to the UK, the Netherlands and Germany. The volumes and importing countries seem to vary a lot, with the Netherlands having imported over 200.000 metric tonnes in 2010 and in 2011, and the UK over 130.000 metric tonnes in 2011. For Eurostat, similar data indicate in 2013 imports to Belgium, but also France and Germany (Table 5 in Annex 4) with over 8500 tonnes in total. The figures do not correspond to US data above and may relate to different categories of products.

Regarding monthly exports from the USA (USDA-FAS, 2014), deciduous woodchips to Turkey were imported in January, March, June and September. For other countries, imports occurred throughout the year, with the lowest quantities in September and October (Table 7 in Annex 4).

Conclusion. The probability of entry on wood chips and wood waste is considered as "low". Although the volume of trade and frequency are favourable to entry, walnut is not likely to constitute a high percentage of any load of wood chips, entry would require that individuals survive processing and transport, and transfer to a suitable host. This would be more complicated than for wood as *P. juglandis* would be more exposed to desiccation, and transfer would require that wood chips are stored outdoors or used in particular conditions (mulch). Transfer of *G. morbida* if on its own, is considered unlikely, as for wood.
There is a high uncertainty related to the species composition of deciduous wood chips, and the size of the wood chips.
The probability of entry on particle wood and wood waste in agglomerated form is considered as "very low" as all life stages would be destroyed, and these products would mostly be used for burning.

Likelihood of entry on the pathway:	**Uncertainty**:
- particle wood and wood waste of deciduous species (not agglomerated): low	- high (composition of deciduous wood chips, size of wood chips)
- particle wood and wood waste of deciduous species (agglomerated): very low	- low

Bark of *Juglans* and *Pterocarya* from countries where *P. juglandis* or *G. morbida* occurs

Pathway prohibited in the PRA area?: only in some countries
Pathway subject to a plant health inspection at import?: No
Pest already intercepted on the pathway?: Not known

Bark of walnut may be used for various purposes, including mulch. *G. morbida* and all life stages of *P. juglandis* may be associated with bark. It is not known if bark of *Pterocarya* is used.

In areas where the pests occurs, all stages of *P. juglandis* and *G. morbida* are likely to be associated with bark of *Juglans*, but it is not known whether such bark is harvested and traded. Walnut bark contains phytotoxic compounds and is unlikely to be used as mulch.

In the commodity itself, signs of presence may be difficult to detect. All stages of *P. juglandis* are small (1,5-1,9 mm for adults) and remaining individuals would survive in bark pieces of any size. If stages are intact following processing, they will be subject 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 outer part of the pile may be too dry, and the temperature in the core of the bulk may be too high due to composting effect. Nevertheless, part of the bark consignment is likely to present the right conditions of moisture and temperature for the survival and development of the pest. Late stages of larvae, pupae and adults are expected to survive in bark and their survival does not depend on the size of bark pieces.

Bark of deciduous trees is generally not subject to measures in EPPO countries (except where it is prohibited or where measures are in place for other deciduous species) (Table 3 in Annex 2). Detection would be difficult even if inspection is performed. It would also

<table>
<tr><td colspan="2">be complicated by the fact that bark of non-host species may be mixed with those of host species.

If late larvae and pupae are present in the bark, they can complete their development. It is not known if emerging adults would multiply in transport and storage, and whether bark itself is attractive to adults.

If adults emerge at destination, they may be able to find hosts when bark is used outdoors.

Trade. Data is lacking on the trade of bark.

Conclusion. The probability of entry is considered as “low” with a moderate uncertainty, because no information could be found on existing trade. No data was found on trade of bark of deciduous trees from countries where P. juglandis or G. morbida occur.</td></tr>
<tr><td>Likelihood of entry on the pathway:
- low</td><td>Uncertainty:
- moderate (whether there is trade, whether bark of Pterocarya is used)</td></tr>
</table>

8.2 Pathways considered very unlikely, not considered further

Articles made of wood (e.g. furniture, gunstocks, other objects, incl. those still carrying bark). Walnut is used in particular in the furniture and gun industries. Articles of wood are generally exempt from quarantine in the USA when free from bark (e.g. Michigan Department of Agriculture, 2010). All life stages of *P. juglandis* and *G. morbida* may be present on objects made of wood, especially if bark is present. Wood was shown to remain suitable for *P. juglandis* development for several months. It is nevertheless expected that wood will usually be dried before being used for such objects (especially furniture and guns). *P. juglandis* would be exposed to desiccation, and possibly only late stages would be able to complete their development and emerge. If *G. morbida* survives longer than *P. juglandis*, it would lack a vector to reach live trees and would also be exposed to desiccation and be unable to develop. Transfer to a tree would also be complicated for *P. juglandis*. There is no information available to study this pathway in detail, but the likelihood of entry on this pathway is considered very low.

Plant parts (cut branches/foliage) of *Juglans* and *Pterocarya* from countries where *P. juglandis* and *G. morbida* occur. *P. juglandis* and *G. morbida* may be associated to branches, but it seems unlikely that there is any movement or trade of cut branches and foliage of *Juglans* and *Pterocarya*. This pathway is also not mentioned in relation to possible pathways in the USA, and is not thought to be a possible pathway for the EPPO region.

Hitch-hiking. There is no indication that this might be a relevant pathway for the movement of *P. juglandis*. This is not recorded as a possible pathway within the USA (Newton and Fowler, 2009). Even if *P. juglandis* adults become associated with non-host commodities or to conveyances when in flight, they would need to feed. However, the pests could be transported with containers and wagons transporting highly infested commodities, and may remain in these conveyances once unloaded and be transported further. Entry on the commodity itself is covered in the pathway for wood. There is no information available to study the hitch-hiking pathway in detail, especially on whether adults would survive for long transport durations (e.g. without food).

8.3 Pathways not judged possible, not considered further

Seeds, walnuts (fresh or dried, with shell or shelled). No life stage of *P. juglandis* is associated with seeds or walnuts, and neither is *G. morbida*. Nuts are not considered a likely pathway in the USA (Newton and Fowler, 2009). Nuts are exempted from all internal USA quarantines. There is no evidence that *P. juglandis* could become associated to consignments of walnuts as a contaminant (e.g. adults flying amongst harvested walnuts).

Soil or growing media. No life stage of *P. juglandis* seems to be associated with soil. In particular, from the literature available it seems that adults overwinter on the trees. Even if life stages were associated with soil, it is not clear how soil found close to walnut trees would end up being traded. Soil is also heavily regulated in the EPPO region.

Tissue culture of hosts. Even if walnut was exchanged as tissue culture for the purpose of breeding, neither *P. juglandis* nor *G. morbida* could be associated. This pathway is also not mentioned in relation to possible pathways in the USA.

Harvesting and wood-processing machinery, and tools. This is not relevant for international movement of the pests and is mentioned only under Spread.

8.4 Conclusion

The probability of entry is considered as "high". The volumes on some pathways are increasing and the pests are spreading in the USA. The probably of entry will be even higher if volumes further increase and the pests further spread widely to Eastern USA, where the main walnut wood-producing States are located. From Italy, most production plantations of *Juglans* were established in the 1990s and the trees are far from commercial dimensions (see section 8); wood volumes are therefore likely to be much lower than from the USA.

The volume of trade for some of the pathways considered is not known, and transfer to a suitable host may be complicated from some pathways. However, *P. juglandis* is present in infested material in large numbers, and it can multiply on some of them. The probability of entry was considered as follows for the different pathways:

Pathway, from countries where *P. j and G. morbida* occur	**Probability**
Wood with bark of *Juglans* and *Pterocarya*	Very high (low uncertainty)
Untreated wood packaging material, especially dunnage	High (low uncertainty)
Natural spread	High (moderate uncertainty)
Wood without bark (bark-free) of *Juglans* and *Pterocarya*	Moderate (moderate uncertainty)
Plants for planting of *Juglans* and *Pterocarya*	Moderate (high uncertainty)
Scion wood of *Juglans* and *Pterocarya*	Low (moderate uncertainty)
Bark of *Juglans* and *Pterocarya*	Low (moderate uncertainty)
Particle wood and waste wood of deciduous species (not agglomerated)	Low (high uncertainty)
Squared wood of *Juglans* and *Pterocarya* (squared to entirely remove the natural rounded surface)	Very low (low uncertainty)
Wood packaging material treated according to ISPM 15	Very low (low uncertainty)
Particle wood and wood waste of deciduous species (agglomerated)	Very low (low uncertainty)

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. *P. juglandis* and *G. morbida* have established in two provinces of one region of Italy.

9.1 Host plants in the EPPO region

At least *J. regia*, *J. nigra* (although North American species, see below) and *J. mandshurica* occur naturally in the PRA area. These species as well as many other *Juglans* spp. are also grown commercially (for wood or nuts) and as amenity trees (parks, gardens). *Pterocarya* would presumably be grown as amenity tree.

J. regia (Asian/European species)

J. regia is the most widespread *Juglans* in the PRA area. It is used commercially for nuts and wood, and as amenity tree. *J. regia* is native to Asia, possibly also to Central Europe and the Balkans, and locally naturalized in southern and western Europe (Flora Europaea, 2014).

J. regia is important in the wild in Central Asia; in particular wild *J. regia* forests of Kyrgyzstan are unique in the EPPO region, as they cover large areas and are also as pure stands (unusual for *J. regia*) (Hemery, 2000). Forests of *J. regia* in Central Asia are near-threatened (Eastwood et al., 2009). *J. regia* also grows naturally in other parts of the region in border of forests, in forested areas and mountains (e.g. Central Turkey, Hemery, 2000).

J. regia is the main species used for nut production (Hemery, 2000). Data on areas and volumes of production in the EPPO region are given in Annex 5 (Tables 1 and 2). The total production area in the EPPO region covered 255.000 ha in 2012, with slightly less than 100.000 ha in Turkey (ranking 4th worldwide for the production area)). Production of walnuts is recorded from 32 EPPO countries. In terms of areas of production, Turkey, France and Poland accounted for over 50% of the total area of walnut orchards in the EPPO region in 2012. Ukraine and Romania may also have substantial areas (which are not shown in the data) as they are major producers in volume. A map of walnut in the EPPO region (as a crop for nut production) is provided by Monfreda et al. (2008), which also indicates some production in Israel and Jordan (not reflected in FAOSTAT) (Figure 1 in Annex 5). In conclusion, commercial production of walnuts is recorded in most of the EPPO region, to the exception of Northern Europe and part of North Africa (except for Morocco, which has a substantial production). It is likely that there is some local or garden production in most countries.

For silviculture, *J. regia* is planted in different cultivations systems as pure or mixed plantations, in agroforestry systems (*J. nigra* and *J. regia* with cereal and fodder plants), or for combined nut and wood production (Mohni et al., 2009). In countries of the former-USSR, *J. regia* is listed as native in Central Asia; Tajikistan, and cultivated in Russia, Latvia, Lithuania, Belarus, Moldova, Ukraine, Transcaucasus (EPPO, 2000). In Italy, about 170.000 ha were planted with noble hardwoods since 1992, of which about 70.000 ha with walnut as the main species (Ducci et al., 2010). Most walnuts are cultivated in southern part of Italy (Campania) where they are grown for wood and nut, and more intensively (for nuts) in Northern Italy (USDA-FAS, 2012).

J. nigra (North American origin). *J. nigra* was introduced into Europe from North America in the 17th century, has been used as a forest tree since the 19th century and is acclimatized from Western Europe (including Italy) to Ukraine and Russia, through Central Europe(Kremer et al., 2008). Flora Europaea (2014) considers it extensively planted for wood production in parts of central and eastern Europe. Nicolescu (1998) mention that *J. nigra* is mostly grown in France, Germany and Hungary. In Croatia, *J. nigra* is present as pure or mixed stands, occasionally isolated trees. It is expected that it would be similar in other countries. Natural hybrids between *J. regia* and *J. nigra* occur (Kremer et al., 2008). In countries of the former-USSR, *J. nigra* is listed as being cultivated in Russia (CE and SE), Latvia, Estonia, Belarus, Moldova, Ukraine (EPPO, 2000). It is also available for sale as ornamental (see below). The following figures were found for areas of *J. nigra* in Central Europe (some seem to correspond to mixed stands).

Country	**Area**	**Source**
Hungary	3400 ha (plantations)	Salek and Hejcmanova, 2011
Romania	2100 ha (plantations)	Salek and Hejcmanova, 2011
Croatia	827 ha (pure stands), 3162 ha (plantations)	Kremer et al., 2008
Czech Rep.	492,8 ha	Salek and Hejcmanova, 2011
Slovakia	500 ha	Tokár, 2009

J. cinerea (North American species) is recorded as occasionally planted for wood, and occurring in Denmark and Romania (Flora Europaea, 2014). For countries of the former-USSR, it is listed as being cultivated in Russia (CE, SE), Ukraine, S. Siberia, Central Asia (EPPO, 2000). It is available for sale as ornamental.

J. californica (North American species), for countries of the former-USSR, is listed as cultivated in Georgia, Uzbekistan, Turkmenistan. No data were found for other countries. It is available for sale as ornamental.

J. ailantifolia (Asian species), for countries of the former-USSR, is listed as cultivated in Russia (CE, SE), Baltic countries, Belarus, Moldova, Ukraine (EPPO, 2000). No data were found for other countries. It is available for sale as ornamental.

J. mandshurica (Asian species), for countries of the former-USSR, occurs naturally in the Southern Far-East of Russia, and is listed as cultivated in Russia (NE, CE, SE), South Siberia, Moldova, Baltic countries, Belarus, Ukraine and Transcaucasus (EPPO, 2000). No data were found for other countries. It is available for sale as ornamental.

Hybrid *Juglans* are used in the EPPO region, for example as forest trees: in France *J. nigra* x *J. regia* (also called *Juglans* x intermedia), *J. major* x *J. regia* (Becquey and Payre, 2007); in the UK *J. regia* x *J. nigra* (Forestry Commission, 2014). Hybrids of *J. regia* with North American *Juglans* (*J. nigra, J. major, J. hindsii*) are mentioned in Coello et al. (ND). At least *J.* x *intermedia* is available for sale as ornamental.

11 *Juglans* spp. of various origins are recorded as being available for sale in nurseries in Europe (PPP-Index, 2014), as well as the hybrid *J. x intermedia*. These include the species listed above, as well as *J. cathayensis*, *J. hindsii*, *J. major*, *J. microcarpa*. Five species of *Pterocarya* are also available for sale, including *P. fraxinifolia*, *P. rhoifolia* and *P. stenoptera*. It is not known if other North American species are planted for timber production in the EPPO region. There are a large number of other species of *Juglans*, originating from Asia, and these may also be used as ornamentals.

9.2 Climatic conditions

Newton and Fowler (2009) note that *P. juglandis* and *G. morbida* are expected to be able to occur throughout most of the USA, wherever hosts are found. According to the classification of Köppen-Geiger (Annex 6) (Kottek et al., 2006), all climates that occur in the USA where *P. juglandis* and *G. morbida* occur are present in some part of the EPPO region, in a broad area covering North Africa, the Near East, East to Central Asia and Siberia (north to 55°), and the whole of Europe (except the northern parts of Sweden, Norway and Finland).

From the data available on the temperature thresholds of *P. juglandis* and *G. morbida* (see details in the preliminary datasheet), there is no evidence that climate would be a limiting factor for the establishment and survival of the insect in the EPPO region. Extreme cold and hot climates in the EPPO region, which may be limiting for *P. juglandis*, would also occur in areas where *Juglans* does not grow. Suitability of an area would relate more to the presence of hosts.

9.3 Management conditions

P. juglandis is able to develop on healthy or stressed trees, and on cut trees.

It is not known whether measures are applied in the EPPO region against other bark beetles of walnut, either in orchard, forests or ornamental trees. A quick search was made for the walnut bark beetles mentioned in Bright and Skidmore (1997) as being present in Europe. No information on control measures for walnut bark beetles was found.

In forest, few pest management practices are generally applied, and they are therefore not likely to prevent establishment. It does not seem from the literature available that the presence of fallen trees or logs in forest favours attacks and would therefore favour establishment of *P. juglandis*.

In walnut orchards, pest management practices are applied against a number of pests. For example:

- *Rhagoletis completa* is a recently introduced fruit fly that can damage 80% of the production (Verhaeghe et al., 2010). In France, control is compulsory and relies on sprays of insecticides directed towards the crown (phosmet, spinosad, thiacloprid - 2 sprays with 14 days between), or 5-7 local applications of bait in the top of the crown with 10 days in between (Journal Officiel, 2009). Applications are presumably timed when nuts are susceptible to attacks, and would not necessarily correspond to emergence of adults of *P. juglandis* (which may also emerge over a long period). *Cydia pomonella* is also an important pest. In Turkey, control relies on sprays of insecticides such as chlorpyrofos-etyl, deltamethrin, cypermethrin. None of these are effective for bark beetle control.
- Walnut blight, caused by the bacterium *Xanthomonas arboricola* pv. *juglandis*, is a serious disease for which the choice of the variety is very important (Peroys et al., 2012). It occurs throughout Europe to Uzbekistan and Russia, as well as Israel (EPPO PQR). The only control method available is copper compound sprays (in France, 3- 4 from bud break to female flowering), which would probably not have effect on the beetle and fungus as they are not systemic but acting by contact.
- In Turkey, walnut anthracnose, caused by *Gnomonia leptostyla*, is also a common disease of walnut. Control relies on sprays of maneb at four different phenological stages. Maneb is not expected to affect *P. juglandis* and *G. morbida*.

It is unlikely that treatments applied against other pests presently affecting *Juglans* in the EPPO region would have an effect on *G. morbida*, which is protected by the bark, nor on *P. juglandis*, which has hidden life stages, overlapping generations and a long flight period. If minor dieback is observed on a few branches, it may be that they would be pruned, but by that time *P. juglandis* and *G. morbida* would certainly be present in other parts of the tree and in other trees. In Veneto, pruned wood is left in the orchards, and tools and machinery are shared between several orchards' owners. Plantations of *J. nigra* are not always managed for high quality timber production and typically have other pest problems.

9.4 Biological considerations

As stated in section 2 (*Pest overview*), small populations are believed to be able to start an outbreak. However, *P. juglandis* may be present in huge numbers in logs, which would help establishment of populations. Although details are missing on some aspects of the biology of *P. juglandis*, it is known that there are several overlapping generations (estimated to 2-3 in the USA) and it would also have several generations in the EPPO region. *P. juglandis* has a long flight period (in the USA, for example in California, all year except December; in Colorado mid-April to October; see EPPO datasheet). There is a possibility that adults may be present all year round in the southern part of the PRA area. Finally, it has adapted to several *Juglans* species other than those present in its native range, and is very sucessful on some of them. It is very likely that it could move to yet other *Juglans* species than those that have been studied to date.

Establishment of *P. juglandis* and *G. morbida* may be facilitated if it was introduced in an area of continuous presence of *J. nigra*, e.g. plantations of *J. nigra* or in areas where other hosts are widely present (e.g. *J. regia* wild forests in Central Asia). In Italy, the disease was detected on *J. nigra* and *J. regia* in gardens, and in *J. nigra* plantations. The actual infested area is characterized by scattered (separated by hundreds of meters to some kilometres) small plantations for timber production of *J. nigra* (pure or mixed with other species); *J. regia* is widely present (often isolated or in little groups) as fruit or ornamental tree. Susceptible *Juglans* species are present in a network of hosts over a wide area, which would facilitate natural spread.

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

It is supposed that young walnut trees are grown in open nurseries, and not under protected conditions. However, information was not available to answer this question.

11. Spread in the PRA area

11.1 Natural spread

P. juglandis flies and is expected to spread naturally from areas within the EPPO region where it becomes established. No mechanism is currently known for the spread of *G. morbida* in the absence of *P. juglandis*. No other vector is known (see section 4). Although other possible modes of spread are envisaged for *G. morbida* in the literature, such as wind or water (Newton and Fowler, 2009), there is no evidence. The EWG noted that large amounts of mycelium and conidia are sometimes present at the entrance of *P. juglandis* holes, and may be transported further by either wind or water. *G. morbida* may be able to move by itself to the same branch or neighbouring tree, and enter through wounds, as achieved through inoculation. However, spread to other trees and disease development does require a wound-producing vector (with multiple wounding). In addition, *Geosmithia* fungi are strongly associated to bark beetles (Kolarik et al., 2008). The EWG believed that wind and water dispersal are expected to have a minor epidemiological importance.

The EWG considered that spread with *P. juglandis* is the major mode of spread of *G. morbida*.

Natural spread has occurred in the USA, although human-assisted pathways are considered more important for spread and is critical for spread over long distances and across geographic barriers. Cranshaw and Tisserat (2012b) note that some dispersal of *P. juglandis* in North America may have involved wind-blown dispersal and there are examples of small bark beetles transported by wind. However, wind is not considered the main factor of spread in the USA compared to human-assisted spread to establish new outbreaks. The EWG believed that human-assisted spread will also be the main mean of spread in the EPPO region.

In Italy, since the first detection in 2013, *P. juglandis* and *G. morbida* have been detected in the Veneto region at 12 sites over an area broadly 70 km East-West and 30 km North-South. The original point(s) and date of introduction are not known. In Lombardia, *P. juglandis* was detected approximately 50 km to the south-west of the westernmost detection site in Veneto. The origin of the pest is not known (Italian NPPO, 2014).

Natural spread will depend on many parameters (presence and abundance of host trees, climatic conditions, wind). It can also be expected that the population of *P. juglandis* would build up locally before the pest starts spreading, and there may be a few years during which spread is minimal. *P. juglandis* is likely to have several generations per year in the EPPO region as in its original range (2-3). Even though the flight capacity of *P. juglandis* is unknown, other small bark beetles of similar size are capable to fly long distances, and the EWG considered that this data could be used for *P. juglandis*. For example in Nilssen (1984), distances of 86 km was noted for *Pityogenes chalcographus* by trap logs situated at a range of distances North of spruce forests. Comparable distances to those in Nilssen (1984) were observed in Belgium for *P. chalcographus* (unpublished, J.C. Grégoire, pers. communication) and *Ips typographus* (Piel et al., 2005).

In Italy, natural spread could occur in all directions, including towards the main areas of walnut production in the South. It is expected that there is a continuous presence of walnut trees towards these areas. In the North, it is not known if the presence in Lombardia is due to natural spread from Veneto or a separate introduction.

Regarding spread to other EPPO countries, the easternmost detection site in Veneto is located about 110 km from Slovenia and Austria. It is expected that there would be a continuous presence of walnut trees to Slovenia, Austria and Croatia in the East, at least as park and garden trees. To the North, the closest borders from the outbreaks in Veneto and Lombardia, Italy, are those of Switzerland or Austria (about 130 km), but these are located in places where the Alps probably form a natural barrier of high mountains and where the presence of walnut may be partly or completely discontinued (and temperatures may also be less favourable). Natural spread could also occur towards south-east France, which is further away.

Natural spread should also be considered if new outbreaks appear in the EPPO region.

11.2 Human-assisted pathways

Human-assisted pathways are known to carry *P. juglandis* and *G. morbida* (see section 8 of this PRA). Within the EPPO region, the pests could be transported with all forms of *Juglans* and *Pterocarya* wood (incl. round wood, wood chips, wood waste, untreated wood packaging material), bark and plants for planting. *P. juglandis* could also possibly be transported on conveyances (containers, wagons) having transported infested *Juglans* commodities, and spread within a country or between countries; however, there is no evidence of this.

Some EWG members made the hypothesis that *G. morbida* could spread locally through contamination of pruning tools and harvesting and wood processing machinery. To date there is no evidence of this, and it is also recognized that *G. morbida* is not a vascular pathogen.

P. juglandis and *G. morbida* have been introduced to the EPPO region through human-assisted pathways, and if no measures are applied it may happen again, even more as *P. juglandis* and *G. morbida* more extensively move into native stands of *J. nigra* in Eastern USA.

11.3 Estimates of spread and expected spread within the EPPO region

The rate of spread may be high in the absence of control of movement of wood and possibly host plants which could carry *P. juglandis* and *G. morbida*. Both pests are already in the EPPO region, in an area which has similar climate to known infested areas in the USA. There are also pathways from the USA that could introduce the pests to multiple locations. Multiple introductions in several areas would allow more rapid spread within the PRA area. From Italy, it would be important to know if there has been movement of wood from the outbreak area to other parts of Italy or other EPPO countries (note that, for Veneto, such movement is now forbidden by the regional decree; Regione del Veneto, 2014 a, b, 2015). The EPPO region has many areas where hosts are present and to which the pests could spread and establish (see section 9.1 and Annex 5).

The speed of spread will also depend on the implementation of containment measures, and on the trade of walnut wood that has already occurred from that area. Containment options are available to slow down the spread (see section 16.3), which would allow more time to develop management tools. In Italy, containment measures are currently applied in Veneto (Regione del Veneto, 2014 a, b, 2015), but not in Lombardia.

In the absence of effective containment measures in areas where the pests occur, spread can be expected to happen much more rapidly.

Rating of the magnitude of spread - in the absence of containment measures	*Low* ☐	*Moderate* ☐	*High* ✓
- if containment measures are applied	*Low* ☐	*Moderate* ✓	
Rating of uncertainty	*Low* ☐	*Moderate* ✓	*High* ☐

12. Impact in the current area of distribution

This section provides details on the impact in the USA. The situation in the outbreak area in Italy is covered in section 13 (because very limited impact has been observed to date). There is no information on any impact in Mexico.
To date, the impact of the disease in the USA has mostly been in urban/residential areas and amenity trees, agricultural landscapes, and to a certain extent to orchards (in California). In Eastern USA, confirmed cases of thousand cankers disease were in urban areas and roadside, but it is now found in forests in Eastern USA, and it can be expected to move to native stands and plantations in Eastern USA in time.

12.1 Nature of the damage

Thousand cankers disease produces progressive crown dieback resulting in reduced growth rates and, in extreme cases, tree mortality. The disease organisms do not directly damage the wood but timber quality can be affected by reduced growth and yield.Nut production/yield may be reduced in diseased trees or because of tree mortality (butthere is no direct damage to nuts).

12.2 Direct and indirect impacts

To date amenity trees have been most affected. However, the greatest potential impacts of thousand cankers disease in the USA are considered to be on timber production (primarily *J. nigra*) with additional losses to nut production (primarily *J. regia*).

It is difficult to estimate the value of *Juglans* as an amenity plant. These include walnuts that occur in gardens, parks, along streets and fence rows, and in woodlots in the urban-forest interface. In one area of the USA, Boulder Colorado, where thousand cankers diseases has been present for over a decade, the value of affected plants is estimated at approximately $3 million and over 60% of trees died within 6 years of its original detection (Tisserat, 2009). Many municipalities and homeowners in the USA have already incurred costs associated with loss of *Juglans* amenity plants due to tree removal and replacement costs, indirect effects on shade, heating/cooling, and added landscape value to property.

Regarding wood production, the potential impact of thousand cankers disease on *J. nigra* in its native range (Eastern USA) is still unclear, as it has only recently been discovered. Thousand cankers disease does not yet affect the primary areas of USA *Juglans* timber production, where the potential damage is ultimately expected to be greatest. There is a high level of concern for such potential damage in Eastern USA, reflected in the measures put in place by many States to prevent the spread of the pests. In addition, the USA exports significant quantities of walnut logs and wood products (estimated at $325 million annually; Newton and Fowler, 2009). Phytosanitary requirements imposed by import markets may directly impact the value of export markets for certain *Juglans* materials; the Republic of Korea has recently put in place measures on various *Juglans* commodities from the USA (at least Pennsylvania, Robertson, 2014).

Regarding nut production, *J. regia* is considered to be less susceptible to thousand cankers disease than are some other Juglans species (e.g. *J. nigra*, *J. hindsii*). However, mortality, although not extensive, has been observed in the USA. The potential impact on *J. regia* is unknown according to Utley et al. (2013). Potential losses to nut production are likely to be due to decreased nut production (from loss of twigs and branches) and decline or death of producing trees (Newton and Fowler, 2009). Certain rootstock on which nut-producing *J. regia* may be grown (e.g. ‘Paradox’ a hybrid of *J. hindsii* x *J. regia*) are susceptible to thousand cankers disease.

Finally, there are also costs incurred by government and universities associated with survey and detection, monitoring, public outreach, and development and implementation of interstate quarantines.

12.3 Environmental impact

In the USA there are 6 species of native *Juglans* spp. and these occur in many natural areas. In these sites the trees can be important as food crops and shelter for wildlife.

12.4 Social damage

Social damage in the USA is currently due to death of amenity and garden trees, but losses of jobs related to commercial production of *Juglans* can be anticipated at some future point. In some cities of Colorado, mature *J. nigra* have been nearly completely eliminated within the past decade (Tisserat and Cranshaw, 2012) and similar levels of *J. nigra* loss from thousand cankers disease are thought to have occurred in many other areas of the western USA (western Colorado, Utah, Idaho) before the disease was recognized. These tree losses have multiple effects on human activities, including value provided by shade, wind protection, floodwater mitigation and aesthetics of landscapes. Furthermore, in many rural areas of the midwestern USA, there is considerable cultural value given to the collection and use of *J. nigra* nuts by families and small communities. To the extent that thousand cankers impacts nut production, these values may be reduced.

12.5 Control strategies in the USA

No individual control methods are currently available to effectively protect individual trees from developing thousand cankers disease or remediate the health of diseased trees. Research is actively conducted on control methods of this recently-recognized pest complex. Methods that have been investigated (or are under investigation), but currently do not allow for the management of thousand cankers disease are listed in Annex 7.

In the USA, a national response framework was developed by USDA Forest Service in 2011, which covers prevention, detection, management, outreach/education and research (Moltzan, 2011). Several States implement quarantines (see under section 5). Management purposes and implementation differ depending on the area.

- In the native range of *P. juglandis* and *G. morbida* (New Mexico, Arizona, California), control seems to mostly apply to walnut orchards (in California) or amenity trees, which are managed accordingly.
- In Eastern USA, the aim is to avoid further spread, especially to plantation areas of *J. nigra*, and quarantines are in place in many states. There is an increasing effort to conduct detection and monitoring surveys in states to identify newly established populations at an early stage of infestation and to delimit the distribution of the pests to assist in quarantine efforts. Detailed protocols for conducting detection surveys have been developed in recent used and are now widely used (USDA, 2014)
- Finally, in Western USA, while some States make recommendations for management especially in urban environment, no information was found for other States, such as Washington or Idaho at the northern front of the infestation.

Eradication of *P. juglandis* is generally considered unlikely in the USA (Cranshaw, 2009 draft; Haun et al., 2010) due to difficulties in delimiting the occurrence of the pests and cost of removal and disposal of infested material. It is being considered in Indiana in the situation of a single apparently localized detection of *G. morbida* (in 2013) in a region where *J. nigra* is a high value crop.

However containment plans that restrict movement are widely used with the goal of slowing the spread of the disease, and numerous US states have implemented interior and or exterior quarantines on the movement of walnut products towards this end. Guidelines were developed for forests (Haun et al., 2010), although it seems that measures so far are mostly applied to amenity and orchards. Containment plans in the USA combine surveillance and measures to prevent movement of potentially infested material to non-infested areas. Measures that could be used for containment in the EPPO region are detailed under section 16.3.

It is worth noting that sanitation (through removal and disposal of infested trees to slow the spread of the disease) has rarely been used in the USA, also in the context of containment plans. The EWG noted that the limiting factors to its use has included difficulties in implementing it as an effective means of management, in a practical way and at a reasonable cost. It is particularly challenging in urban areas of the USA, where infested trees are widely distributed over multiple ownerships. Sanitation, where used, implies removal and disposal of infested trees. A wide range of methods have been investigated for this purpose in the USA. The EWG discussed their relevance in the context of a PRA for the EPPO region. Measures considered relevant as phytosanitary measures are detailed in the relevant pathway in Annex 8 (pest risk management). Other measures are listed in Annex 9, for the sake of giving complete information on the measures that have been investigated. Some of these may also be useful in the framework of containment plans (see 16.3).

Finally, preventing the spread requires measure to prevent infestation of the wood following felling and treatment. During warm periods, active beetles potentially may even disperse from cut wood as it is moved from the site. Therefore, care should be given in routing trucks hauling infective wood to avoid areas of healthy, uninfected walnut (Cranshaw, 2009 draft). Post-treatment colonization has been observed in treated logs (Sitz, 2013, Peachey, 2012; J. Audley, University of Tennessee, unpublished). If adult *P. juglandis* emerge in a closed environment (e.g. containers), they are likely to reinfest the logs or logs that were previously not infested. In Sitz (2013), 80% of logs treated by heat or cold treatment were reinfested if exposed to *P. juglandis*. The importance of proper storage of logs to avoid reinfestation is mentioned.

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

Juglans regia and *J. nigra* are the two main species used for wood and nut production, as well as ornamental species in the EPPO region and are also important in the environment. Other species *Juglans* and *Pterocarya* spp. are also used as ornamental species. As discussed in the spread section, all walnut trees of the EPPO regions are at risk in the long term. The greatest risk is to *J. regia* nut production, with secondary losses to timber (*J. regia*, *J. nigra*) and amenity plants. Although there are differences in the occurrence of *Juglans* and their uses between the USA and the EPPO region, the EWG considered that similar impacts from thousand cankers disease can be expected. There is an uncertainty on the potential impact on *J. regia* in the EPPO region, because it is less susceptible than *J. nigra*, but in the EPPO region it is also the most widespread host. It is not known how the pest will behave, but it may use the main host available. Some mortality has been observed in the USA, where the potential impact on *J. regia* is unknown according to Utley et al. (2013).

The impact noted so far in the outbreak in Italy is as follows:

- *J. nigra*. Dieback has been observed in plantations. No mortality was noted so far although some trees are severely affected and according to the symptomatology described in North American literature, this corresponds to the last stage before tree death.
- *J. regia*. Infestation on *J. regia* has only been detected on few trees near to two infested *J. nigra* plantations. Only few branches (less than 6-7 cm diameter) were affected. It is not possible to draw any conclusion on the severity of the disease at this stage.

To date, in Lombardia region, no symptoms have been observed.

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

Potential impacts in the EPPO region:

Economic impact (without environmental impact)

- *Impact for wood production***.** Although *P. juglandis* and *G. morbida* are considered to not affect wood quality, they will cause premature decline and death of trees. *J. nigra* is likely to be the most affected, and mortality could be high. Walnut wood is valuable, with similar uses as in the USA, and there is a large furniture-making industry based on walnut in Italy (Hemery, 2000).
- *Impact on nut production*: *J. regia*, the main walnut-producing species, is not resistant and some losses are likely to occur. It will take years before replacement trees come into full production (at least 10 years (http://www.noixdegrenoble-riviere.com/qualite/des-producteurs/)), provided more resistant cultivars and rootstocks can be found. Data on areas and volumes of production in the EPPO region are given in Annex 5 (Tables 1 and 2). 560.000 t walnuts were produced in the EPPO region in 2012, of which over 194.000 t

in Turkey (which is the ranking 6th worldwide for production volume). Production of walnuts is recorded from 32 EPPO countries, with the bulk of the production concentrated in few countries. Turkey and Ukraine accounted for over 50% of the volume of production in the EPPO region in 2012, and 80 % together with France, Romania, Greece, Belarus, Germany, Uzbekistan, Serbia and Spain.

- *Impact on amenity trees*: Decline and death of *Juglans* in parks, gardens and cities will occur. This will cause a loss of patrimonial value for large old trees, and will also have costs for removal and replacement of trees.
- *Increase in production costs:* treatment of wood will entail additional costs, as well as replacement of trees and pruning.
- *Impact on internal and external markets:* It is likely that the presence of *P. juglandis* and *G. morbida* will have an impact on internal markets and on exports. For example, the Republic of Korea is implementing phytosanitary measures on several commodities of *Juglans* from Italy as of February 2014 (ICE, 2014).

Environmental impacts. *P. juglandis* and *G. morbida* will have an impact on walnuts in the wild, especially when they reach areas where those are important (e.g. sensitive environments, mountains, wild pure stands in Central Asia). Changes to ecosystems may also occur due to the death of trees and animal species associated with walnut may be affected (such as the endemic woodpecker *Dendrocopos leucopterus*, closely associated to walnut forests in Kirghizstan – Rehnus et al., 2011). Walnut is already near-threatened in Central Asia and the establishment of *P. juglandis* and *G. morbida* would cause invaluable damage. In semi-natural environment such as agriculture landscape, the disappearance of the walnut could influence the landscape structure and ecosystem services.

Social impact. The social impact may be locally high in areas of intensive plantation or orchards, and in areas where walnuts are an important source of income for local populations (either collected from the wild, orchards or gardens). The recreational and aesthetic value of forests, parks and gardens will be affected by death of trees. Nut production in family gardens will be affected, as well as the livelihood of populations that harvest walnuts in the wild for their own consumption or for selling. In cities, walnut trees may have to be removed and replaced, possibly at a large scale.
For walnuts in Kirghizstan, the nuts of the wild *J. regia* forests are used by locals of some 50.000 people who live within the forest, for their own consumption or for selling in local markets; an individual tree's nuts production typically peaks at 130 years and continues until the tree is 300 to 400 years old (Hemery, 2000).
Losses of jobs in the wood and nuts industries cannot be estimated, but may occur locally.

Costs likely to be incurred by the introduction of *P. juglandis* or *G. morbida* (other than direct costs linked to the impacts above)

- General costs: surveillance and monitoring, containment efforts (note: eradication was considered feasible in very limited circumstances throughout this PRA – see section 16 of this PRA), communication.
- Sanitation practices (including cost of removal and disposal of trees), phytosanitary measures for export.
- Costs of shifting cultivars.
- Research: susceptibility trials including hybrids, better detection and monitoring tools, cultural controls, chemical and biological control etc.

14. Identification of the endangered area

P. juglandis and *G. morbida* have the potential to establish throughout the EPPO region where *Juglans* species occur. They are likely to be more damaging (more generations of *P. juglandis*) in the Southern and Eastern parts of the EPPO region, where walnuts are also grown more widely.

15. Overall assessment of risk

The likelihood of entry is estimated as high, especially on wood (with or without bark) of *Juglans* and *Pterocarya* and untreated wood packaging material. Plants for planting are also a very suitable entry pathway, if there is a trade. Establishment is likely where *Juglans* is grown in the EPPO region, and there is no factor that would limit the spread until the entire endangered area is colonized. The EWG considered that the potential impact in the absence of phytosanitary measures would be high in the long term.

Stage 3. Pest risk management

16. Phytosanitary measures

The entry section (section 8) identified wood with or without bark as a major pathway, and management measures were considered. In addition, bark, particle wood and waste woodcould also be pathways. The likelihood of entry on plants for planting of host plants was rated as moderate, with a moderate uncertainty, and measures are also considered here (scion wood was considered together with plants for planting).
For wood (except firewood), the measures were considered for the genera *Juglans* in general and for *Pterocarya*. It is considered here that all *Juglans* species are liable to carry the pest, and three *Pterocarya* species have recently been shown to be hosts. For firewood, measures are general. For wood chips and wood waste, measures relate to deciduous species, and for bark to *Juglans* and *Pterocarya*.

Given that the pests have been found in Italy (Veneto and Lombardia), more extensive surveys should be conducted as soon as possible. Containment measures are in place in Veneto (Regione del Veneto, 2014a,b, 2015).
Survey and trapping may be considered in EPPO countries, even more intensively in those countries importing large quantities of walnut wood and wood chips from the USA. In particular, trapping could be performed at points of entry (e.g. ports) and facilities (e.g. mills) receiving *Juglans* wood and plants, and in areas where *Juglans* are grown close to such facilities.

16.1 Measures identified

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 PM 5/3. The risk of entry associated with the other pathways identified in section 8 is very low, and measures were not considered necessary.

Measures identified for individual pathways (additional details in Annex 8)
PC= Phytosanitary certificate

Pathway	**Estimated probability of entry from countries where the pest occurs *(with uncertainty)***	**Existing regulation**	**Measures**
Wood of *Juglans* and *Pterocarya*	With bark: very high *(low uncertainty)* Without bark: moderate *(moderate uncertainty)*	No	PC, and - Pest Free Area (PFA) officially recognized by the importing country [1] or - Squaring to entirely remove the natural rounded surface [2] or - Heat treatment (for at least 56°C for at least 40 min. measured at 1 cm below the sapwood surface[3]) + handling/packing methods to prevent infestation after treatment. or - Making the wood bark-free + heat treatment (as above) *[note: handling/packing methods not needed as P. juglandis unlikely to reinfest wood made bark-free – see 7.25].*
Untreated wood packaging material, especially dunnage	High *(low uncertainty)*	Not fully	Treated according to ISPM 15
Natural spread	High *(moderate uncertainty)*		No measure proposed, but containment plans would slow down natural spread, and surveillance would help early detection
Plants for planting of *Juglans* and *Pterocarya* Scion wood of *Juglans* and *Pterocarya*	Moderate *(high uncertainty)* Low *(moderate uncertainty)*	Not fully	PC, and - PFA officially recognized by the importing country [1] or - Systems approach (on the basis of bilateral agreement):

Pathway	Estimated probability of entry from countries where the pest occurs *(with uncertainty)*	Existing regulation	Measures
			Growing the plants under complete physical isolation + handling and packing methods preventing infestation after leaving the protected conditions + visual inspection of the consignment.
Bark of *Juglans* and *Pterocarya*	Low *(moderate uncertainty)*	No	PC, and - PFA officially recognized by the importing country [1] or - Heat treatment (for at least 56°C for at least 40 min. if applied throughout the profile of the material[3]) + handling and packing methods to prevent infestation after treatment
Particle wood and waste wood of deciduous species (not agglomerated)	Low *(high uncertainty)*	No	PC, and - PFA officially recognized by the importing country or - Heat treatment (for at least 56°C for at least 40 min. if applied throughout the profile of the material[3]) + handling and packing methods to prevent infestation after treatment

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:

- A monitoring programme based on visual examination and pheromone traps in areas where hosts are present. This would require appropriate identification capabilities to avoid misidentifications and ascertain pest freedom.
  Specific surveillance is currently based in the USA on visual examination and pheromone traps (USDA, 2014). The surveys that are used to detect the insect also include sampling of symptomatic branches to detect the fungus. Surveillance would require visual examination and use of pheromone traps for at least 2 years, possibly throughout the year, and especially in the period when temperatures exceed (18-19°C) (Seybold et al., 2012b). The density of trap for detection surveillance is not given in USDA (2014) or Seybold et al. (2012b), but should be high to detect very low populations.
- Measures should be in place to prevent the entry of the pests, i.e requirements on commodities.
- Handling and packing methods allowing to prevent infestation of consignments after leaving the PFA (i.e. during transport) (see 7.26).
- Areas isolated by appropriate physical barriers (e.g. absence of hosts or sufficient distance) or minimum distance from the limits of infested areas. The flight capacity of *P. juglandis* is not known. However, there is information regarding another bark beetle of similar size, *Pityogenes chalcographus*, which was found infesting spruce trap logs 86 km from the nearest spruce forest (Nilssen, 1984), and the EWG considered this data was relevant for *P. juglandis* in the absence of specific data. As *P. juglandis* seems able to establish on trees in any condition (standing trees as well as cut logs), even a small fraction of a population reaching its maximal flight distance is likely to establish, given the presence of hosts. The EWG consequently proposed that a PFA should be separated by a distance of 100 km from the nearest infested area. *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 for a scenario where the fungus is introduced in one tree heavily infested with the vector, with a population of vector large enough so that spread starts the following spring, considering that host availability was not a limiting factor and that every infectious vector would lead to an infection. The exercise excluded any human assisted spread. The combined events enabling long distance dispersal include that part of the population is active above the forest canopy during the flight period coinciding with stable strong winds in one direction. The experts judged that 5% of the infection/infestation events within a year would occur during such conditions of long-distance dispersal. Based on a review of the evidence, experts judged that 5% of the infections/infestations will occur after one year in distances to the starting point above 31 km (best estimate of the median value), with a 90% uncertainty range from 8 to 80 km. Report of the EKE exercise is made available at https://upload.eppo.int/download/933o02d521b6b*

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 of the pests and the uncertainties on their distribution, the EWG noted that the PFA requirement could be applied to countries of North America and Europe, and not to countries on other continents.

2. **Squaring to entirely remove the wood natural rounded surface**. Quarantines in the USA require that squared wood be kiln-dried, because squared wood may still contain pockets of included bark. The EWG recognized that there is still a possibility that some bark remains on such wood. However, the EWG considered that squaring the wood reduces the risk and could be used as a

phytosanitary measure on its own. This is consistent with some measures that already exist in a number of EPPO countries (including the EU Directive 2000/29), for *Quercus* with regards to *Ceratocystis fagacearum* and its vectors.

3. **Schedule for heat treatment**. Heat treatments have proven to be highly effective for subcortical insects and pathogens. According to EPPO Standard PM 10/6(1) *Heat treatment of wood to control insects and wood-borne nematodes*, Scolytidae are killed in round wood and sawn wood which have been heat-treated until the core temperature reaches at least 56°C for at least 30 min. Effective treatment schedules against *P. juglandis* in the USA were 56°C for 40 minutes measured 1 cm below the sapwood surface (Mayfield et al., 2014) The EWG recommended as schedule at least 56°C for at least 40 minutes measured at 1 cm below the sapwood surface. Note that kiln-drying that fulfils the heat treatment conditions above is considered effective. This schedule is also expected to be effective for particle wood and waste wood, if applied throughout the profile of the material.

The main uncertainties in the management part are:

- Effective treatments
- Whether complete removal of bark is sufficient to reduce the risk to an acceptable level

16.2 Eradication

Eradication of *P. juglandis* is generally considered unlikely in the USA (Cranshaw, 2009 draft; Haun et al., 2010) due to difficulties in delimiting the occurrence of the pests and cost of removal and disposal of infested material. It is apparently being considered in Indiana in the situation of a single apparently localized detection of *G. morbida* (in 2013) in a region where *J. nigra* is a high value crop. Because there is a period of several years between initial infestation of a tree by *P. juglandis* and *G. morbida* and appearance of symptoms, it is likely that some spread will have occurred before the pest is detected. Similarly in the EPPO region, eradication may be possible in very limited circumstances, provided that:

- *P. juglandis* and *G. morbida* are introduced in a very isolated population of walnuts, clearly separated by sufficient distance or geographical barriers (large body of water, mountains, desert) from the next walnuts. Eradication would require elimination of all walnut trees (showing symptoms or not) in the area. This seems drastic. Because the pest affects nut production or wood production slowly, the choice may be made to benefit from the trees even if infested, possibly applying containment measures, instead of destroying them immediately.
- *G. morbida* only was detected, and intensive surveillance did not show the presence of *P. juglandis*. Disposal of trees would probably remove *G. morbida* from the area. However, this situation is unlikely, i.e. *P. juglandis* is likely to occur if *G. morbida* is present at such a level needed to detect damage on a tree, except if *P. juglandis* had suddenly disappeared after some population build-up, due for example to sudden extreme climatic conditions (which should be very extreme according to observations in the USA).

In any case, eradication seems difficult for Italy, where walnut is widely grown in a wide diversity of environments, and where both *P. juglandis* and *G. morbida* were detected.

16.3 Containment

Containment seems more realistic than eradication in most cases, but requires stringent measures. It would probably be difficult in areas with a high density of walnut trees in different environments, and especially in forest areas. The EWG had no time to make specific proposals for containment for the whole EPPO region, but described here the containment options used in the Veneto region (Italy) and in the USA. It is worth noting that the treatment schedule and size of buffer zone recommended in the options for pest risk management (section 16.1) are different from the ones below.

The Regional decrees of Veneto (Regione del Veneto, 2014a,b; 2015) make the following provisions:

- determination of a delimited area, comprising the infested area (corresponding to the area delimited by the sites of findings) and a buffer zone (2 km beyond the infested area)
- delimited area subject to the following compulsory phytosanitary measures:
- interdiction of movement outside of the delimited area of plants for planting of *Juglans* and *Pterocarya* with a diameter above 10 mm, and wood and wood products (including felling and pruning residues and bark) (except 1- wood squared to remove entirely the bark, the phloem layer and the first xylem rings, and 2- wood heat treated to reach 60 °C for at least 45 minutes at the level of the first xylem rings).
- control by the plant protection service of nurseries producing plants for planting of *Juglans* and *Pterocarya* in the delimited area, and obligation to maintain a registry of plant movements.

General measures that have been used in the USA and may be considered for containment programmes are:

- determination of an infested areas should be done through surveys (trapping and/or visual examination) followed by laboratory confirmation.
- deciding on potentially contaminated material to be subject to quarantine measures to prevent its movement out of the area. The establishment of effective regulations to prevent further spread of infested material can have tremendous effect in reducing risk of thousand cankers spread in the upcoming decades (Cranshaw and Tisserat, 2012);
- proper handling and transport of cut wood to avoid escape of *P. juglandis* adults to areas that are still healthy;
- ensuring proper communication with the public and awareness (for detection and notification of possibly infested trees). Involvement of the public and detection of symptoms by individuals on their trees is also very important (Haun et al., 2010; Hansen et al., 2011)
- planting of walnut is not recommended where *P. juglandis* and *G. morbida* already occur (Cranshaw and Tisserat, 2012).
- sanitation practices that can reduce populations of beetles can be assumed to reduce severity or slow the progress of the disease, and are useful for containment. In particular, walnut wood may support development of *P. juglandis* until thoroughly dried, and infested wood must be destroyed or isolated. The efficacy of sanitation depends on the situation and sanitation needs to be done over a wide area. Infected wood must be disposed of in a way that will reduce further emergence and dispersal of beetles. It is recognized that sanitation has rarely been used in the USA (see 12.5, difficulties in implementing it as an effective means of management, in a practical way and at a reasonable cost, multiple ownerships), and is further complicated by the long time between tree infestation and symptom expression from thousand cankers, and difficulties in detecting *P. juglandis* and *G. morbida* when populations are low. Nevertheless, the EWG considered that some measures may be useful as part of containment plants to dispose of infested trees and wood or to reduce populations on disposed wood within an infested area, for example isolation/storage, debarking, chipping and appropriate disposal of the wood, insecticide treatments (some details in Annex 9).

17. Uncertainty

The main uncertainties are as follows:

- The current distribution of *P. juglandis* and *G. morbida*.
- Hosts, and whether other *Juglans* not yet identified as hosts may be attacked.
- In pest risk management: whether walnut bark is used, wood chips production processes and their influence on infestation by *P. juglandis* (size, etc.).
- Susceptibility of the different *Juglans* species and cultivars.
- Why the disease progress seems to have slowed in some trees.
- Possible other vector of *G. morbida*, and role of other modes of transmission for *G. morbida* (including wind).
- Whether the introduction of *G. morbida* alone presents a risk.
- Progression and severity of the disease in a timber plantation or natural forest.
- The precise distribution of hosts in the EPPO region, especially *J. nigra*.

18. Remarks

In conducting EPPO PRAs for tree pests, there is not always such a clear case where a trade exists (even if in moderate quantities) for several commodities that may carry the pests (from the USA), to a large number of EPPO countries and in different parts of the region, and where the pests still have the potential to spread at origin (i.e. in the USA and in Italy).

Finally, there are gaps in the knowledge about these pests, and research on their biology and management is critical to developing better management measures. However the pests can establish throughout the EPPO region where *Juglans* are present and they have the potential to cause damage.

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ANNEX 1. Other species of insects whose association to *G. morbida* is being studied in the USA, and list of *Pityophthorus* spp. in Europe

A number of insects are mentioned in the US literature as potential vectors:

- *Stenomimus pallidus* (Coleoptera: Curculionidae). The only instance to date where any other species had documented association with the fungus is an observation that the fungus was recoverable from the body of *S. pallidus*; this finding occurred while trapping insects on two girdled *J. nigra* in Indiana (USA). *P. juglandis* has not been found at this site (Indiana Department of Natural Resources, 2014; thousandcankers.com, 2014 [press release]; Warmund and van Sambeek, 2014). *S. pallidus* is a bark weevil associated with dying branches, attacking wounded *Carya* and *J. nigra*, and dead *Quercus*, and present in Eastern and Central USA This association was found only at one of the sites surveyed in Indiana (on 3 of 19 *S. pallidus* tested) (Indiana Department of Natural Resources, 2014). Ginzel and Juzwik (2014) note that the low frequency of occurrence of *G. morbida* on *S. pallidus* suggests at least a very casual relationship between the fungus and this beetle. Moreover, the low population density of *S. pallidus* suggests that it may not be capable of vectoring enough of the pathogen to adversely affect tree health.
- *Pityophthorus lautus*. Haun et al. (2010, citing others) mention that *P. lautus* is considered to have the potential to carry *Geosmithia* conidia. Most *Pityophthorus* species in North America are associated with conifers, and only a few to deciduous trees. Of the latter, *P. lautus* is present in eastern North America, is polyphagous and has *J. nigra* in its host range (Cranshaw and Tisserat, 2012a). *P. lautus* and *P. juglandis* are the only species in the *Pityophthorus* genus found to infest the *Juglans* genus (Nix, 2013, citing others). In Europe, 18 species of *Pityophthorus* have been recorded, all on conifer trees (except *P. juglandis* which found recently in the north of Italy) (see Table below, Unité d'entomologie de l'ANSES, France, 2014-08).
- In surveys of walnut, the following species were found that have potential to serve as "vectors" for *G. morbida* according to Newton and Fowley (2009, citing others):
  - *Xylosandrus germanus* (Coleoptera: Scolytidae) is widely distributed, polyphagous (with *J. regia* and *J. nigra* among its hosts; 19 tree genera in EPPO PQR), native from Asia and introduced in the USA and Europe. Two *Geosmithia* spp. have been isolated from the related species *X. mutilatus* in Mississippi. *X. germanus* was shown to be associated symbiotically with the fungus *Ambrosiella hartigii* and was also shown as a vector of several *Fusarium* species (Weber and McPherson, 1983; Yang et al., 2008; Kessler, 1974; Weber and McPherson, 1985; Frigimelica et al, 1999).
  - *Xyleborinus saxeseni* (Coleoptera: Scolytidae) is widely distributed in North America, and also present on other continents, incl. Europe. Polyphagous, it often attacks weakened trees. *X. saxeseni* is often associated with *P. juglandis* in thousand cankers-affected trees in Colorado and is likely to be exposed to *G. morbida* conidia. It is generally the most common and widely distributed species in traps across the USA, and is a vector of some *Geosmithia* in Europe (Hasey and Seybold, 2010). In laboratory studies on the attraction to volatiles produced by *G. morbida*, *X. saxeseni* avoided containers with *G. morbida* (Luna et al., 2014).
  - *Xyleborus ferrugineus* (Coleoptera: Scolytidae) is present on several continents (not Europe), polyphagous. It most commonly attacks stumps and logs on the ground, and has a symbiotic relationship with *F. solani*.
  - *Hypothenemus eruditus* (Coleoptera: Scolytidae) is present in North America on *J. nigra* and *J. regia*, and is capable of carrying *Fusarium* spp. It also occurs in tropical and subtropical regions throughout the world, to Europe and Japan (Bright and Stark, 1973).
  - *Scobicia declivis* (Coleoptera: Bostrichidae) and *Xylotrechus nauticus* (Coleoptera: Cerambycidae) were found emerging from walnut branches.
- Finally, *Hylocurus hirtellus* (Coleoptera: Scolytidae) was found associated with *J. hindsiii* in California (Dallara et al., 2012). Preliminary data on transmission in the laboratory indicated that woodborers may not be suitable to transmit *G. morbida* (experiments conducted with *X. saxeseni*), and Dallara et al. (2012) make the hypothesis that it may be the same with *H. hirtellus*.

Of the insects above, no record was found for *S. pallidus* in the EPPO region, and it is presumed absent. *X. saxesenii*, *H. eruditus* and *X. germanus* are present in the EPPO region.

Table. ***Pityophthorus*** **spp. in Europe (provided by Unité d'entomologie, ANSES, France).**

Species	Hosts	Reference
P. balcanicus	*Pinus nigra*, *P. leucodermis*	Grüne. 1979
P. buyssoni	*Pinus nigra*, *P. sylvestris*, *Larix decidua*	Grüne, 1979
P. carniolicus	*Pinus nigra* var. *austriaca*, *P. sylvestris*	Grüne, 1979
P. cephalonicae	*Abies cephanonica*, *A. alba*	Grüne, 1979
P. exsculptus	*Picea abies*, *Pinus sylvestris*	Grüne, 1979
P. glabratus	*Pinus* spp., *Larix decidua*	Grüne, 1979
P. henscheli	*Pinus cembra*, *P. montana*, *P. nigra*	Grüne, 1979
P. juglandis	*Juglans* spp.	Montecchio et al., 2014
P. knoteki	*Pinus cembra*, *P. montana* var. *mughus*	Grüne, 1979
P. lapponicus	*Picea obovata*, *Pinus cembra* var. *sibirica*, *P. kovaiensis*	Fauna Europaea; Wood & Bright, 1992
P. lichtensteinii	*Pinus sylvestris*, *Pinus* spp., *Abies alba*, *Picea obovata*	Grüne, 1979
P. micrographus	*Picea abies*, *P. obovata*, *Pinus sylvestris*, *P. cembra*, *Abies sibirica*, *Larix sibirica*	Grüne, 1979
P. morosovi	*Picea abies*, *P. obovata*, *P. engelmanni*, *P. pungens*	Grüne, 1979
P. pinsapo	*Abies pinsapo*	Fauna Europaea; Wood & Bright, 1992
P. pityographus	*Picea* spp., *Pinus* spp., *Abies alba*, *A. nordmanniana*, *Larix decidua*, *Pseudotsuga gouglasii*, *Tsuga canadensis*	Grüne, 1979
P. pubescens	*Picea* spp., *Pinus* spp.	Grüne, 1979
P. solus	*Pinus* spp.	Goldarazena et al., 2014
P. traeghardhi	*Picea abies*	Grüne, 1979

ANNEX 2. Phytosanitary import requirements of EPPO countries in relation to *Juglans* and *Pterocarya*

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), Switzerland (2010), Turkey (2007).

* indicate pests that occur in the USA and Mexico according to PQR (EPPO, 2014), i.e. if there are requirements from where the pest occurs, they will apply to these countries.

\# indicate pests that occur in the USA according to PQR (EPPO, 2014), i.e. if there are requirements from where the pest occurs, they will apply to the USA.

✓ indicates when the requirement would imply a measure for the commodity from USA or Mexico.

× indicates when the requirement would not specifically apply to that commodity from USA or Mexico (i.e. would not have any effect).

? indicates an uncertainty (whether the pest occurs in USA or Mexico, or whether the requirements would apply to the commodity from USA or Mexico).

Warning: the tables below 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. Regulations of some countries might have changed in the meantime, but it still gives some indication of the measures in place.

Table 1. Wood of host species from countries where *P. juglandis* or *G. morbida* occur

Country		General and specific requirements
Albania		✓ All non-squared or squared wood: import permit, PC
Algeria		✓ All non-squared or squared wood: PC
Belarus		✓ All non-squared or squared wood: import permit, PC
EU, Switzerland, Serbia		✓ Fraxinus, Juglans mandshurica, Ulmus davidiana, Ulmus parvifolia and Pterocarya rhoifolia from Canada, China, Japan, Mongolia, Rep. of Korea, Russia, Taiwan & USA: PFA for Agrilus planipennis or squared.
Israel		✓ Logs with bark: IP. If originate from Europe or South Africa, PC, vapour treatment and inspection ✓ Debarked logs: PC, vapour treatment (phosphine or methyle bromide) in accordance with treatment manual
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		× No requirements applying to *Juglans* wood (only for coniferous and some other deciduous species)
Russia		× No requirements for wood (only Pinus and packing wood from Asia)
Tunisia		✓ All squared or non-squared wood: PC.
Turkey		✓ 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 wood waste of deciduous species from countries where *P. juglandis* or *G. morbida* occur

Country	Prohibitions or requirements implying prohibition from USA 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, Switzerland, Serbia		✓ Chips in whole or part from Fraxinus, Juglans mandshurica, Ulmus davidiana, Ulmus parvifolia, Pterocarya rhoifolia from Canada, China, Japan, Mongolia, Republic of Korea, Russia, Taiwan and USA: PFA for Agrilus planipennis or processed into pieces of not more than 2,5 cm thickness and width. ?- wood chips in whole or in part from Acer saccharum from USA and Canada, Platanus from the USA or Armenia, Populus from the American continent: produced from debarked round or kiln-drying to below 20 % moisture content or appropriate fumigation, or appropriate heat treatment (minimum core temperature of 56 °C for at least 30 minutes) ?- wood chips in whole or in part from Quercus from USA: kiln-drying to below 20 % moisture content, or appropriate fumigation, or appropriate heat treatment (minimum core temperature of 56 °C for at least 30 minutes) ✓- Fuel wood and non-coniferous wood chips from outside the EU (Fraxinus, Juglans mandshurica, Ulmus davidiana, Ulmus parvifolia, Pterocarya rhoifolia, from Canada, China, Japan, Mongolia, Republic of Korea, Russia, Taiwan and USA): specific requirements for inspection (Annex, B)
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?
Moldova		? No requirements for wood chips?
Morocco		? No requirements for wood chips?
Norway	? Wood waste of Castanea and Quercus from North American countries, Populus from countries of the American continent	? 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, or fumigated
Russia		? No requirements for wood chips?
Tunisia		? No requirements for wood chips?
Turkey		✓ wood chips of angiosperms: 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 *P. juglandis* or *G. morbida* occur

Country	Prohibitions or requirements implying prohibition from USA or Mexico	Other general and specific requirements
Albania	✓ All isolated bark: prohibited	
Algeria		✓ All isolated bark: PC
Belarus		? No requirement for isolated bark.
EU, Switzerland, Serbia	? Isolated bark of Castanea from third countries, Quercus and Acer saccharum from North American countries, Populus from countries of the American continent	? Isolated bark of Fraxinus, Juglans mandshurica, Ulmus davidiana, Ulmus parvifolia, Pterocarya rhoifolia from Canada, China, Japan, Mongolia, Rep. of Korea, Russia, Taiwan and USA: PFA or processed into pieces of not more than 2,5 cm thickness and width.
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

Country	Prohibitions or requirements implying prohibition from USA or Mexico	Other general and specific requirements
Norway	? Isolated bark of Quercus (other than Quercus sube) from North American countries ? Isolated bark of Acer saccharum from North American countries ? Isolated bark of Populus from countries of the American continent	
Russia		× No requirement for isolated bark (except for that of Pinus)
Tunisia	✓ Isolated bark of forest trees: prohibited [if Juglans considered forest tree]	
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 *P. juglandis* or *G. morbida* occur

Country	Prohibitions or requirements implying prohibition from USA 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 ✓ *Juglans*: IP
Belarus	✓ Plants from countries where *Bemisia tabaci** occurs: prohibited ✓ Plants with roots originating in countries where *Popillia japonica*# occurs: prohibited ✓ Plants originating in countries where Phymatotrichopsis omnivora* occurs: Prohibited ✓ Deciduous woody plants originating in countries where Dialeurodes citri*, Icerya purchasi*, Lopholeucaspis japonica#, Pantomorus godmani? or Pseudococcus calceolariae? occur: prohibited ✓ Plants originating in countries where *Spodoptera littoralis* or *Spodoptera litura*# occur: prohibited	✓ 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, Switzerland, Serbia		General requirements: ✓ Plants for planting from third countries: must be subject to a plant health inspection in the country of origin (Annex V.B.I.1) ✓ Plants from third countries (IV.A.I.36.1): grown in nurseries and requirements for Thrips palmi* (PFA, PFPP, treatment). ✓ Trees and from third countries other than European and Mediterranean countries (Annex IV.A.I.39): clean and free from flowers and fruits, grown in nurseries, inspected and found free from symptoms of pests or treated. ✓ Deciduous trees and shrubs from third countries other than European and Mediterranean (Annex IV.A.I.40): dormant and free from leaves. ✓ Plants with roots, planted or intended for planting, grown in the open air (IV.A.I.33) place of production free from *Clavibacter michiganensis* ssp. *sepedonicus#*, *Globodera pallida#*, *Globodera rostochiensis**, *Synchytrium endobioticum*. ✓ Soil and growing medium, attached to or associated with plants ((IV.A.I.34) originating in a number of countries (incl. Mexico, USA): specific requirements regarding the growing medium. ✓ Naturally or artificially dwarfed plants from non-European countries: detailed requirements, including grown in nurseries, found free, inspections, requirements regarding growing medium (IV.A.I.43). ✓ *Fraxinus, Juglans mandshurica*, *Ulmus davidiana*, *Ulmus parvifolia, Pterocarya rhoifolia* from CA, CN, JP, Mongolia, Rep. of Korea, Russia, Taiwan and US: requirements for *Agrilus planipennis* (PFA or PFPP)
Israel		✓All plants: IP

Country	Prohibitions or requirements implying prohibition from USA or Mexico	Other general and specific requirements
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 chitwoodi**
Morocco		✓ All plants: PC; ✓ Plants with soil: pest free ? Fruit trees: free from A*grobacterium tumefaciens**
Moldova		✓ All plants: PC, IP, disinfection; ✓ Plants with roots: free from soil.
Norway		✓ Juglans: from countries where Q. perniciosus* occurs: PFA and place of production that has been under official monitoring since the beginning of the last two cycles of vegetation, and where no signs of Quadraspidiotus perniciosus (Comstock) have been observed
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	✓ All plants: import permit, PC, ✓ Plants with roots: free from soil
Tunisia	✓ Forest trees: prohibited (if Juglans considered forest tree)	✓ All plants: PC, free from *F. occidentalis** × Plants from countries where *F. oxysporum* f.sp. *albedinis* occurs: prohibited; ✓ *Juglans*: 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. ✓ Juglans: 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
Ukraine		✓ All plants: import permit, PC; free from quarantine pests or disinfested at the point of entry.

ANNEX 3 – TRADE OF WALNUT WOOD INTO THE EPPO REGION FROM COUNTRIES WHERE *P. JUGLANDIS* OR *G. MORBIDA* OCCUR

Table 1. Walnut roundwood. Export from the USA to EPPO countries of " Walnut (juglans Spp.) Wood In The Rough, Whether Or Not Stripped Of Bark Or Sapwood, Or Roughly Squared, Not Treated (4403990070) (Unit: m3) (source USDA-FAS, 2014) (EPPO countries with no data are not listed)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014 (Jan-Mar)	Total
Azerbaijan											3							3
Austria	12						156	128	576	191	368	192	386	755	67			2831
Belgium	1041	248	255	220	222	873	248	297	684	1219	448	913	655	1125	1637	1191	634	11910
Belarus											33	29	162	98	132	33		487
Cyprus										63	54	11	45					173
Denmark				374	29	107	183	397	1357	1589	998	191	324	157	223	668	155	6752
Ireland		31		34	30	97	303	62	333	117	140	45	11	76	16	149	33	1477
Estonia									32		92			20				144
Czech Rep.										144	198	62	545	1127	65	285	48	2474
Finland	191					241	95	292	131	410	256	14	122	541	37			2330
France	55	71	69	56	60	580	4568	560	473	647	394	624	970	730	829	78		10764
Germany	1386	1643	3431	2063	1757	4286	3334	6666	10850	13862	11558	8761	11598	14972	9106	4953	1950	112176
Greece					29	64	27	61	28	90	73					17		389
Croatia				37					9	72		122	29					269
Israel							29	28		141	137	148	356	121		101		1061
Italy	13075	17193	16730	16656	15020	18549	18137	21416	23913	30619	20810	8763	13234	22063	12181	7056	1816	277231
Jordan							113			125	103	315	208	238	281	188	30	1601
Latvia										18								18
Lithuania					30	23	450		67	26	31	55	216	29	84	88	127	1226
Morocco											35					26		61
Malta		21							10	36	34	51	81	72	33	93		431
Netherlands	85	67	142	375	251	338	2505	543	1069	2019	1279	397	464	381	408	175	27	10525
Norway				74		30	19	59	85	86		8	28	19	8	7		423
Poland								17			48	165	334	72	46	104	31	817
Portugal	62	12	219	38	128	661	397	283	228	1161	472	1253	1505	1869	627	1242	817	10974
Serbia													67			30		97
Romania							27	37		33	33		81					211
Russia										179	93	57	58		4	22		413
Slovenia				19						219	40	231	1128	877	1532	1668	250	5964
Spain	2768	3837	5981	4152	2430	2631	2134	687	745	641	1110	2071	6957	5167	4713	1488	304	47816
Sweden			148	104		80	681	150	693	608	534	354	382	327	152			4213
Switzerland	2317	1733	3482	394	526	463	491	320	594	734	127	103						11284
Turkey				38	56	10	1654	1118	533	260	345	310	829	2080	2309	2189	809	12.540
UK	2230	625	828	731	655	1043	1306	1740	2346	3798	2666	1512	3137	2047	1733	1328	689	28414
Ukraine																19		19
Total	**23222**	**25481**	**31285**	**25365**	**21223**	**30076**	**36857**	**34861**	**44756**	**59107**	**42512**	**26757**	**43912**	**54963**	**36223**	**23198**	**7720**	**567518**

ANNEX 3 - Table 2. Import to the EU of firewood (100 kg) (fuel wood, in logs, billets, twigs, faggots or similar forms - 44011000) (source Eurostat, 2014) (EPPO countries with no data are not listed)

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		Total	
	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA
Austria																								4					0	2	1		1	6
Belgium					8	7																1											8	8
Bulgaria																																0	0	0
Croatia														245						242													0	487
Cyprus																				123												0	0	123
Czech Rep																						28											0	28
Denmark				285		116		356		45				66		3				1		68								73		8	0	1021
Estonia																																660	0	660
Finland																														2		0	0	2
France										122										213										0		2	0	337
Germany				567		744		492		61		13		250		20				94				1		28		50		277		25	0	2622
Greece																																	0	0
Hungary																												17				186	0	203
Ireland						34		23		248		63		30		21		6		1500		850		34		3		1		0		0	0	2813
Italy				230				45												4238		408											0	4921
Latvia																																	0	0
Lithuania																																	0	0
Luxembourg																																	0	0
Malta						7		80						456										0									0	543
Netherlands								0																						5			0	5
Poland																																0	0	0
Portugal				1169				94						540				822		812		440		1576				1519		75			0	7047
Romania																																0	0	0
Slovakia																																	0	0
Slovenia																	**0**																0	0
Spain								355														130						0					0	485
Sweden		1		99	370	19		16		14		18		220		295		37		35		7		0		11		6		0		31	370	809
UK		86		5		2038		3290		936		4469		3335	1	6296		6808		9045		8737		5327		6334		222		268		716	1	57912
Total EU	**0**	**87**	**0**	**2355**	**378**	**2965**	**0**	**4751**	**0**	**1426**	**0**	**4563**	**0**	**5142**	**1**	**6635**		**7673**	**0**	**16303**	**0**	**10669**	**0**	**6942**	**0**	**6376**	**0**	**1815**	**0**	**702**	**1**	**1628**	380	80032

ANNEX 3- Table 3. Exports from Italy to other EPPO countries (fuel wood, in logs, billets, twigs, faggots or similar forms - 44011000) (100 kg) (source Eurostat, 2014) (EPPO countries with no data are not listed)

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total**
Albania										245							245
Austria	9761	28	638			1	0	124	35		0	20	3401	1058	16193	71708	102967
Belgium							29		7	3							39
Bosnia and Herzegovina										160		387					547
Bulgaria													11	1	2	8	22
Croatia						207						340				33	580
Cyprus										22	24	12					58
Czech Republic			48														48
Finland															468	234	702
France	1929	97	300	1	168			1610	15733	13	171	1451	1836	113	511	2521	26454
Germany	7	0		11		8	0	0		238	242	20	3	0	57	69	655
Greece	669								15				0		18		702
Hungary							0		2	486	4	43	1	570	237	2813	4156
Israel								33		20							53
Latvia											0						0
Luxembourg								31									31
Malta	378	927	327	708	562	468					1	25	8	190	238	482	4314
Poland			24	12	23		3	8	2	5	4	4	2			27	114
Portugal			0										0				0
Romania	2					874	185	48		16	123	202	122	279	15	20	1886
Russia															19	39	58
Slovakia												36					36
Slovenia								0	2	779	67	50	140	260	372	152	1822
Spain	13					2	9		20	55					34	0	133
Switzerland		290	278	1848	208	94	112	1286	437	1683	335	571	1077	1914	1820	2034	13987
Ukraine								1									1
UK											9	3		1	2		15
Total	**12759**	**1342**	**1615**	**2580**	**961**	**1654**	**338**	**3141**	**16253**	**3725**	**980**	**3164**	**6601**	**4386**	**19986**	**80140**	159625

ANNEX 3 - Table 4. Export from the USA to EPPO countries of "poles, piles and posts, treated with paint, stain, cresote or other preservatives" (in number) (4403100030) (source USDA-FAS, 2014) (EPPO countries with no data are not listed)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Belgium		267	82				189				2627	223				1	3389
Cyprus						336											336
Czech Rep.	562		20														582
Denmark		989	223	1484				726		66		31				22	3541
Estonia					95												95
Finland			609	2700													3309
France	7	534	525	176	181	1608	67	5976	30	1		64		10	11		9190
Germany	2	2140	506	136	254	882				118	76	661	638	13		69	5495
Greece			154														154
Hungary				455		177											632
Ireland			215	11932	77	280	3434	4212		5307	30	1206	270				26963
Israel		73	638	360	4			12	250		51	564	76	63	18		2109
Italy	151	6810	454		1	2984	736	1	640	141							11918
Kazakhstan	52		4														56
Malta							102										102
Netherlands	1177	156	511	11963		86						55	62	68	80		14158
Norway			357				65			46	189		85	44		75	861
Poland									228						1		229
Romania									5								5
Russia	13													120			133
Slovakia																12	12
Spain		2681	538	855				692		16	11		150		19	201	5163
Sweden	500	478	828	185		73								3		63	2130
Switzerland				74		1393		5									1472
Turkey											173	25			440		638
UK	4248	506	314	482	796	6277	1680		133	394	55	941		38	80	151	16095
Ukraine				290													290
Uzbekistan										67							67
Total EPPO	**6712**	**14634**	**5978**	**31092**	**1408**	**14096**	**6273**	**11624**	**1286**	**6156**	**3212**	**3770**	**1281**	**359**	**649**	**594**	109124

ANNEX 3 - Tables 5a and 5b. Sawn wood of walnut (EPPO countries with no data are not listed)

Table 5a. Export from the USA to EPPO countries of walnut sawn wood (unit: m³) (source USDA-FAS, 2014)

- until 2006 walnut wood, sawn lengthwise, over 6 mm: rough (4407990075) not elsewhere specified or included (4407990076)

4407990075

	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Austria			42	102		28	96	10	270	548
Belgium	151	393	303	450	694	819	392	909	1300	5411
Cyprus			9	6	4	14	35	32	70	170
Denmark	24	151	359	356	657	1093	1003	1516	2202	7361
Ireland	45	11	22	77	261	443	672	1199	1440	4170
Estonia				3	3	4	17	10	12	49
Czech Rep.		82	83		116	409	50	146	38	924
Finland	91	157	367	324	414	229	350	343	270	2545
France	5			28		58		4	45	140
Germany	82	214	206	540	765	1485	3444	3990	3293	14019
Greece	56	82	94	38	136	52	40	258	202	958
Israel	76	103	266	101	116	45	43	116	79	945
Italy	3878	5000	5111	6253	5072	4207	3539	1736	1685	36481
Jordan			35	6	4	6	71	79	119	320
Kazakhstan									8	8
Lithuania					75	23	168	258	199	723
Morocco					40					40
Malta	66	11	36	51	78	78	82	64	74	540
Netherlands	23	269	649	671	475	706	1577	1463	1849	7682
Norway		10	487	540	70	20	28	68	97	1320
Poland							37	89		126
Portugal	13	138	144	14	52	144	176	107	190	978
Romania		58						331	108	497
Russia						62	44	27		133
Spain	729	948	911	1514	1684	925	544	670	630	8555
Sweden	102	248	213	678	1128	932	1407	1686	1923	8317
Switzerland	8		31	60	37		113	251	27	527
Turkey					264				30	294
UK	475	830	999	1370	2008	2466	2262	3327	3729	17466
Ukraine				295					31	326
Total	**5824**	**8705**	**10367**	**13477**	**14153**	**14248**	**16190**	**18689**	**19920**	121573

4407990076

	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Azerbaijan								60		60
Austria									388	388
Belgium			35						45	80
Denmark	11				110	305	138		44	608
Ireland	26		35			7		26	29	123
Finland			35	13	33	44				125
France					14					14
Germany	7		86	150	149	178	187	55	756	1568
Greece							30			30
Italy	147	126	121	415	511	641	1020	750	2567	6298
Lithuania					28	235	28		244	535
Malta							27		10	37
Netherlands				20	4		88		76	188
Norway				64					66	130
Poland									27	27
Portugal	26			41		20	1	187	670	945
Russia								50		50
Spain	47	53	2	19	82	136	81		67	487
Sweden							27	58	876	961
Turkey						8	266			274
United Kingdom	50		4	53	132	191	278	557	369	1634
Total	**314**	**179**	**318**	**775**	**1063**	**1765**	**2171**	**1743**	**6234**	14562

ANNEX 3 - Table 5b. Export from the USA to EPPO countries of walnut sawn wood (unit: m^3) (source USDA-FAS, 2014)

- from 2007 walnut (Juglans spp.) wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or finger-jointed, thickness over 6 mm (4407990161)

	2007	2008	2009	2010	2011	2012	2013	Total
Austria	719	121	18	30	329	28		1245
Belgium	1635	776	346	382	854	820	899	5712
Belarus				33	33	56	175	297
Bulgaria		16	125			18	34	193
Cyprus	48	57	7		28	59		199
Denmark	1071	570	132	548	740	615	686	4362
Ireland	1438	1377	847	436	529	512	347	5486
Estonia	6	13	40	188	201	187	215	850
Czech Rep.	169	92	85	95	57	40	68	606
Finland	330	405	272	169	603	148	109	2036
France	160	97	204	214	110	27	17	829
Germany	4725	2763	3847	6991	9863	8432	6324	42945
Greece	166	371	77	91	113	100	11	929
Croatia	137	117	178	59	309		32	832
Israel	80	98	52	119	329	371	325	1374
Italy	4440	1233	1567	2113	2701	2525	2345	16924
Jordan	121	113	51	106	349	588	739	2067
Latvia		56					134	190
Lithuania	82	136	105	124	730	534	588	2299
Luxembourg							21	21

	2007	2008	2009	2010	2011	2012	2013	Total
Slovakia					3		15	18
Morocco			5	15	50	29	60	159
Malta	45	145	92	100	63	162	139	746
Netherlands	1624	1518	881	1237	2114	1797	1516	10687
Norway	156	204	59	23	153	67	16	678
Poland	185	462	295	449	473	555	624	3043
Portugal	859	297	129	521	245	570	865	3486
Serbia				29			54	83
Romania	28		30				538	596
Russia			84	196	30	167	265	742
Slovenia		147		30	112	41		330
Spain	622	765	797	302	434	564	940	4424
Sweden	2274	1057	613	565	1026	1027	617	7179
Switzerland	3	29					24	56
Turkey	115	146	327	659	879	1359	1312	4797
UK	3703	2459	2650	3095	3267	3565	3852	22591
Ukraine	37			43				80
Total	**24978**	**15640**	**13915**	**18962**	**26727**	**24963**	**23906**	**149091**

ANNEX 3 - Table 6. Monthly exports of walnut logs (4403990070) from the USA in 2013 (unit: m³) (source: USDA-FAS, 2014) (EPPO countries with no data are not listed)

2013	January	February	March	April	May	June	July	August	September	October	November	December	Total
Belgium	50	280	216	248	230		24		79		64		1191
Belarus				33									33
Denmark	58	96	55	72		127	52	51			106	51	668
Ireland	9				32			42			66		149
Czech Rep.			80	40			36				129		285
France	12							30	20			16	78
Germany	797	707	969	502	647	313	36	88	207	177	279	231	4953
Greece			17										17
Israel		28		30		31					12		101
Italy	780	950	1517	816	794	907	36	176	145	358	255	322	7056
Jordan		31	66			30		31				30	188
Lithuania				19				18			51		88
Morocco												26	26
Malta			32	29				32					93
Netherlands	18	88		28	19			22					175
Norway				4	3								7
Poland			79				25						104
Portugal	178	198	196	20	278	23	12		79	41	138	79	1242
Serbia				30									30
Russia				4					18				22
Slovenia	222			30			180	160		110	300	666	1668
Spain	505	460	449			6		3	30			35	1488
Turkey	167	161	322	188	559	137	77	23	99	122	190	144	2189
UK	157		234	139	163	228	61	129	66	117		34	1328
Ukraine			19										19
Total	**2953**	**2999**	**4251**	**2232**	**2725**	**1802**	**539**	**805**	**743**	**925**	**1590**	**1634**	**23198**

ANNEX 4 – TRADE OF WOOD CHIPS AND WOOD WASTE FROM COUNTRIES WHERE *P. JUGLANDIS* OR *G. MORBIDA* OCCUR

Countries with no imports are omitted from the tables

Table 1. Deciduous wood chips - export from the USA to EPPO countries of "hardwood chips" (4401220000) (unit: metric tonnes) (source USDA-FAS, 2014)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Belarus										78							78
Belgium	1				58			14	9		664		609				1355
Bulgaria		1719	2	6	17			14	636		813	813	111	813	2596	2461	10001
Czech Rep.											65						65
Denmark					50862					496	2088				183	4676	58305
Finland	801	2095	2237			465	524	541			44					637	7344
France	1385	1250	1559	769	77	19	8	103	7100	12578	15341	10075	6738	11119	11849	23207	103177
Germany		7		42	428	1040	90	340	3666	5360	3309	3470	7930	9641	14470	12279	62072
Greece	729	464	30	865	3	11		4									2106
Ireland		3	66	3													72
Israel	1	6	10	3	22		6	465	491	2228	1319	2181	1674	2518	2827	1981	15732
Italy	358	255	19916	28059	21840	30048	39892	4292	6103	8594	8318	13364	11741	12403	2772	1906	209861
Kazakhstan				151													151
Moldova											473				50		523
Morocco				2	5	258	5	1									271
Netherlands						10	5	1	164	893	5642	2745	2025	63	130	2192	13870
Portugal					33	6	3	23	654	2763	4005	1373	513	2800			12173
Slovenia						126	2682										2808
Spain	1764	3727	970	1062	20	19	139	907	2808	7413	4016	4065	5423	4212	4941	5111	46597
Sweden										421	965			70	875	3240	5571
Switzerland	15								270			476		194		532	1487
Turkey		10								226		45			12184	122441	134906
UK	6	95	253	31	24		15	40	360	228	128	223	130	334	7209	2758	11834
Total	**5060**	**9631**	**25043**	**30993**	**73389**	**32002**	**43369**	**6745**	**22261**	**41278**	**47190**	**38830**	**36894**	**44167**	**60086**	**183421**	**700359**

ANNEX 4 - Table2. Import to the EU of deciduous wood chips (44012200) from the USA and Mexico (source Eurostat, 2014)

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		Total	
	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA	MX	USA
Austria		0						0				3		23		64		4						0		0		4		0		186	0	284
Belgium				1						18										0				4				182		175			0	380
Bulgaria																		41										100				302	0	443
Croatia																		1		2						0		0		2		0	0	5
Cyprus																						1						1					0	2
Czech R.												1		9																0		0	0	10
Denmark										746379						0					0			75		59		33		645		1599	0	748790
Estonia																				1													0	1
Finland								0						0		0		0						10		6						113	0	129
France		2										200						0		193		253		119		256		822		2361		3012	0	7218
Germany	465		873		896	15	245	0	697	36	432	92	407	16	431			182	509	678		472	888	567	1067	1223	252	1580		1565		2576	7162	9002
Greece						37										70										0		12					0	119
Hungary				3508		327		271		288		26		28				231		209		91		12		19		5		3		7	0	5025
Ireland		294		34		106		201		4		159				48		10		63		215		85		18						6	0	1243
Italy		23		180		226		311		274		275		399092				140		431		225		201		768		835		194		143	0	403318
Malta						27		65				0		1		2																	0	95
Netherl.		26		4	3	34		28		34		56		75		46		122		106		99		191		386		661		424		176	3	2468
Poland																				0		9						0		2		7	0	18
Portugal		6		8		14				10				0		197		108		556		471		250		56		330				0	0	2006
Romania						8						9		13		7																	0	37
Slovakia																														0			0	0
Slovenia																																	0	0
Spain				111		771		305		276		27		17		237		597		912		947		766		378		885		1062		1230	0	8521
Sweden		98		17		22		70		4		10				30		15		0				0		17		16		251		465	0	1015
UK		752		186		0				138		468		432		1015		1889		681		430		563		573		741		757		1687	0	10312
Total EU	**465**	**1201**	**873**	**4049**	**899**	**1587**	**245**	**1251**	**697**	**747461**	**432**	**1326**	**407**	**399706**	**431**	**1716**	**0**	**3340**	**509**	**3832**	**0**	**3213**	**888**	**2843**	**1067**	**3759**	**252**	**6207**	**0**	**7441**	**0**	**11509**	7165	1200441

Remark: the figures for Denmark in 2002 and Italy in 2004 may be anomalies.

Annex 4 - Table 3. Exports from Italy to EPPO countries of deciduous wood chips (44012200) (source Eurostat, 2014)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Albania				10								45					55
Austria			1		935	7619			3		226	745	17209	6648	4186	20481	58053
Belgium		0		0	9	1	2	3	5				0	0		142	162
Bulgaria											66	22	22	10	149	2	271
Croatia											235	230			6	24	495
Cyprus													0				0
Czech Republic										4	6					17	27
Denmark			12							6	16	3	4	3	2	0	46
Estonia														0			0
Finland														0			0
France		11	0	20	463	1		1348	2	32	11678	255	380	241	517	2313	17261
Germany		3	5	153	0	22	46	30	18	57	19	12	2	1	20	737	1125
Greece						8	90	184	3	262	537	880	511	20	11	17	2523
Hungary										151	183	345	6	6	8	4	703
Ireland					0								0	65			65
Kazakhstan											5		5				10
Latvia															2	9	11
Lithuania									8	16	11						35
Luxembourg													226				226
Malta			132							70			0	2	84		288
Netherlands		92	0	1							19	61		0	0		173
Poland				35	61		14	15	2	32		401	0	68	35	24	687
Portugal					1	15		15		80	184	45	3	4	1	3	351
Romania												16	0	30	0	48	94
Russia												4					4
Slovakia								34	11	27	102	74	2	1			251
Slovenia		486								31	9	85	50	39	30	90	820
Spain			8	25	47	49	184	376	1114	1481	970	1125	54	12	4	53	5502
Sweden													1	0	1		2
Switzerland		291		1393	1434	1540	1719	2070	1615	974	1409	1442	889	732	1352	35	16895
Tunisia														54			54
Turkey												4			14		18
UK		0	0		2	11			13	147	230	262	0	0	1	220	886
Total	**0**	**883**	**158**	**1637**	**2952**	**9266**	**2055**	**4075**	**2794**	**3370**	**15905**	**6056**	**19364**	**7936**	**6423**	**24219**	**107093**

Annex 4 - Table 4. Wood waste - 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	Total
Algeria																33.1	0
Belgium						32.6	65	31.1	18.7	18.9	121121.7	259030.8	85225.8	3478.3	16.4	26.8	65
Bulgaria			1		6.5												1
Denmark		2.9							2.6	31.7	16.1	26	46	54.4	54.1		72
Ireland			.9				61.8	78.3		100.3	211.7	30.9					0
Czech Rep.						1.2								19.1			0
Finland											307.8			4.6			0
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		84
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	1093
Greece	49.2		17		85.6	97.8	105	104.4	81.7	66	66	40.1	15.9				254
Israel			17.2		3.6	19.4				24.2	37	22.9		34.3			37
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		0
Jordan								6		68.6							6
Kazakhstan						37.8	19.2										0
Latvia						2.2											0
Malta												16.8		42.3	0.0	13.0	0
Netherlands	164.6	1.2	2.6		0.5				8.4		49782.7	235221.9	222979.8	90548.3	98.3	279.9	0
Norway					17.2				6			2.4					6
Poland											4.3	2.8					0
Portugal		20				16		7.9									36
Russia	26.3							17.6	13	14.3	45.1	28.1	68	47	27.9	4.6	128
Spain	16.2	120.7	149.2	232	413.5	876	1041	148.7	1007.3	1177.3	812.9	242.7					2149
Sweden				1.1				6.7			778.2	68.9	90.7		734.8		0
Switzerland			4.1			16.6	22.9		11.6			16.7		7.4	0.4		0
Turkey							15.7		22.7	273.9		15.9	55.5	35.8	0.1	42.3	0
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	321
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**	**1675316**

Annex 4 - Table 5. Wood waste - Imports to the EU of wood waste not agglomerated. Quantities in 100 kg (source Eurostat, 2014)

- 1998-2008 44013090 - wood waste and scrap, whether or not agglomerated in logs, briquettes, pellets or similar forms (excl. sawdust)
- 2009-2011 44013080 - wood waste and scrap, whether or not agglomerated in logs, briquettes or similar forms (excl. sawdust and pellets)
- 2012 44013990 - wood waste and scrap, whether or not agglomerated in logs, briquettes or similar forms (excl. sawdust and pellets
- 2013 44013980 - wood waste and scrap, not agglomerated (excl. sawdust)

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010		2011		2012		2013		TOTAL	
	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US	MX	US
Austria		85				1		0								14		0				17		0	0	0	1	0		0			1	117
Belgium		122		537		874		350		516		695		161		717		2344		1477		642		1265		60778		116550		268378		48270	0	503676
Bulgaria												6		4				12												7		7	0	36
Croatia												0								4													0	4
Cyprus												0								15													0	15
Czech Rep																		145				1		64		0		82		91		49	0	432
Denmark										320		21594		82		107		338		729		980		332		849		750		201		1	0	26283
Estonia																																	0	0
Finland		0				0								4		186		41		34		0				3		4					0	272
France		1547		1638		2659		1683		2704		2469		2828		2777		2663		2125		3339		1556		1037		1698		963		11497	0	43183
Germany				222		461		8754	215	26817		14817		12501		4222		2433		6331		20748		15498		12152		10013		13025		19948	215	167942
Greece				0		2		2								75								192		76						43	0	390
Hungary				2298		1852		1865		393		281		170		39		71															0	6969
Ireland		2613		731		0		148	27	304		413		512		1529		978		972		3352		688				91		3		0	27	12334
Italy		585		755		737		672		269		660		2502091	6	3358217		11855		40921		1231		1416		548		1061		0		200	6	5921218
Latvia						124														0													0	124
Lithuania																																	0	0
Luxembourg				0		1																											0	1
Malta						5						156		1														8		0			0	170
Netherlands				158		28		12		406		386		15		143		14		7093		679891				0		5		2		3269	0	691422
Poland																				0				28		7		80425		1			0	80461
Portugal		259		0								177														143		14					0	593
Romania				21												3																	0	24
Slovakia														8																			0	8
Slovenia				54		36		15		35																0							0	140
Spain		605		1138		5909		5807		3430		1584		429		2010		837		329		120		257		762		151					0	23368
Sweden		18		3		302		4		1		2		3				7		254		55782		94		139		44770		119015		25	0	220419
UK		400		1731		1010		283	10	4412		8936		20838		1340		3676		12804		166650		3205		4349		11806		1135		1739	10	244314
Total EU	0	6234	0	9286	0	14001	0	19595	252	39607	0	52176	0	2539647	6	3371379	0	25414	0	73088	0	932753	0	24595	0	80843	1	267428	0	402821	0	85048	259	7943915

Annex 4- Table 6. wood waste – Exports from Italy to other EPPO countries of wood waste not agglomerated. Quantities in 100 kg (source Eurostat, 2014, same codes as for Table 4)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	TOTAL
Albania		107	59	82					8	15	371	128					770
Algeria									1285	1036							2321
Austria	10813	28082	24398	15024	25669	11294	9050	10593	46885	11219	78996	75839	71713	76425	74278	77896	648174
Azerbaijan														35	26		61
Belgium			391	7	85	23	22	24	178	72	152	1579	1427	1309	1138	116	6523
Bosnia And Herzegovina			13		15						86	36	12				162
Bulgaria										75	85	26	23	48	41		298
Croatia	134	127	121	249	863	702	210	414	343	379	1028	95	264	57	517	27	5530
Cyprus		109		1428	1495	911	283	31	56	253	756	1084	105	94	190	145	6940
Czech Republic	379	2017	1043	1156	2111	1678	179	12	115	412	1401	472	381	198	240	59	11853
Denmark			155					15	3	4	1				0		178
Estonia		416	354	169	672	359	184	3	1	5	267	214	30	21		2	2697
Finland			6						8			0		1	0		15
France	1453	2416	5466	859	553	242	311	313	402	1520	1229	1726	731	837	1737	268	20063
Germany	2795	553	4404	1201	1035	1091	294	93	664	1335	1040	1893	477	414	43	60	17392
Greece	394	444	1876	950	1287	170	285	707	720	1554	4875	2496	2051	3530	715	102	22156
Hungary	395				544	1159	21	48	262	105	269	197	95	306	196	61	3658
Ireland				4				15	21	46	17			0			103
Israel	140		44	151	246	36					2	1	2	39			661
Jordan										750							750
Kazakhstan														15			15
Kyrgyz, Republic								42									42
Latvia								17	31	202	61	226	305	160	79		1081
Lithuania											14	86	73	58	65		296
Luxembourg			12														12
Malta	1191	3074	1270	150	458	904	30	34	1559	114	3276	2354	1780	1153	1833	133	19313
Moldova, Republic Of					10										13		23
Morocco								20	25					584			629
Netherlands	254		504					0	7	1	31	96			5		898
Norway			130					4									134
Poland		7		371	17		5	268	38	223	490	165	335	230	81	38	2268
Portugal	415	966	552	104	223	122	119	507	1155	2200	2412	828	452	506	487	319	11367
Romania				6		455	223	650	213	991	1265	427	880	440	320	40	5910
Russia			40	4	23		8	19	63	196	61	417	44	12	5		892
Slovakia							1	3	116	346	551	79	19	4	8	3	1130
Slovenia	234	273		395	657	344	223	2533	3132	16239	18535	9466	14445	43222	487	119	110304
Spain	161	74	1397	158	94	235	293	562	1544	1878	3910	918	597	421	436	64	12742
Sweden	33	10	162	37			24	21			84	363	0	1	3		738

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	TOTAL
Switzerland	5200	6590	3326	2605	3189	2094	2628	1650	1954	2087	4165	3283	3489	1562	2746	2392	48960
Tunisia			513						302		6						821
Turkey	321	6		5		119	12				77		326	178			1044
Ukraine									639				6				645
United Kingdom	21		505	91	102	171	487	55		43	19	824	758	3565	9424		16065
Total	**24333**	**45271**	**46741**	**25206**	**39348**	**22109**	**14892**	**18653**	**61729**	**43300**	**125532**	**105318**	**100820**	**135425**	**95113**	**81844**	985634

Annex 4 - Table 7. Deciduous wood chips - Monthly exports in 2013 from the USA to EPPO countries of "harwood chips" (4401220000) (unit: metric tonnes) (source USDA-FAS, 2014)

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Bulgaria					863		1598						2461
Denmark	698		245	1134		86						2513	4676
Finland				479							158		637
France	3875	1164	2317	2964	2089	1824	646	1819	204		2093	4212	23207
Germany	3081		552		2901	3304		570		998	519	354	12279
Israel		65			698	400	617		201				1981
Italy		1196					149				561		1906
Netherlands					537			812	500			343	2192
Spain		517	2183		1680					731			5111
Sweden		1620			1620								3240
Switzerland										91	441		532
UK		113		510	127	113			113	162	1620		2758
Sub-total (without Turkey)	**7654**	**4675**	**5297**	**5087**	**10515**	**5727**	**3010**	**3201**	**1018**	**1982**	**5392**	**7422**	**60980**
Turkey	25000		47158			30075			20208				122441
Total EPPO	**32654**	**4675**	**52455**	**5087**	**10515**	**35802**	**3010**	**3201**	**21226**	**1982**	**5392**	**7422**	**183421**

ANNEX 5 – Walnut in the EPPO region

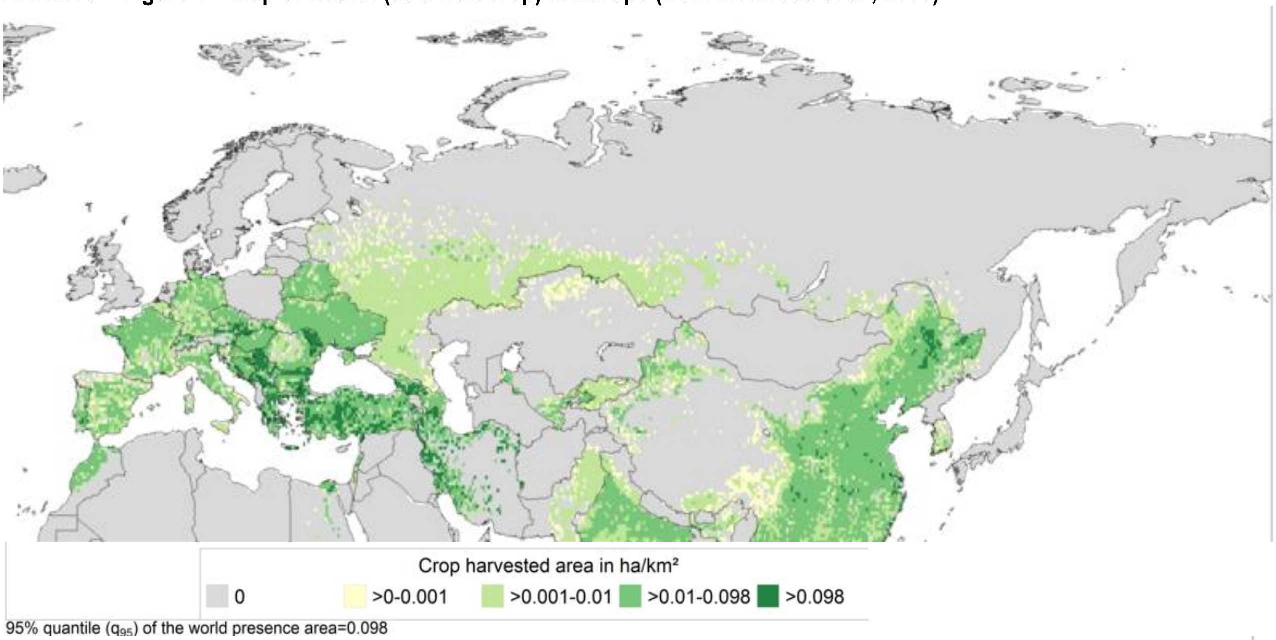
Table 1 - Area of production of walnut (for nut production) (FAO Stat, in ha)
The number before the country indicates its worldwide rank.
The data for Serbia in 2000 corresponds to Serbia and Montenegro

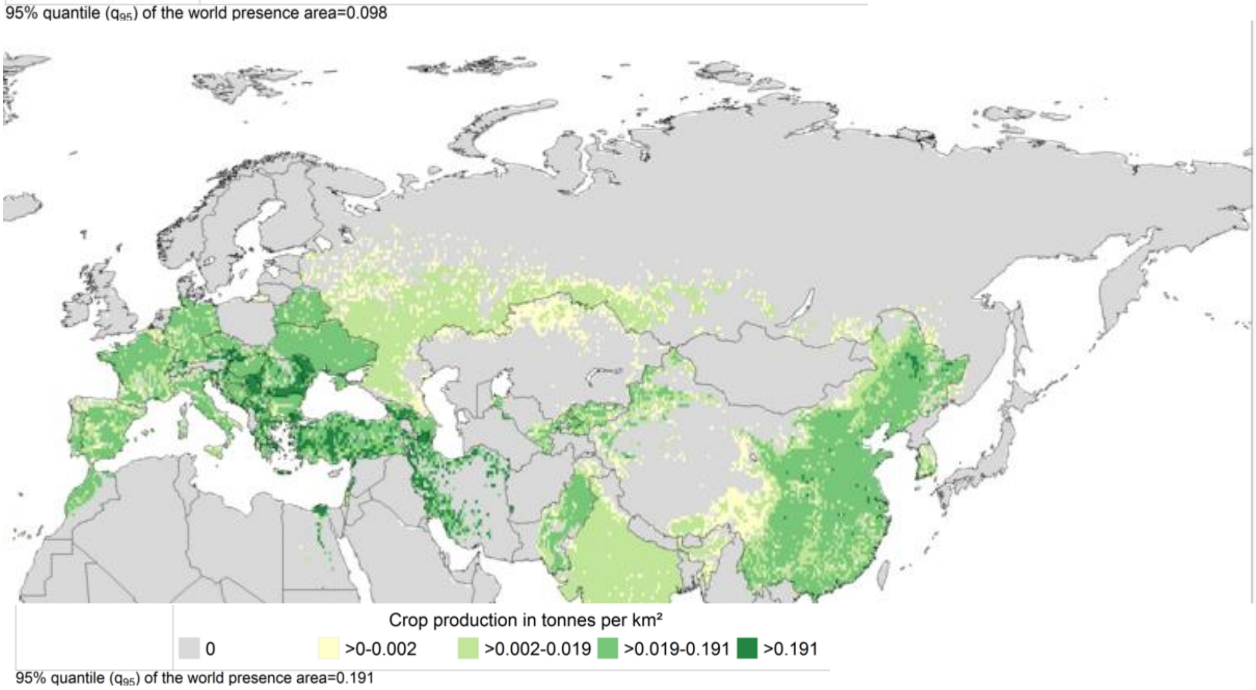
EPPO countries	2000	2008	2010	2012
2. Turkey	59000	84917	90683	99617
6. France	14519	17126	18893	19073
8. Poland	1758	19583	29059	16529
9. Ukraine	15100	14100	14060	14100
10. Greece	15000	13700	10500	10900
11. Serbia	13734*	16115	13000	10000
12. Spain	4065	7418	7899	8000
13. Russian Fed.	14000	7566	7500	7800
14. Bulgaria	6407	1628	7217	7519
16. Germany	6000	5262	5633	6000
17. FYR Macedonia	1800	5710	5000	5200
18. Moldova Rep.	3288	3581	4088	5045
19. Belarus	5273	5145	5100	5000
20. Morocco	4800	4999	5094	4881
22. Italy	4000	4450	4205	4400
23. Hungary	7000	3303	4182	4356
24. Bosnia and Herzegovina	2400	4568	4000	4200
25. Croatia	5200	6945	4402	3700
26. Uzbekistan	2609	3125	3200	3600
Portugal	3088	3158	2700	2800
Azerbaijan	2065	2629	2725	2798
Czech Republic	4300	1400	1450	1900
Slovakia	3000	1000	1650	1600
Switzerland	2500	1150	1550	1600
Romania	2122	1726	1490	1433
Kyrgyzstan	1200	1210	1200	1280
Austria	6000	6500	2100	950
Kazakhstan	626	382	300	600
Cyprus	410	280	259	288
Belgium	220	233	249	260
Slovenia	77	92	115	171
Luxembourg	70	76	12	12
TOTAL EPPO				**255.612**
1. China	168000	275000	350000	425000
3. United States of America	78100	90246	95911	98980
4. Mexico	43000	64903	69548	69796

ANNEX 5 - Table 2 – Volume of production in tonnes
* data for 2000 for Serbia is that for Serbia and Montenegro)
The number before the country indicates its worldwide rank.

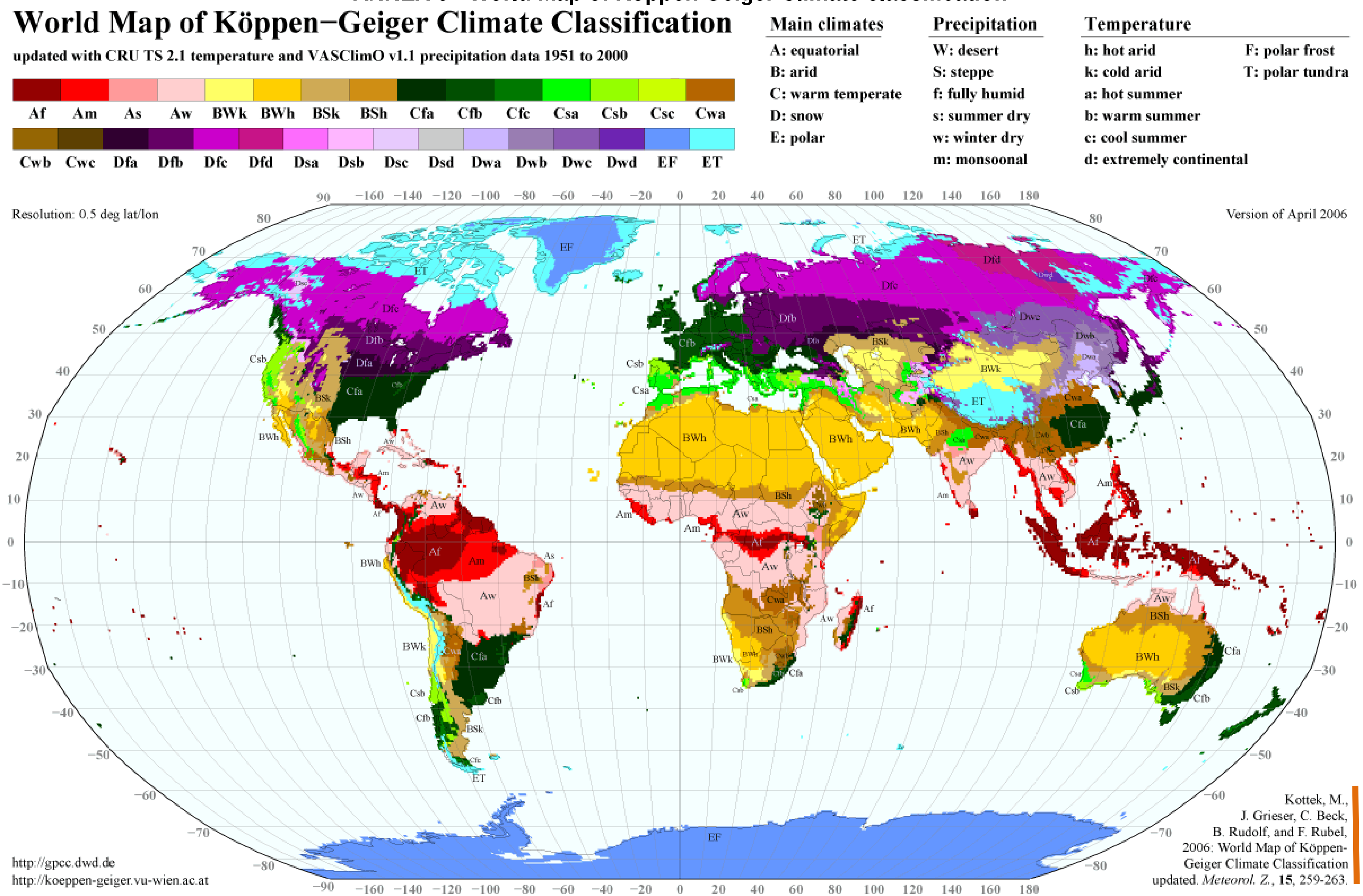
Country	2000	2008	2010	2012
4. Turkey	116000	170897	178142	194298
6. Ukraine	49995	79170	87400	96900
8. France	28615	36912	31737	36425
9. Romania	31503	32259	34359	30546
10. Greece	23518	15100	22200	24200
12. Belarus	13655	12771	13500	16500
13. Germany	18200	18374	12313	16000
14. Uzbekistan	9000	13543	14000	16000
15. Serbia	23776	24405	21419	14892
17. Spain	11418	11682	13525	13100
19. Poland	4000	11577	9175	12310
20. Czech Republic	6465	9500	9500	12000
22. Italy	16000	12046	14000	11000
23. Azerbaijan	9983	8376	8470	9174
24. Moldova Rep.	5992	13742	11583	9062
26. Morocco	6500	12894	10129	8319
28. Kyrgyzstan	2500	4868	5000	5800
29. FYR Macedonia	3862	4863	5769	4952
31. Slovenia	2940	2844	2952	4380
33. Portugal	3922	3752	3400	4200
34. Hungary	7847	5751	5637	3239
35. Bosnia and Herzegovina	5390	4839	4907	3171
37. Bulgaria	6000	422	1240	2925
39. Austria	17082	19130	6000	2700
40. Switzerland	4220	1837	2401	2432
41. Kazakhstan	2644	1427	1180	2300
42. Russian Fed.	12000	1916	2000	2250
45. Slovakia	3000	1100	1120	1200
46. Croatia	4908	6828	8651	900
49. Belgium	500	400	329	470
51. Cyprus	300	207	155	222
53. Luxembourg	150	125	24	17
TOTAL				**561.884**
1. China	309875	828635	1284351	1700000
2. Iran (Islamic Republic of)	130605	433630	433630	450000
3. USA	216820	395530	457221	425820
5. Mexico	60000	79770	76627	110605

ANNEX 5 – Figure 1 – Map of walnut (as a fruit crop) in Europe (from Monfreda et al., 2008)





ANNEX 6 - World Map of Köppen Geiger Climate classification



ANNEX 7. Control methods that have been investigated (or under investigation) in the USA

- *Chemical control*. Various such methods (sprays, soil applied systemic insecticides, trunk injections) have been investigated, involving insecticides against *P. juglandis*, but to date none have indicated they can adequately manage the progression of thousand cankers disease (Tisserat and Cranshaw, 2012, Cranshaw and Tisserat, 2012b; Hasey and Seybold, 2010). Furthermore, the range of insecticides – and all other pesticides – allowed for use in the USA on any *Juglans* species is limited because these are regulated as a nut-bearing food crop, which implies limitations regarding active ingredients and timing of pesticide use (Cranshaw and Tisserat, 2012b; Tisserat and Cranshaw, 2012).

- *Biological control.* Several natural enemies are found associated with *P. juglandis*, including parasitoids (such as *Theocolax* sp., *Aeletes floridae*, *Leptophloeus angustulus*, *Bitoma quadriguttata*) and some generalist predators (notably clerid beetles) (Nix, 2013), and under some conditions may provide some suppression. However, an active biological control programme for *P. juglandis* has not yet been developed. Research is being carried out on *P. juglandis*, including use of entomopathogenic fungi. In addition, biological control of *G. morbida* including on evaluation of antagonist organisms and induction of host plant resistance has not yet been initiated.

- *Semiochemicals*. Some attractants of *P. juglandis* have been identified, and are effectively used in detection and monitoring. They are not used for control. More recently repellent compound have been reported but their use in management of thousand cankers disease have not yet been developed.

- *Use of resistant cultivars.* Differences of susceptibility have been observed between trees within a species. Studies are in progress to evaluate whether differences occur between different populations of *J. nigra* (N. Tisserat, unpublished). Surviving trees in affected areas may be particularly promising sources of genetic material to develop resistant cultivars. Identifying resistant or less susceptible cultivars would provide a very promising and sustainable control method for the long term.

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

Pathways for “Particle wood and waste wood of deciduous species” and “bark of *Juglans* and *Pterocarya*” are considered together. Differences are identified in the answers where appropriate.

Wood packaging material is not considered in detail in this stage, as the likelihood of entry is very low if it is treated in accordance with ISPM 15 (see Section 8 in the PRA). Wood packaging material not treated according to ISPM 15 is mentioned in the conclusions.

7.02 - Is natural spread one of the pathways?

Yes from Italy, no from USA and Mexico

Natural spread is only a pathway for the spread from Italy to other EPPO countries

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

yes

P. juglandis and *G. morbida* may be spreading from the outbreak area in Italy to other parts of Italy or other EPPO countries. The pests have not yet been detected in other EPPO countries (see Section 11 of the PRA). They cannot enter the PRA area by natural spread from the USA. However, The EWG believed that human-assisted spread will also be the main mean of spread in the EPPO region.

Pathway 1: Wood of *Juglans* and *Pterocarya*

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**

G. morbida and *P. juglandis* are not quarantine pests in the PRA area. At the scale of the whole PRA area, there are no measures that would completely prevent the introduction of *P. juglandis* and *G. morbida*. A number of countries have phytosanitary measures in place against *Agrilus planipennis* on *Juglans mandchurica* and *Pterocarya rhoifolia*, but these species are not the main hosts traded.

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, Switzerland, Serbia) have regulations in place targeting "non-European Scolytidae", the phytosanitary measures relate to conifers. General requirements are also in place for some countries.

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)?

yes in a Systems Approach

Level of uncertainty: **low**

Possible measure: visual inspection at the place of production

P. juglandis and *G. morbida* are difficult to detect especially at low levels of infestation. They are likely to be detected if populations have built and symptoms are expressed in the crown of the tree. Entry and exit holes are difficult to observe, cankers are not or little visible. In case of low infestation levels, these are not likely to be noticed. Symptoms are also not specific to these pests, and may be overlooked. This measure is not sufficient on its own but may be combined with others.

Samples can also be collected, examined for the signs of presence (galleries, cankers) and the pests present identified. However, sampling needs to target suspected material, i.e. where crown symptoms have already appeared.

Pheromone traps are available, seem effective and can be used to detected *P. juglandis*. They have also been used at low levels of infestation (Seybold et al., 2012b). Information is lacking on whether they are able to detect very low populations (i.e. would they detect *P. juglandis* if the pest had just established in an area?).

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**

Not relevant.

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

no

Level of uncertainty: **low**

There is no known control method that could be applied to prevent infestation or control the pests in standing trees.

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.

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 production.

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**

Not relevant 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 for wood.

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

high rate of spread

Level of uncertainty: **medium**

Possible measure: pest-free area

Although the rate of natural spread is considered to be low, potential for rapid spread through human-assisted movement of wood is high.

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

yes

Level of uncertainty: **low**

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

- A monitoring programme based on visual examination and pheromone traps in areas where hosts are present. This would require appropriate identification capabilities to avoid misidentifications and ascertain pest freedom. Specific surveillance is currently based in the USA on visual examination and pheromone traps (USDA, 2014). The surveys that are used to detect the insect also include sampling of symptomatic branches to detect the fungus. Surveillance would require visual examination and use of pheromone traps for at least 2 years, possibly throughout the year, and especially in the period when temperatures exceed (18-19°C) (Seybold et al., 2012b). The density of trap for detection surveillance is not given in USDA (2014) or Seybold et al. (2012b), but should be high to detect very low populations.
- Measures should be in place to prevent the entry of the pests, i.e requirements on commodities.
- Handling and packing methods allowing to prevent infestation of consignments after leaving the PFA (i.e. during transport) (see 7.26).
- Areas isolated by appropriate physical barriers (e.g. absence of hosts or sufficient distance) or minimum distance from the limits of infested areas. The flight capacity of *P. juglandis* is not known. However, there is information regarding another bark beetle of similar size, *Pityogenes chalcographus*, which was found infesting spruce trap logs 86 km from the nearest spruce forest (Nilssen, 1984), and the EWG considered this data was relevant for *P. juglandis* in the absence of specific data. As *P. juglandis* seems able to establish on trees in any condition (standing trees as well as cut logs), even a small fraction of a population reaching its maximal flight distance is likely to establish, given the presence of hosts. The EWG consequently proposed that a PFA should be separated by a distance of 100 km from the nearest infested area. *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 for a scenario where the fungus is introduced in one tree heavily infested with the vector, with a population of vector large enough so that spread starts the following spring, excluding any human assisted spread, considering that host availability was not a limiting factor and that every infectious vector would lead to an infection. The experts judged that 5% of the infection/infestation events within a year will encounter the conditions of long-distance dispersal. The events enabling long distance dispersal include that part of the population is active above the forest canopy during the flight period coinciding with stable strong winds in one direction. Based on a review of the evidence, experts judged that 5% of the infections/infestations will occur after one year in distances to the starting point above 31 km (median value), with a 90% uncertainty range from 8 to 80 km. Report of the EKE exercise is made available at https://upload.eppo.int/download/933o02d521b6b*

The PFA should be officially recognized by the importing country.

Due to the limited distribution of the pests and the uncertainties on their distribution, the EWG noted that the PFA requirement could be applied to North America and Europe and 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**

Possible measure: visual inspection of the consignment

Visual inspection will not easily detect early infestation because of the size of wood consignments. Signs of presence of *P. juglandis* and *G. morbida* may be confused with signs of other bark beetles species, or disorders (for cankers). Detection requires removal of the bark as dark staining is not always visible and holes are very tiny. *P. juglandis* may be misidentified and *G. morbida* needs to be cultured for identification.

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**

Not relevant.

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

yes in a Systems Approach
Level of uncertainty: **low**
Possible measure: specified treatment of the consignment
The following treatments could be applied. They need to be combined with handling and packing methods preventing infestation of the consignment after treatment (in particular during transport) (see 7.26).

Heat treatment. Heat treatments have proven to be highly effective for subcortical insects and pathogens. According to EPPO Standard PM 10/6(1) *Heat treatment of wood to control insects and wood-borne nematodes*, Scolytidae are killed in round wood and sawn wood which have been heat-treated until the core temperature reaches at least 56°C for at least 30 min. Effective treatment schedules against *P. juglandis* in the USA were 56°C for 40 minutes measured 1 cm below the sapwood surface (Mayfield et al., 2014) The EWG recommended at least 56°C for at least 40 minutes measured at 1 cm below the sapwood surface. Note that kiln-drying that fulfils the heat treatment conditions above is considered effective.

Methyl bromide fumigation of wood. Methyl bromide fumigation would be an option, but there is not yet a documented effective concentration to eliminate *G. morbida*. A fumigation schedule is not yet available. Research is being conducted in the USA. 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).

The following other treatments were considered but are not considered appropriate as phytosanitary measures (see Annex 9 of the PRA for details): submergence, irradiation, insecticide-impregnated nets, cold treatment, chemical pressure impregnation, vapour steam treatment, insecticide treatments, solarisation.

Processing. Processing is considered in 7.25.

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)
Yes for squared wood, yes in a systems approach for bark-free wood
Level of uncertainty: **low**
Possible measure: removal of parts of plants from the consignment
Squaring to entirely remove the wood natural rounded surface is considered effective and would adequately reduce the risk. Quarantines in the USA require that squared wood be kiln-dried, because squared wood may still contain pockets of included bark. The EWG recognized that there is still a possibility that some bark remains on such wood. However, the EWG considered that squaring the wood reduces the risk and could be used as a phytosanitary measure on its own. This is consistent with some measures that already exist in a number of EPPO countries (including the EU Directive 2000/29), for *Quercus* with regards to *Ceratocystis fagacearum* and its vectors.

Making the wood bark-free. Bark-free wood in the sense of ISPM 5 may contain pockets of bark. Making the wood bark-free will remove most individuals, but *G. morbida* may also be present in the (superficial) sapwood. In the USA, some quarantines exempt wood from which 100 % of the bark was removed but only if other treatments have been applied (e.g. kiln-drying, heat treatment, squaring; Kansas, Michigan, Nebraska).
The EWG considered that making the wood-bark free was not sufficient on its own. However, it reduces the risk, and the pests would also be exposed to desiccation. Complete removal of bark could be used in combination with other measures. In this case, handling methods preventing reinfestation of the consignment would not be needed as *P. juglandis* would be unlikely to reinfest wood that has been made bark-free.

Debarking, processing of the wood into sawn wood and, chipping were not considered appropriate as phytosanitary measures (see Annex 9)

7.26 - Can infestation of the consignment be reliably prevented by handling and packing methods?
yes in a Systems Approach
Level of uncertainty: **medium**
Possible measure: specific handling/packing methods

Handling and packing methods need to be used in combination with other measures to avoid infestation during transport and storage, for all measures except squaring, as well as complete removal of bark (only if combined with a treatment allowing to eliminate the pests in the wood). The only method to achieve this would be that the wood is, immediately after treatment, packed in a way preventing infestation. Transport only at some periods of the year is not considered an option.

The EWG noted that isolation and storage had been investigated in the USA as a measure to dispose of infested wood (see Annex 9 of the PRA). However, it considered that there is not enough information to determine with sufficient confidence an appropriate duration of storage that would guarantee that the wood is pest free. This is therefore not recommended as a phytosanitary measure at export.

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 possible 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, during period when adults are not likely to fly, with appropriate measures relating to disposal of bark and waste. The risk attached to the disposal of bark and waste, which can be heavily infested, is too high, and it is difficult to control that the wood will be processed immediately. There is also an uncertainty on the flight period and the temperature at which adults will emerge. Consequently the adequate period would differ between geographical location in the PRA area and even between years, which makes it difficult to apply in practice.

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 could be put in place in areas where walnut is grown, as well as in countries importing wood and deciduous wood chips from the USA, both in forest areas and in orchards (especially for *J. nigra* and *J. regia*). Pheromone traps are available. However, surveillance and early detection are difficult. Eradication is considered possible only in very limited situations, and establishment is still likely (see section 16 of the PRA). Containment programmes may be applied but would not prevent establishment.

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

yes

Q.	Standalone	System Approach	Possible Measure	Uncertainty
7.13		X	visual inspection at the place of production	low
7.20	X		pest-free area	low
7.24		X	specified treatment of the consignment	low
7.25	X(squared)	X(bark-free)	removal of parts of plants from the consignment	low
7.26		X	specific handling/packing methods	medium

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
- Squaring
or
- Treatment (heat treatment) with handling/packing methods to prevent infestation after treatment.

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 are not sufficient on their own:
- visual inspection at the place of production
- handling and packing methods to prevent infestation during transport
- making the wood bark-free

Combinations that reduce the risk to an acceptable level are:
- making the wood bark-free + 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, but the industry has experience of applying similar measures for other wood species.
- from Mexico, but the trade is probably very limited.
- from countries of North America and Europe where the pests do not occur and which would need to demonstrate pest freedom

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.

Surveillance is already applied in the USA. Any requirements for PFA would have costs, also for countries in which the pests are not present.

However *P. juglandis* and *G. morbida* would be impossible to eradicate in most cases if introduced, will have a high impact if it established, especially as it is likely to be introduced with *G. morbida*. Although the measures preventing introduction create additional costs, they are likely to be cost effective. The case where *G. morbida* would be introduced on its own is very theoretical.

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
The following measures have been identified:
- PFA
or
- Squaring
or
- Treatment (heat treatment) + handling/packing methods to prevent infestation after treatment.
or
- Making the wood bark-free + treatment (heat treatment)

Pathways 2 & 3: Particle wood and waste wood of deciduous species / Bark of *Juglans* and *Pterocarya*

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

yes

The pathways for particle wood and wood waste and for bark are considered together. Differences are identified in the individual questions.

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**

G. morbida and *P. juglandis* are not quarantine pests in the PRA area. Although a number of countries in the PRA area (such as the EU, Switzerland, Serbia) have regulations in place targeting "non-European Scolytidae", the phytosanitary measures relate to conifers and a few deciduous species. A number of countries have phytosanitary measures in place against *Agrilus planipennis* on *Juglans mandchurica* and *Pterocarya rhoifolia*. General requirements are also in place for some countries (see Annex 2, Table 2).

There are no measures that target directly wood chips, wood waste and bark of Juglans and *Pterocarya*, apart from those targeting *A. planipennis*, and which apply only to *Juglans mandshurica* and *Pterocarya rhoifolia*. These require that the wood chips or bark pieces either originate in a PFA or have been processed into pieces of not more than 2,5 cm thickness, and this would not ensure destruction of *P. juglandis* and *G. morbida*. These apply to wood from the USA but not from Mexico.

There are requirements for other deciduous species, which in practice might have consequences when walnut wood chips, wood waste or bark is present in mixed consignments. The EU (as well as other countries, e.g. Switzerland, Serbia and Norway) prohibit isolated bark of *Quercus*, *Populus* and *Acer saccharum* from the USA (and other American origins) and *Castanea* from third countries (not for Norway). Particle wood and waste wood (including wood chips) are not prohibited, but wood chips of these species are subject to requirements that they should have been produced from debarked round or kiln-drying to below 20 % moisture content or appropriate fumigation, or appropriate heat treatment (minimum core temperature of 56 °C for at least 30 minutes) (which would ensure destruction of *P. juglandis* and *G. morbida*).

There are no requirements that would completely prevent the introduction of *P. juglandis* and *G. morbida* on these pathways into the PRA area. Requirements in EPPO countries are presented in Annex 2 (Table 3). 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 both pathways seems to be open for all or most countries in the PRA area from all origins. Where isolated bark, wood chips and wood waste are subject to measures against other pests, these would only apply to mixed consignments where some regulated species are present. General requirements (e.g. import permit or phytosanitary certificate) may ensure that inspections are carried out, but detection of the pests would be difficult.

Turkey, which imports large quantities of deciduous wood chips from the USA, seems to have some measures in place, but not all may be effective against the pests (e.g. produced from fumigated wood, or kiln-dried).

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)?

yes in a Systems Approach

Level of uncertainty: **low**

Possible measure: visual inspection at the place of production

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**

Possible measure: specified testing at the place of production

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**

As 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**

As for wood.

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

high rate of spread

Level of uncertainty: **medium**

Possible measure: pest-free area

7.21 - The possible measure is: 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 detect in wood chips and bark.

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**

As for wood.

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

yes in a Systems Approach

Level of uncertainty: **low**

Possible measure: specified treatment of the consignment

For particle wood and waste wood, any treatment should be combined with handling and packing methods preventing infestation of the consignment after treatment (in particular during transport) (see 7.26). no data but precaution due to bigger size chips. There is no indication of whether isolated bark could be reinfested.

The following treatments could be applied to the wood chips, wood waste or bark:

- Heat treatment. There have not been specific studies on heat treatment of wood chips. The schedule recommended for wood (i.e. 56°C for 40 min) is expected to be effective if applied throughout the profile of the material.
- Fumigation. In New Zealand, requirements for wood chips against insects are methyl bromide or sulphuryl fluoride fumigation (80 g/m^3), in separate units no larger than 2 m^3, for more than 24 continuous hours at a minimum temperature of 10°C. In Israel, methyl-bromide fumigation is required against internal and external pests for 16 hours at 80 g/m^3 at 10-20°C or at 48g/m^3 for 16 hours at 21°C or more.

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).

Wood could also be treated prior to chipping (provided infestation is prevented between treatment and chipping) (see 7.24 for the wood pathway – heat treatment, methyl bromide fumigation), and this could be equivalent to treatment of wood chips. The EWG did not know if this is common practice (this is not included in the table of section 16.1).

For bark, fermentation (composting) was mentioned as an option for treatment of the bark of conifers in EPPO Standard PM 3/53(1) on fermenting (composting) of bark of conifers, but the doubts were raised on the efficacy and the standard is being withdrawn.

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**

Possible measure: removal of parts of plants from the consignment

Wood chips could be produced from wood which is bark-free. However this does not correspond to known practice.

This is probably not applicable to wood waste, and is not relevant for the bark pathway.

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

yes in a systems approach

Level of uncertainty: **medium**

Possible measure: specific handling/packing methods

If particle wood or waste wood are stored in the exporting country for a sufficient period, individuals would not survive desiccation or would be unable to complete their development over time as wood chips dry out. This would have the same effect as requiring a treatment. However, part of the wood chips consignment/pile is likely to present the right conditions of moisture and temperature for the survival and development of the pest. If any adults emerge, they may infest some wood chips in the same pile. This measure would also be difficult to check in practice.

For particle wood or waste wood, handling and packing methods need to be used in relation to other measures to avoid infestation during transport. It is not known if isolated bark is attractive and requires such precautions. This may be achieved by packing these commodities in a way preventing infestation. Transport outside of the flight period of *P. juglandis* is not considered an option (see 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**

This would not be applied for wood chips, wood waste or bark.

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 at a time when adults cannot emerge. However, such measures are difficult to implement and control (ensuring immediate processing, mixing consignments of wood chips, etc.). Currently wood chips seem to enter throughout the year.

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?

yes

Q.	Standalone	System Approach	Possible Measure	Uncertainty
7.13		X	visual inspection at the place of production	low
7.20	X		pest-free area	low
7.24		X	specified treatment of the consignment	low
7.26		X	specific handling/packing methods	medium

For bark, of the measures above, only visual inspection at the place of production, pest-free area and treatment were identified.

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

no

Level of uncertainty: **low**

The following measures reduce the risk to an acceptable level.
- PFA
or
- Treatment (heat treatment), with suitable handling/packing methods to prevent infestation after treatment)

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 were identified that do not reduce the risk to an acceptable level on their own.
- Visual inspection at the place of production
- Produced from treated wood
- Handling and packing methods to prevent infestation during transport

The following combinations may be used:
- Produced from treated wood+ handling/packing methods to prevent infestation during transport

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

international trade.

Level of uncertainty: **low**

For wood chips, wood waste and bark the pathway is already regulated in some countries with some general measures, and the measures will not interfere more with trade.

Any PFA requirements for countries where the pests are 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**

Surveillance could be put in place at wood chips processing facilities, but would be complicated. In addition, adults fly and surveillance may not be sufficient to detect outbreaks early enough to ensure eradication. *P. juglandis* and *G. morbida* would be impossible to eradicate in most cases if introduced, will have a high impact if it established. Therefore measures preventing introduction will be cost effective. The case where *G. morbida* would be introduced on its own is very theoretical.

The EWG did not know if producing wood chips of the species concerned from wood that is bark-free is a current practice.

Fumigation with methyl bromide has undesirable environmental consequences.

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

The following measures reduce the risk to an acceptable level for particle wood, wood waste and bark:

- PFA

or

- Treatment (heat treatment) + handling and packing methods preventing infestation after treatment

Pathway 4 & 5: Plants for planting (including scion wood) of Juglans and Pterocarya

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

yes

This covers rooted plants for planting of *Juglans* and *Pterocarya* and scion wood of *Juglans* and *Pterocarya*.

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

no (the pest is not a plant)

7.10 - Are there any existing phytosanitary measures applied on the pathway that could prevent the introduction of the pest?

no

Level of uncertainty: low

Requirements in EPPO countries are presented in Annex 2 (Table 3). 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 both pathways seems to be open for all or 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 the pests would be difficult.

Plants for planting of *Juglans* and *Pterocarya* from the USA or Mexico are not prohibited in the EPPO region, except through prohibitions applying to certain origins due to the presence of other pests. Belarus, Russia and Tunisia may have such prohibitions in place (Table 3 in Annex 2). There are no requirements that would completely prevent the introduction of *P. juglandis* and *G. morbida* on these pathways. Where plants for planting are subject to general measures, these may ensure inspection. There are also a number of requirements targeting deciduous trees that would apply to *Juglans* and *Pterocarya*. However, they are not specific and would not be sufficient to prevent the introduction of the pests.

Options at the place of production

7.13 - Can the pest be reliably detected by visual inspection at the place of production ?

yes in a Systems Approach

Level of uncertainty: low

Possible measure: visual inspection at the place of production

Inspection may detect some infestation but will not detect early infestations as most of the life stages are hidden within the plant (e.g. when only entry holes are present, and cankers not visible).

Pheromone trapping is available.

7.14 - Can the pest be reliably detected by testing at the place of production?

no

Level of uncertainty: low

Not relevant.

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

no

Level of uncertainty: medium

Possible measure: specified treatment of the crop

If available, suitable insecticide treatments will only lower pest populations. However insecticide treatments have not proved effective.

7.16 - Can infestation of the commodity be reliably prevented by growing resistant cultivars?

no

Level of uncertainty: low

See wood.

7.17 - Can infestation of the commodity be reliably prevented by growing the crop in specified conditions?

yes in a Systems Approach

Level of uncertainty: medium *(it is not common practice for the host species)*

Possible measure: specified growing conditions of the crop

Plants for planting can be grown under complete physical isolation throughout their life with sufficient measures to exclude the pest. 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. It is not known if any *Juglans* bonsais are produced.

Plants will then need to be transported in conditions preventing infestation during transport.

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: medium

Possible measure: specified size of the plant

P. juglandis and *G. morbida* may infest small size material, and the minimum size is also not known

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 (high rate of spread with medium uncertainty), select the rate of spread.

high rate of spread

Level of uncertainty: medium

Possible measure: pest-free area

7.21 - The possible measure is: 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?

yes in a Systems Approach

Level of uncertainty: medium-high

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. Symptoms are best seen when removing bark, which would not be possible, neither on plants for planting nor on scion wood. Early infestations may be overlooked. This measure can be used as a verification measure.

7.23 - Can the pest be reliably detected by testing of the commodity?

no

Level of uncertainty: low

As for wood.

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

no

Level of uncertainty: low

There are no treatments available so far

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?

no

Level of uncertainty: low

It is not possible to remove the bark without damaging the plant and scion wood.

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

Yes in a systems approach

Level of uncertainty: low

Possible measure: specific handling/packing methods

There is a need to avoid infestation during transport. This may be ensured by transporting the plants and scion wood packed in a way preventing infestation. Transporting plants at specific periods outside the flight period is not considered effective as there seems to be flight throughout the year in some areas.

Plants and scion wood should in any case be packed in a way preventing infestation in storage.

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 (including scion wood) in post-entry quarantine for a sufficient time to detect the symptoms of larval activity or emergence of *P. juglandis*. This would happen before signs of canker production can be observed. When the plants are in active growth, a period of 8 weeks should be sufficient but during winter time when the plant contain overwintering stages, plants will need to be maintained in Post-entry quarantine for a longer period. There are many uncertainties linked to the duration needed.

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, and if adults emerge, they could fly and find hosts in the vicinity.

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. It would be easier in orchards where scion wood was used.

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

yes

Q.	Standalone	Systems Approach	Possible Measure	Uncertainty
7.13		X	visual inspection at the place of production	low
7.17		X	specified growing conditions of the crop	low
7.20	X		pest-free area	low
7.22		X	visual inspection of the consignment	Medium-high
7.26		X	specific handling/packing methods	low

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

no

Level of uncertainty: low

- PFA

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: high

The following measures do not reduce the risk to an acceptable level:

- Visual inspection at the place of production
- Specified growing conditions
- Visual inspection of the consignment
- Handling and packing methods to prevent infestation

The following measures may be combined:
- Growing the plants under complete physical isolation + handling and packing methods preventing infestation after leaving the protected conditions + visual inspection of the consignment.

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

Level of uncertainty: low

Requirements on 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 at most limited.

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

P. juglandis and *G. morbida* would be impossible to eradicate in most cases if introduced, will have a high impact if it established. Therefore measures preventing introduction will be cost effective. The case where *G. morbida* would be introduced on its own is very theoretical.

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
- Growing the plants under complete physical isolation + handling and packing methods preventing infestation after leaving the protected conditions + post-entry quarantine + visual inspection of the consignment.

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:

- Untreated wood packaging material, especially dunnage
- Wood with bark of *Juglans* and *Pterocarya*
- Plants for planting of *Juglans* and *Pterocarya*
- Natural spread
- Particle wood and waste wood of deciduous species (not agglomerated)
- Bark of *Juglans* and *Pterocarya*
- Wood without bark (bark-free) of *Juglans* and *Pterocarya*
- Scion wood of *Juglans*

7.45 - Conclusions of the Pest Risk Management stage.

List all potential management options and indicate their effectiveness.
Uncertainties should be identified.

Conclusions are given in the main text of the PRA, section 16.

ANNEX 9. Measures not retained as phytosanitary measures in this PRA

Measures that were not retained as phytosanitary measures are detailed below. Measures marked with * are those mentioned in the literature as having been investigated for the disposal of infested wood in the USA. Others were considered by the EWG when studying risk management options. Note that some would have a value as part of any containment plans (see section 16.3 of the PRA).

Processing

Chipping. Chipping does not kill all developing *P. juglandis* due to the small size of the beetle (Tisserat, 2010-2014, Hasey and Seybold, 2010). It is however considered as an option for disposal of infested wood as it accelerates the speed of wood material becoming unsuitable for *P. juglandis* breeding, provided chipped wood is handled with care (Cranshaw, 2009 draft; Moltzan., 2011; Tisserat and Cranshaw, 2012). In experiments, chipping killed 94% of *P. juglandis*, and emergence from chipped material ceased after 2-5 weeks, whereas *P. juglandis* emerged from control logs for up to 9 weeks (in the absence of recolonization) (Sitz, 2013; Sitz et al., 2013). As *P. juglandis* was shown to survive and emerge from wood chips, and it could certainly survive in bigger chips where bark is present, chipping is not a possible phytosanitary measure, but could be used to reduce populations on disposed wood.

Debarking. Debarking is not fully effective, but may be used to reduce the period of suitability of the wood for *P. juglandis* (Tisserat, 2010-2014; Cranshaw, 2011). *G. morbida* can occur in the extreme outer sapwood and can survive, at least temporarily, on the surface of a freshly debarked walnut log (see section 8. pathway for wood). It was not possible to remove 100% of the bark even on small diameter logs owing to knots, branch stubs, and other forms of included bark.

Processing into sawn wood will remove part of the bark and outer surface of the wood, and eliminate some life stages of *P. juglandis* and part of the *G. morbida* population. The wood will dry out more quickly, causing additional mortality. Processing the wood will expose the galleries and make it more likely that infestation will be detected. However, some life stages of *P. juglandis* may survive in larger pieces of sawn wood where bark is present.

Specific handling

Burial. The wood may be buried (Tisserat and Cranshaw, 2012). This could be useful to dispose of infested material (wood, chips, bark).

Burning. Burning is considered an option in Hasey and Seybold (2010).

Isolation/storage. Wood is handled and isolated so as to prevent the dispersal of *P. juglandis* until it no long supports its development (i.e. sufficiently dried), or if the isolated area is intended as the final destination and the wood will no longer be used. Isolation can be achieved by piling wood in a site distant from healthy walnuts, particularly walnuts located downwind. Storage of logs in buildings can achieve *P. juglandis* containment. Tarping logs with clear plastic also may contain beetles within logs.

Regarding the duration of storage, Cranshaw (2009 draft) mentions 2-3 years and that logs may remain suitable for breeding for that duration after felling under conditions where drying is slow. Peachey (2012) observed emergence of *P. juglandis* from logs (even with some treatment) for up to 21 months after sampling and Pscheidt and Ocamb (2014) that logs can remain a source of *P. juglandis* and *G. morbida* for at least 18 months (note: this are estimates with the possibility that emerging adults recolonize the logs).

There is no data on the persistence of *G. morbida*, but Audley (2013) mentions that research is being carried out (by S. Fraedrich in 2012 – no publication found; length of time remains viable in *J. nigra* wood).

Solarisation. Peachey (2012) covered infested logs with plastic tarps for 6 months. Inner bark temperature reached 50-60°C at the top of the logs, but only 30-40°C at the bottom. This method was not fully effective

Treatment

Chemical pressure impregnation. This will not be effective because of the presence of bark, the size and the moisture of the logs: chemical pressure impregnation requires wood surface clean from dirt and bark (as bark is impermeable to liquid chemicals), small wood thickness, and wood moisture below 25-30%.

Cold treatment. Cold treatments of -25°C for seven days was completely effective in one experiment, and *P. juglandis* continued to emerge for 5 weeks in another (Sitz, 2013; Sitz et al., 2013). In both cases, recolonization was possible. Further research and data are needed before retaining this as a possible phytosanitary measure. It is also not known if cold treatment of wood can be used as a phytosanitary measure.

Insecticides. Insecticidal treatments were partly effective in controlling emergence in logs, and bifenthrin was the more effective (rather than carbaryl) (Sitz, 2013). Permethrin and biodiesel were also not fully effective (Peachey, 2012). This is consequently not a possible phytosanitary measure, but could be used to reduce populations on disposed wood.

Insecticide-impregnated nets. Consignments may be kept for some time under insecticide-impregnated nets (see 7.26) but this is not an approved phytosanitary treatment, and would require at least 8 months treatment. Other methods of isolation are also considered in 7.26, but not considered as possible phytosanitary treatments.

Irradiation. According to *EPPO Standard PM 10/8(1) Disinfestation of wood with ionizing radiation*, insects infesting wood (including Scolytidae) are killed after an irradiation of 1kGy. The effect on *G. morbida* is unknown, and this option has not been retained.

Kiln-drying. Kiln-drying aims at reducing the moisture content of the wood. There is no specific information on whether reducing the moisture content to a certain level will be effective to eliminate both *P. juglandis* and *G. morbida*. As this method is a common commercial method, further research would be interesting. (note: kiln-drying that fulfils the conditions of heat treatment (see Annex 7) is effective).

Submergence treatment. Alcohol and water soaks are used to prepare construction wood and their efficacy on *P. juglandis* and *G. morbida* was studied by Sitz (2013). Soaking logs in 70% ethanol for 8 days sanitized logs, but *P. juglandis* survived an 8-day water emergence (Sitz, 2013). This was not investigated for commercial-size trade.

Vapour steam treatment. This can be applied for subcortical fungal infections (Nicoletti et al., 2005). It is also apparently already used by the wood industry (Mayfield et al., 2014), but it is not known whether it is a fully effective method, and whether it could be used as a phytosanitary measure.