Pest risk assessment for the European Community: plant health: a comparative approach with case studies

Prima phacie

Pest Risk Assessment: Test Method 4*

June 2011

*Assuming risk reduction measures are not in place

Preface

Pest risk assessment provides the scientific basis for the overall management of pest risk. It involves identifying hazards and characterizing the risks associated with those hazards by estimating their probability of introduction and establishment as well as the severity of the consequences to crops and the wider environment.

Risk assessments are science-based evaluations. They are neither scientific research nor are they scientific manuscripts. The risk assessment forms a link between scientific data and decision makers and expresses risk in terms appropriate for decision makers.

Note

Risk assessors will find it useful to have a copy of ISPM 11, Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms (FAO, 2004)[1] and the EFSA guidance document on a harmonized framework for pest risk assessment (EFSA, 2010)[2] to hand as they read this document and conduct a pest risk assessment.

[1] ISPM No. 11 available at https://www.ippc.int/id/13399

[2] EFSA Journal 2010, **8**(2),1495-1561, Available at http://www.efsa.europa.eu/en/scdocs/doc/1495.pdf

CONTENTS

Supporting documentation

References

- Please see Annex 1 (separate file).

EU Outbreaks

- A map showing the location of *Anoplophora glabripennis* outbreaks within the EU as at January 2011; please see Annex 2 (separate file).

Quantitative spread models

- A detailed report modelling spread of *A. glabripennis* using a variety of quantitative models developed within EU project PRATIQUE and tested within the current project is provided as Annex 3; please see Annex 3 (separate file).

Uncertainties

- A list of uncertainties that have a bearing on determining risk is provided as Annex 4; please see Annex 4 (separate file).

Executive Summary

Provide a technical summary reflecting the content of the assessment (the questions addressed, the information evaluated, and the key issues which resulted in the conclusion)

The purpose of this pest risk assessment is to evaluate the plant health risk associated with *Anoplophora glabripennis* within the framework of EFSA funded project CFP/EFSA/PLH/2009/01 assuming that risk reduction measures are not in place. Comparing the results of this assessment with the results of an assessment where it is assumed that risk reduction measures are in place can be used to evaluate the effectiveness of risk reduction options.

Pest biology (see datasheet for details, Anderson *et al.,* 2010)

- Identity of the pest

  Anoplophora glabripennis (Motschulsky) (Coleoptera: Cerambycidae)

- Life history:

  In China adults emerge from host trees from April to October. They feed on leaves and twigs and live for approximately 1 to 10 weeks. After maturation feeding males and females locate each other and mate, stimulated by a combination of aggregation pheromones, visual cues and sex pheromones. Eggs are laid in slits chewed by females in the bark of the upper trunk and main branches of hosts. However, in young trees, e.g. *Acer* of 10 -15 years, oviposition may take place over the whole stem, excluding root collar and roots. After 1 or 2 weeks eggs hatch and larvae burrow into the cambial region before later moving into the heartwood of hosts. Larvae develop through several instars and most individuals overwinter as larvae which are freeze tolerant, e.g. US laboratory trials showed female larvae could recover from being kept at -40^{o}C for 24 hours and go on to develop, mature and successfully reproduce, when retuned to temperatures above 12^{o}C. Pupae develop in chambers within the wood and pupation occurs in late spring / early summer. Development varies according to temperature and within its native range in China, the life cycle is normally completed in one year, although in cooler regions it can take longer. In Toronto, Canada, development is reported to take up to three years. Optimum conditions for development occur around 23^{o}C although development can be completed between approximately 12 and 35^{o}C.

- Host range / habitat:

  Anoplophora glabripennis feeds and develops on a variety of hardwood trees, *Acer*, *Populus*, *Salix* and *Ulmus*, common across much of the EU, are particularly favoured hosts.

- Means of dispersal / spread:

  Although adults can fly, they tend to remain within a few hundred meters of their emergence site. However, as beetle density increases, they will disperse further and more quickly. Marked individuals have been recorded almost 3km from where they were first marked.

Geographic Distribution

Asia:	native to China and Korea
North America:	under eradication in both USA since 1996 and in Canada since 2003.
Europe	under eradication in Austria, France, Germany and Italy.

Stage 2: Pest risk assessment (outline)

Summary of risk elements

- Climate – host interaction:

Anoplophora glabripennis occurs in at least eight plant hardiness zones in China, ranging from zone 10 in the south where mean annual minimum temperature is from -1 to 5^{o}C, up to zone 2 or zone 3 in the north, where mean annual minimum temperature ranges from -45 to -35^{o}C. In the EU, there are eight hardiness zones, from zone 10 in the south to zone 3 in the north. Hosts occur across large parts of the EU. Cold winter temperatures are not likely to inhibit the distribution of *A. glabripennis* within the EU.

- Host range

Forests and other wooded areas occupy almost 40% of the total area of the EU. As a highly polyphagous pest of hardwood trees *A. glabripennis* would find many favoured hosts such as *Acer*, *Populus*, *Salix* and *Ulmus* occurring widely across the EU, sometimes as part of natural or managed woodland.

- Dispersal

Although adults can fly several hundred metres, they tend to remain fairly localized and do not spread far from the tree from which they emerged. In studies, the majority of adults do not disperse more than 350m. However, as population density increases adults disperse greater distances and can travel around 3km to locate a host tree.

- Potential consequences

Anoplophora glabripennis could cause significant damage to hardwood forestry in the EU, potentially killing trees within a few years, particularly where summers are warm and where forests are managed with wide spacing, are fragmented, and grown in monoculture with rows of trees.

- Environmental impact

There is little doubt that over time, *A. glabripennis* would be able to infest and subsequently destroy many hardwood trees, commonly found across Europe in the urban and suburban environment. This would result in landscape changes. The speed at which damage would materialise would depend upon the pests' population development which in turn will be determined by summer temperatures.

Introduction potential

Pathways : This assessment considered solid wood packaging material (SWPM) from Asia, with a particular focus on China, as the sole pathway for introduction.

- Potential for introduction

Past interceptions of *A. glabripennis* in Chinese SWPM provides evidence that the pathway is real. Whilst implementation of ISPM No. 15 does reduce the likelihood that wood boring pests, such as *A. glabripennis,* can be introduced into the EU from China, as long as some SWPM is transported to the EU either untreated or without effective treatment, the likelihood that SWPM can carry *A. glabripennis* into the EU at least once over the next few years remains high. Findings by Germany and Sweden in 2009 and 2010 support such conclusions.

Overall pest risk

There are a number of ongoing *A. glabripennis* outbreaks being dealt with by NPPOs in the EU. Without measures in place to inhibit further introductions, this assessment concludes that the likelihood that infested SWPM from China will carry *A. glabripennis* to the EU and lead to further introductions of the pest is high. Without phytosanitary intervention, introduced *A. glabripennis* will be able to infest and subsequently destroy many hardwood trees, commonly found across Europe in the urban and suburban environment, as well as in forestry. This will cause yield losses in forestry and have significant impact to amenity trees. The speed at which damage will materialise will depend upon the pests' population development which in turn will be determined by summer temperatures.

A Bayesian Belief Network (BBN) that combines individual risk elements is shown as Figure 0.1. The BBN suggests overall risk, "expected pest risk", shown on the right hand side of Figure 0.1, is mostly within a category "high", but is also somewhat "medium", with a very small amount "low". Exactly what high, medium and low means has not been defined.

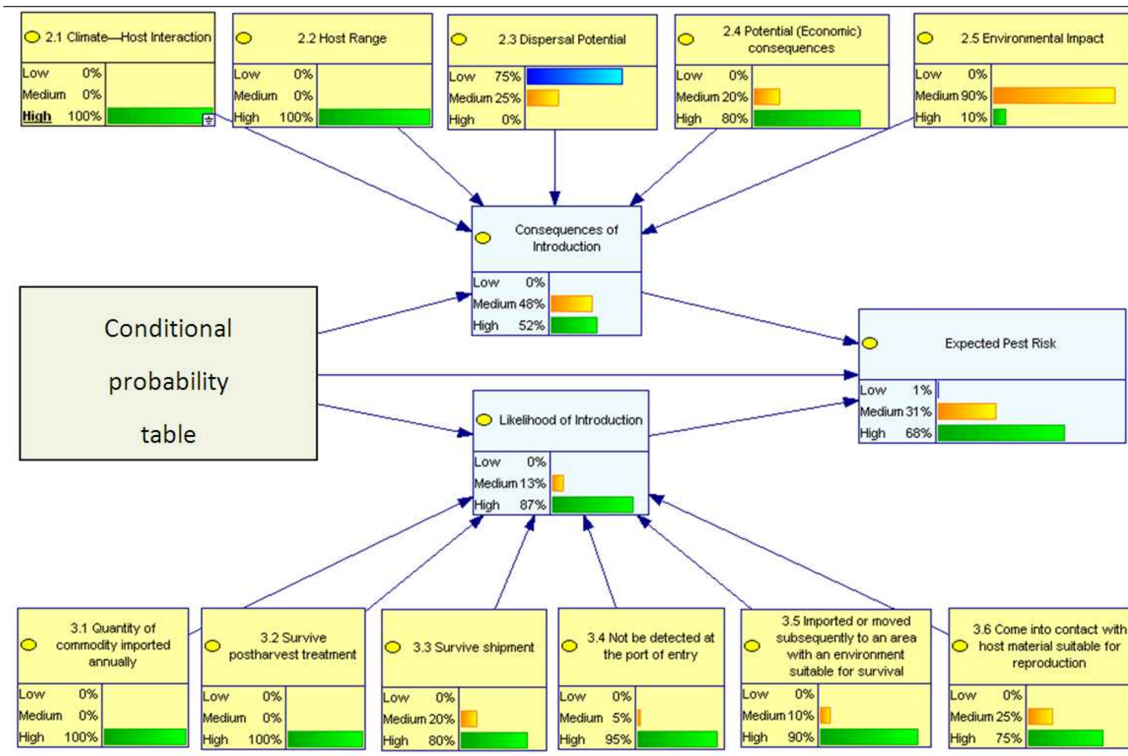


Figure 0.1: Graphical representation of combining consequences of introduction (2.1 to 2.5) with potential for introduction (3.0 to 3.6), using a BBN to determine an overall risk rating.

Conclusion

At present *Anoplophora glabripennis* satisfies the IPPC definition of a quarantine pest for the EU. Without intervention, the pest is highly likely to be introduced via SWPM from China. Hosts are widely available across the EU. The climate in southern and central Europe is suitable for development within one or two years. Further north development would take longer or may not be possible due to insufficient summer temperatures. Many hosts that are an important feature in urban and suburban landscapes, as well as in EU forestry could be killed by larvae feeding internally although impacts would vary across the EU. With no active measures to manage cerambycid beetles in broadleaved trees in the EU there is every prospect that *A. glabripennis* would eventually become a significant pest.

Keywords: *Anoplophora glabripennis,* solid wood packaging material, risk assessment.

Stage 1 – Initiation

1.1 Background and Initiation

Provide the background and terms of references as provided by the originator of the risk assessment request (European Commission, European Parliament, Member States, or EFSA)

The purpose of this assessment is to evaluate the plant health risk of *Anoplophora glabripennis* (Motschulsky) (Coleoptera: Cerambycidae) (Asian longhorn beetle) within the framework of EFSA funded project CFP/EFSA/PLH/2009/01 (Prima phacie).

The terms of reference are described in EFSA call CFP/EFSA/PLH/2009/01, Pest risk assessment for the European Community plant health: A comparative approach with case studies (EFSA, 2009). The text in Section 1.4 of the call, "Structure and essential requirements of the proposal", pages 7-9, provide the terms of reference e.g. that a systematic review of risk assessment methodologies, with emphasis on quantitative and semi-quantitative approaches, used in pest risk assessment to analyse and predict the likelihood of entry, establishment and spread, the potential negative consequences, the overall risk characterisation and the associated level of uncertainties be assessed, together with a systematic review of the methods used to assess the effectiveness of management options in reducing the risk of introduction and/or spread. The quantification of economic losses in monetary values and the assessment of potential effects on export markets, employment and tourism were not to be included.

Initiation Point

This assessment was initiated as a case study pest to be examined within EFSA project CFP/EFSA/PLH/2009/01 (Prima phacie). *Anoplophora glabripennis* had been selected as a case study pest because it satisfied a number of criteria needed to provide a range of contrasting pest examples for consideration in the project (see report of kick-off meeting, (MacLeod, 2010)).

1.2 Identification of the PRA Area

The PRA area is the 27 Members of the EU with focus on the continental European area, specifically excluding the ultra-peripheral regions, i.e. the French overseas departments, Spanish Canary Isles and Portuguese Azores and Madeira.

1.3 Available pertinent regulatory information

Previous PRA?

There is a previous analysis of pest risk from *A. glabripennis* to hardwood trees in the European Community by MacLeod *et al*., (2002). The published assessment is based on findings in MacLeod (1997). The NPPO of Canada produced a risk assessment in 2004 (CFIA, 2004). Since the analysis by MacLeod *et al.*, there has been many scientific papers published about *A. glabripennis* and the analysis was considered out of date.

MacLeod A (1997): Pest risk Analysis for *Anoplophora glabripennis* (Motschulsky). Proposal for addition to the EPPO A1 list of quarantine pests.

http://www.eppo.org/QUARANTINE/Pest_Risk_Analysis/PRA_documents.htm

Available Pest Fact Sheets/ Pest Alerts etc.
A pest factsheet for *A. glabripennis* was prepared as part of the Prima phacie 1st interim report (July 2010). The datasheet is available on the EFSA extranet.

As a harmful organism with known quarantine pest status there are a number of pest factsheets available via websites (Table 1.1).

Table 1.1: Examples of pest factsheets available for *Anoplophora glabripennis*

Year	Details	Source
1999	EPPO Data sheets on quarantine pests: *Anoplophora glabripennis* http://www.eppo.org/QUARANTINE/insects/Anoplophora_glabripennis/ANOLGL_ds.pdf	EPPO
2008	USDA Pest Alert: Asian longhorned beetle (*Anoplophora glabripennis*) http://www.na.fs.fed.us/pubs/palerts/alb/alb_pa.pdf	USDA
2009	Plant pest fact sheet *Anoplophora glabripennis* (Motschulsky) Asian long-horned beetle http://www.inspection.gc.ca/english/plaveg/pestrava/anogla/tech/anoglae.shtml	CFIA
2009	Datasheet: *Anoplophora glabripennis* (Asian longhorned beetle) http://www.cabi.org/cpc/default.aspx?LoadModule=datasheet&dsID=5557&CompID=1&site=161&page=868	CABI
	Centre for Invasive Species and Ecosystem health, Asian long-horned beetle http://www.invasive.org/species/subject.cfm?sub=2178	University of Georgia
2010	EFSA project CFP/EFSA/PLH/2009/01 Interim Report Annex 1b	Prima phacie

Current regulatory status
What is the pest's status in the Plant Health Directive (Council Directive 2000/29/EC[3]) ?

European emergency legislation against *A. glabripennis* was first published in 1999 (Anon., 1999). Subsequently *Anoplophora glabripennis* was listed in Annex I/AI of the Plant Health Directive. Thus *A. glabripennis* is officially recognised as a harmful organism not known to occur in any part of the community and relevant for the entire community and whose introduction into, and spread within, all member states shall be banned. However, given that *A. glabripennis* may have been present in the EU since 2000, and action against outbreaks is ongoing, one could query whether *A. glabripennis* should be transferred into Annex I/AII.

What is the pest's status in the European and Mediterranean Plant Protection Organisation (EPPO)? (mark box) (www.eppo.org)

EPPO List:	A1 regulated pest list	X	A2 regulated pest list		Action list		Alert list	

[3] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0029:EN:NOT

Anoplophora glabripennis was added to the EPPO Alert List in November 1996 (EPPO, 1999) then added to the EPPO A1 list of pests recommended for regulation as quarantine pests in September 1999.

Given that *A. glabripennis* may have been present within the EPPO region (EU) since 2000, and action against outbreaks is ongoing, the transfer of *A. glabripennis* from EPPO A1 to EPPO A2 list could be considered.

1.4 Strategy of data searching (*identity of data bases, data banks and information systems, key search terms and strategies applied, and the time period covered should be provided*)

Information from systematic literature reviews conducted previously for this project were drawn upon to provide support for judgements made in this assessment. (Prima phacie Interim Report No. 1, Annex 4b, WP2: Systematic literature review to support the assessment of risk for *Anoplophora glabripennis*; Prima phacie Interim Report No. 1 Annex 5b, WP3: Systematic literature review to evaluate risk management options for *Anoplophora glabripennis*). A pest datasheet drafted for this project was also used heavily. (Prima phacie Interim Report No. 1, Annex 1b, datasheet for Prima phacie case study pest: *Anoplophora glabripennis*).

Additional information searches were performed consulting several sources such as:

- Abstracting databases: e.g. AGRICOLA, CAB Abstracts, ISI Web of Knowledge
- Internet search machines: Google Scholar
- EPPO information systems: e.g. EPPO reporting service, EPPO PQR v 4.6
- Europhyt (for notifications of interceptions)
- Information from Member States on issues related to host distribution at a national level was acquired via a questionnaire prepared in the framework of the Prima Phacie project and distributed by EFSA to all NPPOs.
- References and information obtained from experts and from citations within other references.

Stage 2 - Pest Risk Assessment
(Outline approach)

This system for pest risk assessment involves evaluating six risk elements,

1. climate – host interaction
2. host range
3. dispersal
4. potential consequences
5. environmental impact
6. introduction potential

Each element is divided into three categories. Assessors review data / evidence and either select a single category or spread their judgment between categories. Guidance is provided to interpret the categories.

The last risk element "Introduction potential" is composed of six sub-elements, (i) quantity imported, (ii) survival of post harvest treatment, (iii) survival during shipping, (iv) likelihood of detection at entry, (v) likelihood of movement to suitable habitat, and (vi) likelihood of contact with host. Again allocate % likelihood to appropriate categories for each sub-element. Guidance is provided as to how sub-elements should be interpreted.

Pest risk is determined via use of BBN software based on matrices that combine consequences of introduction with introduction potential.

Having apportioned your assessment across categories for each risk element, record the scores in the associated Excel spread sheet (Method 4 Inputs.xls) and e-mail the spreadsheet to Willem Roelofs. Scores will be combined using BBN software. Results of combing the scores will be provided to risk assessors for interpretation.

Contact for queries regarding operation of this approach:

Willem Roelofs (willem.roelofs@fera.gsi.gov.uk)
Tel: +44(0)1904 462495

or

Alan MacLeod (alan.macleod@fera.gsi.gov.uk)
Tel: +44(0)1904 462350

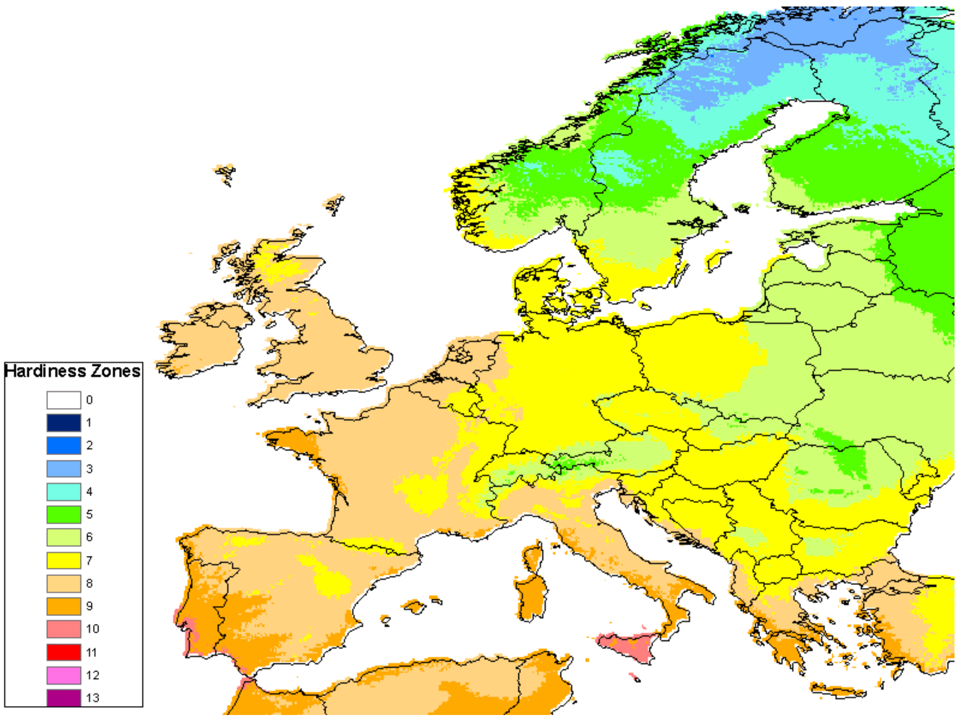
Stage 2 - Pest Risk Assessment

(Case study example)

2.1 Climate-Host Interaction

When introduced to new areas, pests can be expected to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of the pests and their biotic and abiotic environments are considered in this element. Estimates are based on availability of both host material and suitable climate conditions.

Due to the availability of suitable host plants and suitable climate, judge how many hardiness zones the pest has potential to establish a breeding colony in.



European Hardiness Zones updated by Magarey *et al*., (2008)

Examples of hardiness zone maps for other regions are available via the following link, http://treesandshrubs.about.com/od/treeshrubbasics/tp/worldhardinesszones.htm

Information / evidence: *Provide reasoning then give judgment.*
<u>*Anoplophora glabripennis* hosts</u>

Anoplophora glabripennis is highly polyphagous and can adapt to feed and develop on many tree species. In Asia, North America and Europe various species from many different families have been reported (Lingafelter & Hoebeke, 2002; Hérard *et al*., 2006; Sawyer 2008) (see also project pest datasheet). The main hosts include species from *Acer*, *Populus*, *Salix* and *Ulmus* (Lingafelter & Hoebeke, 2002; Wang 2004; Williams *et al.,* 2004; Haack 2006).

In the United States, *A. glabripennis* has completed development on species of *Acer, Aesculus, Albizia, Betula Cercidiphyllum, Fraxinus, Platanus, Populus, Salix, Sorbus* and *Ulmus* (Haack *et al*., 2006; Schröder 2007) with *Acer* being the most commonly infested genus followed by *Ulmus* and *Salix*. In Canada the complete development could be confirmed only on *Acer, Betula, Populus*, and *Salix*, with *Acer* again being the most commonly infested genus (Turgeon *et al.*, 2007).

Hosts in Europe

Forests and other wooded areas occupy almost 40% of the total area of the EU. Within Europe *Acer* species, especially *A. negundo*, *A. platanoides* and *A. pseudoplatanus*, as well as some *Populus* ssp., *Salix* ssp. and *Aesculus hippocastanum* are widely spread.

The complete development of *A. glabripennis* in Europe has been recorded on *Acer, Aesculus, Alnus, Betula, Carpinus, Fagus, Fraxinus, Platanus, Populus, Prunus, Salix* and *Sorbus* with *Acer* being the most commonly infested genus followed by *Betula, Salix, Aesculus* and *Populus* (Hérard *et al*. 2006; 2009).

In response to questionnaires distributed to the EFSA Network on Plant Health, some EU Member States provided descriptions or information on the distribution of the five major *A. glabripennis* European host genera grown in their country (Tables 2.1.1 to 2.1.5).

Table 2.1.1: EU MS replies to requests for information about *A. glabripennis* hosts
Host: *Acer* (sycamore / maples)

EU MS	Area (ha)	Notes
Austria		Widespread, especially across central Austria. See distribution maps at http://bfw.ac.at/700 /2092_1_15.html
Belgium	300	Data for the Flemish region only
Bulgaria		Occurs in all regions in gardens, parks, roadsides and native forest
Czech Republic	25,706	Area is based on estimate that 1% of total timber area is *Acer*
Denmark	20,000	Within forest area of DK
Estonia		A small percentage of the overall forest area. Spreads along the roads, landscaping, parks
Finland		In southern Finland, common (density = 50-100/km^2) In central Finland, rare (0-20/km^2)
France	168,000	
Italy		Occurs in all regions
Latvia		Occurs in all regions
Netherlands		Common tree in urban and suburban areas. Found along roadsides, in tree nurseries and mixed forests.
Poland		Occurs in all provinces
Slovenia	401,335	
United Kingdom		9.1% of urban trees
Sum	>615,341	Generally widespread in the EU

Table 2.1.2: EU MS replies to requests for information about *A. glabripennis* hosts Host: *Aesculus* (horse-chestnut)		
EU MS	**Area (ha)**	**Comments**
Austria	-	Widespread in urban areas. See distribution maps at http://bfw.ac.at/700 /2092_1_15.html
Belgium	-	No specific data
Bulgaria	-	Occurs across the country (gardens, parks, roadsides)
Czech Republic	-	No specific data
Denmark	-	No specific data
Estonia	-	Found only in parks, public green sites & home gardens
Finland	-	Only some individuals in southern Finland
France	-	Grown for ornamental purposes only
Italy	-	Occurs in all regions
Latvia	-	Occurs in all regions in parks & gardens etc.
Netherlands	-	Common tree in urban and suburban areas. Found along roads and at tree nurseries
Poland	-	Occurs in all provinces
Slovenia	311	Widely distributed in Slovenia
UK	-	0.4% of urban trees
Sum	>311	Generally widespread in the EU though few detailed statistics are available

Table 2.1.3: EU MS replies to requests for information about *A.glabripennis* hosts Host: *Betula* (birch)		
EU MS	**Area (ha)**	**Comments**
Austria		Widespread but mainly occurs in southern and northern Austria. Less common in the west. See distribution maps at http://bfw.ac.at/700 /2092_1_15.html
Belgium	4,100	Data for the Flemish region only
Bulgaria	-	Occurs in all regions (gardens, parks)
Czech Republic	73,764	ha- area of forest stands
Denmark		
Estonia	669,000	
Finland	-	Very common in the whole country
France	299,000	
Italy	-	Occurs in all regions
Latvia	855,471	It is widely distributed in the forest lands. It is a significant species for Latvian forestry.
Netherlands	22,000	Estimated forest area, Also common in urban and suburban areas, also tree nurseries.
Poland		Occurs in all provinces (voivodeship)
Slovenia	7,354	Widely distributed in Slovenia
UK		5.0% of urban trees
Sum	>1,930,689	Generally widespread in the EU, can be a major part of forestry

Table 2.1.4: EU MS replies to requests for information about *A. glabripennis* hosts Host: *Populus* (poplar)		
EU MS	**Area (ha)**	**Comments**
Austria		Occurs in eastern Austria (Niederösterreich). See distribution maps at http://bfw.ac.at/700 /2092_1_15.html
Belgium	21,000	Data for the Flemish region only
Bulgaria		All country(gardens, parks, roadsides, plantation)
Czech Republic	12,853	Estimated as 0.5 % of forest area
Estonia	117,000	
Finland		Very common in the whole country
Italy		All the regions
Latvia	122,173	It is widely distributed in the forest lands. It is significant species for the Latvian forestry.
Malta		Sparse and present along the bank of watercourses
Netherlands	(25,000)	*Populus* & *Salix* combined grow in 25,000 ha of NL forestry. Also common tree in urban and suburban areas. Tree nurseries. Along roads.
Poland		Occurs in all Provinces (voivodeship)
Slovenia	12,141	Widely distributed in Slovenia
UK		0.8% of urban trees
	> 310,167	Generally widespread in the EU

Table 2.1.5: EU MS replies to requests for information about *A. glabripennis* hosts Host: *Salix* (willow)		
EU MS	**Area (ha)**	**Comments**
Austria		Occurs widely but less so in the west. See distribution maps at http://bfw.ac.at/700 /2092_1_15.html
Belgium	1,500	Data for the Flemish region only
Bulgaria		All country (gardens, parks, roadsides, native forest, plantation)
Czech republic		data is unavailable
Estonia		A small percentage of the overall forest area. Found along roadsides, public green sites
Finland		Very common in the whole country
France	113,000	
Italy		Occurs in all regions
Latvia		In all territory of the Latvia. It is distributed more as shrub. Some of his forms are using in ornamental planting.
Malta		Sparse and present along the bank of watercourses
Netherlands		Common tree in urban and suburban areas. Tree nurseries. Along roads. forests
Poland		all voivodeship
Slovenia	187	Widely distributed in Slovenia
UK		3.0% of urban trees
	>114,687	Generally widespread in the EU

Summarising the data in Tables 2.1.1 to 2.1.5, it should be noted that *Acer* spp. can be found to a large extent in Slovenia and France. Elsewhere, although no statistics are available, the genus is a common tree in urban and suburban areas, along roadsides and in mixed woodlands. Few EU countries collect statistics for *Aesculus*. Large areas of *Betula* spp. can be found in Baltic nations, where it is an important tree of forestry. Elsewhere it is a common tree in the urban environment. *Populus* occurs widely across the EU where it is both a tree used in forestry and for amenity planting. Finally few EU countries collect data for *Salix* although in France over 100,000 ha are grown.

Figures 1(i) to 1(vi) are maps showing the natural range of some *A. glabripennis Populus, Salix, Acer* and *Betula* hosts.

Figure 1(i): The natural range of *Populus nigra* in Eurasia and Africa

(Source: originally from Vanden Broeck, 2003)

Figure 1 (ii) Natural range of *Populus alba* in Eurasia and Africa.

(Source: Originally from Fenaroli & Gambi, 1976

http://www.fao.org/forestry/16776-0ab7845f6d9a878ce701ecb2cd0866e6e.pdf

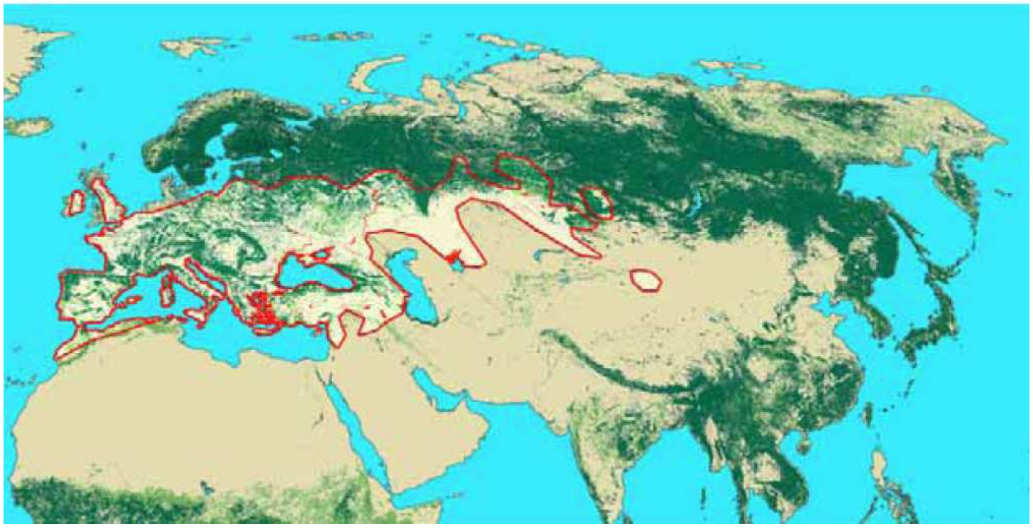


Figure 1 (iii) Natural range of *Salix alba* in Eurasia and Africa.

(Source: Originally from Skvortsov, 1999)

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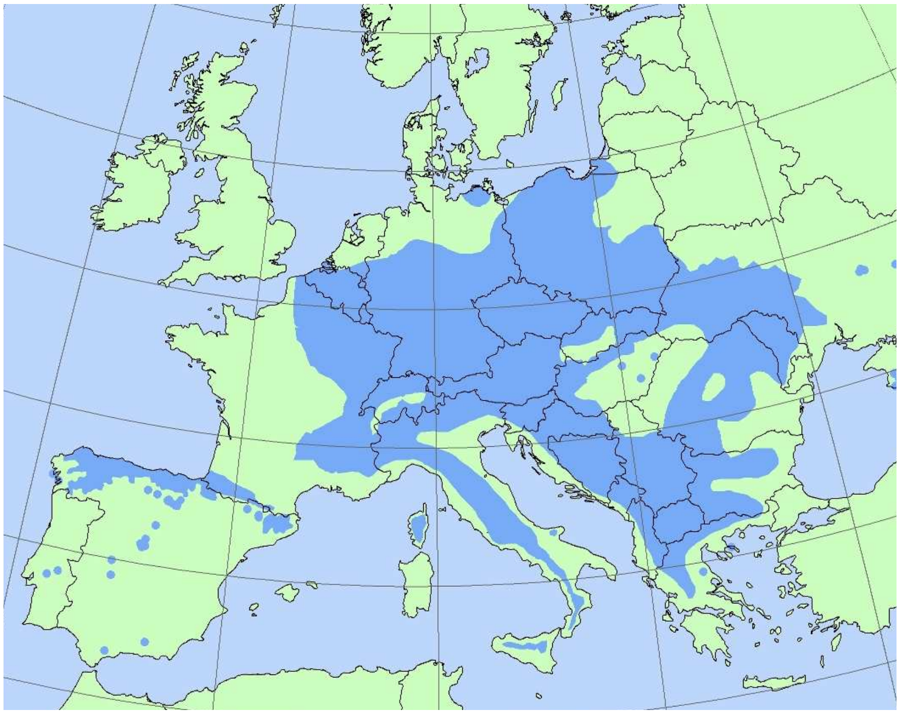

Figure 1 (iv) *Acer pseudoplatanus*

(Source: http://www.euforgen.org/distribution_maps.html)

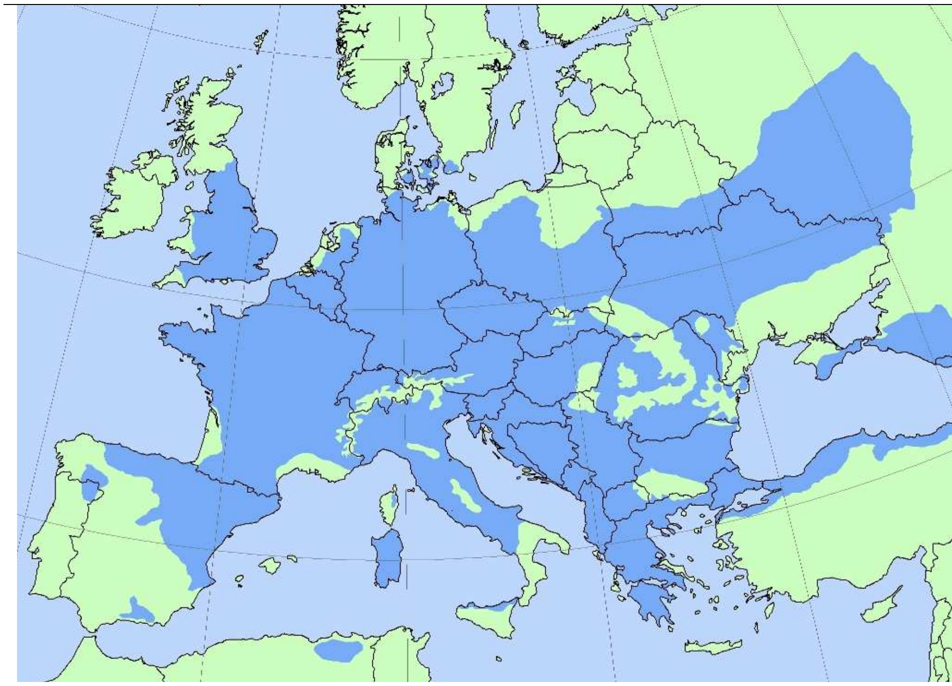

Figure 1 (v) *Acer campestre* (Source: http://www.euforgen.org/distribution_maps.html)

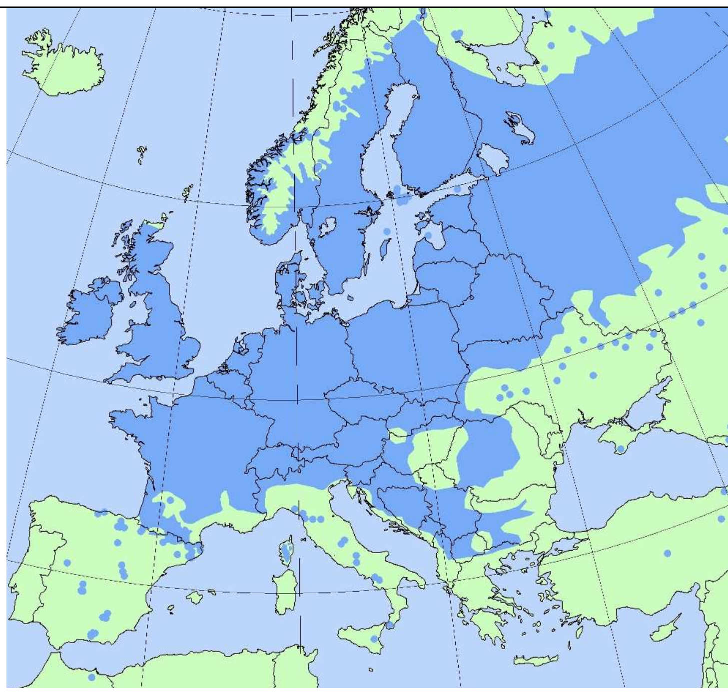

Figure 1 (vi) *Betula pendula* (Source: http://www.euforgen.org/distribution_maps.html)

Conclusion (hosts):

Anoplophora glabripennis is highly polyphagous and its major hosts are present in many European countries. Hosts occur widely in urban and natural environments. Some hosts are grown across large areas for forestry or to a lesser extent within mixed and natural forests.

Climatic suitability

Anoplophora glabripennis is a common pest in many parts of China, where *Salix* (willow), *Ulmus* (elms) and *Acer* (maples) occur (Gao & Li, 2001). Yan (1985) reported *A. glabripennis from* four climate zones of China, (i) the warm temperate zone, (ii) the cool temperate zone, (iii) the arid temperate zone, (iv) a transitional zone between the tropical zone to the south and the warm temperate zone to the north (Yan, 1985). However, since 1985, A. glabripennis has been found further north, further south and further west in China (Fig. 2).

Figure 2 shows the distribution of *A. glabripennis* in China. Figure 3 is a USDA hardiness zone map for China (note that hardiness zones are different from the climate zones referred to by Yan (1985)).

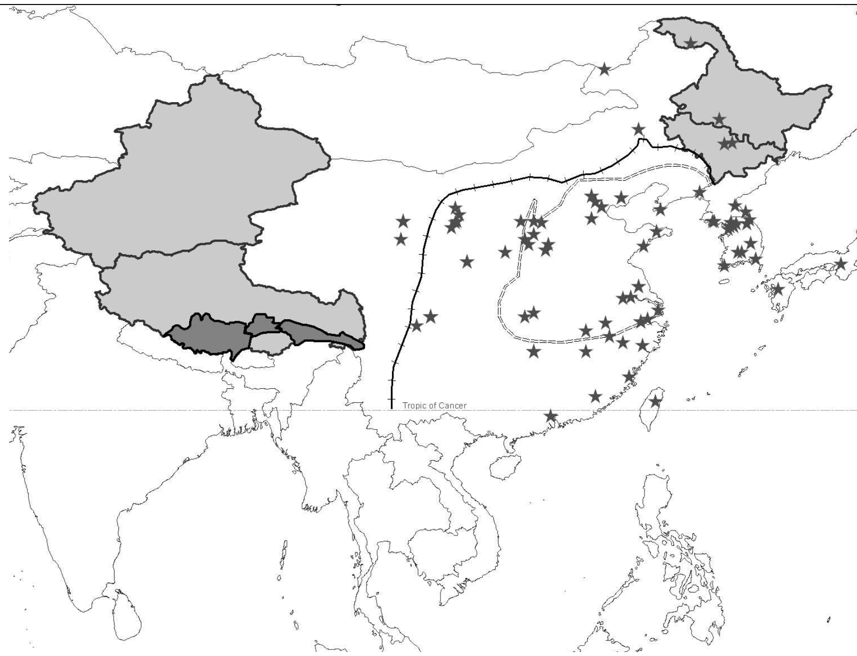

Figure 2: Distribution of *A. glabripennis* in China 2010 (updates MacLeod *et al*., 2002). Stars mark locations where *A. glabripennis* specimens were taken as reported in Lingafelter & Hoebke (2002); Haack *et al*., (2010) report *A. glabripennis* in western China (Chinese Provinces of Xinjiang & Xizang - light grey shading) and north eastern China (Heilongjiang, Jilin). *A. glabripennis* was reported in southern Tibet for the first time by Wang *et al.* (2003).

In China *A. glabripennis* requires 1 to 2 years to develop from egg to adult, the overwintering stage is usually the larvae, but rarely eggs and pupa can be found as overwintering stages (Li & Wu, 1993; Haack *et al*., 2006). The number of generations per year may vary as a function to local climatic conditions and a significant correlation has been found with latitude (Li & Wu, 1993). The type of host can have an effect on duration of development as well. The initiation of adult emergence is influenced by accumulated annual temperatures (Zhao & Yoshida, 1999). Yang *et al.* (2002) and Zhang *et al*. (1995) reported that 1,264 degree-days (DD) above a threshold of 13.4 ℃ was needed under field conditions for complete development. In China adults emerge from trees and are present in the field from April/May to October.

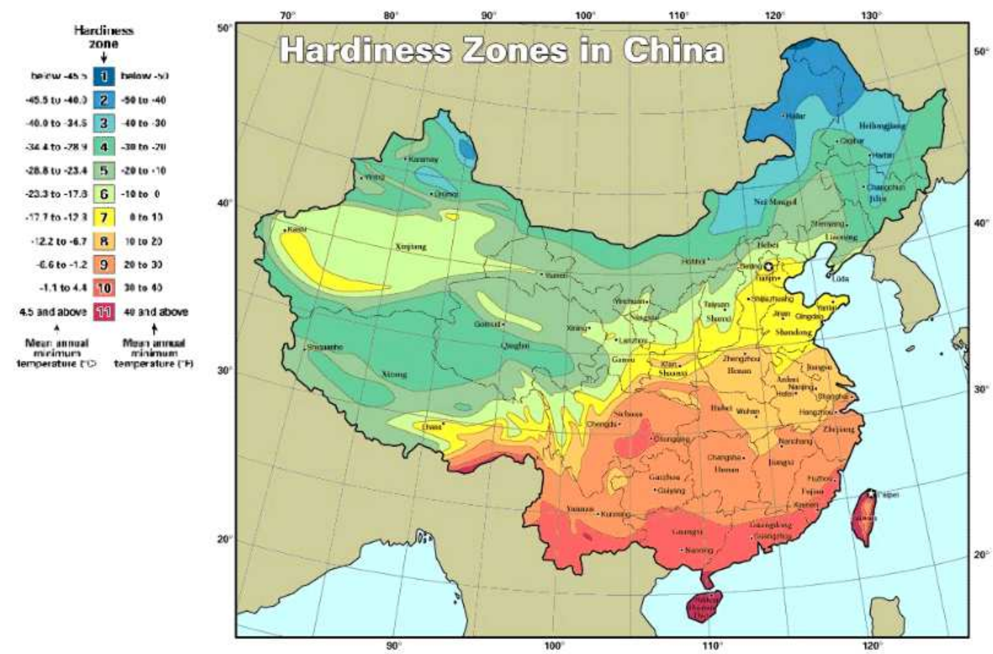

Figure 3: Hardiness zones in China
Source: http://www.ars.usda.gov/Main/docs.htm?docid=9815&page=2

Overlaying the distribution of *A. glabripennis* in China in Figure 2 with the hardiness zones in Figure 3, it can be seen that *A. glabripennis* occurs in hardiness zones from zone 10 in the south, where mean annual minimum temperature is from -1 to 5^{o}C (30 to 40^{o}F), to zone 2 or zone 3 in the north, where mean annual minimum temperature ranges from -45 to -35^{o}C (-50 to -30^{o}F (Figure 4).

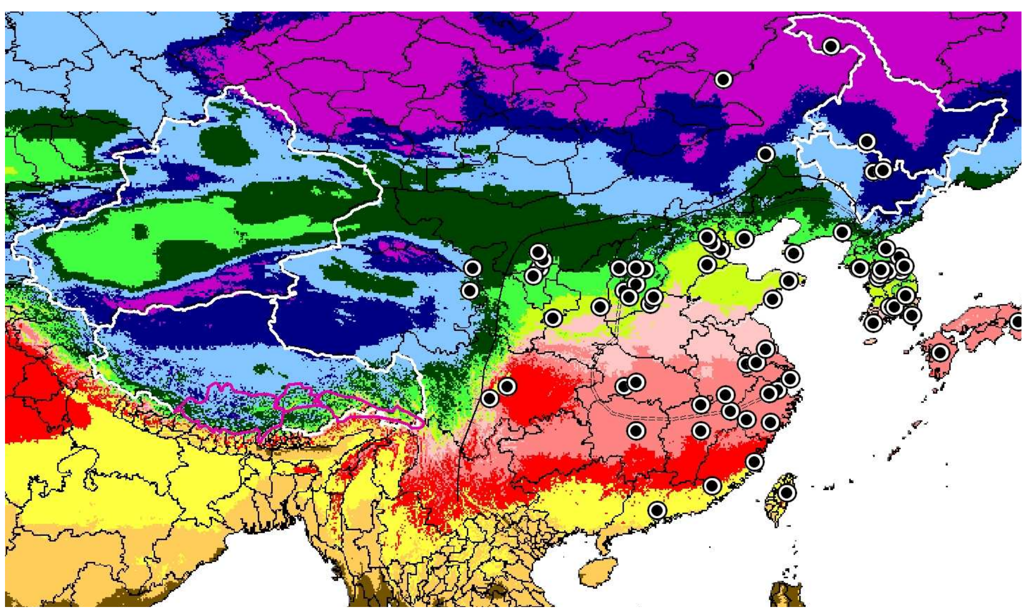

Figure 4: *Anoplophora glabripennis* finds in relation to hardiness zones in Asia.

The hardiness zone map for Europe (Fig. 5) shows that zones 10 to 3 occur in the EU. However, whether *A. glabripennis* hosts grow in zones 3 and 4 in the EU are not known. Hosts certainly occur in zones 5 to 10.

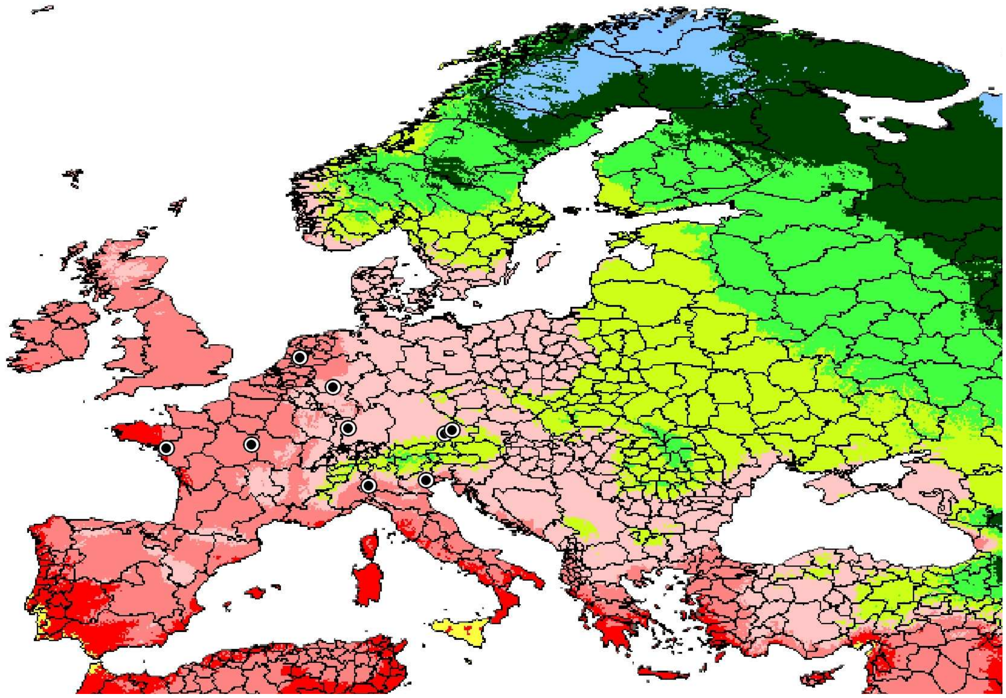

Figure 5: Hardiness zone map for Europe (Colour code as Figure 4, from Red (zone 10), to blue (zone 3) . *Anoplophora glabripennis* outbreaks are marked.

Conclusion (climate – host interaction):

Based on hardiness zones and host distribution, it can be concluded that *A. glabripennis* could establish a breeding colony in at least 6 hardiness zones within the EU.

2.1: Climate host interaction		
Rating	**Description**	**Probability Assignment [1]**
High	in four or more EU plant hardiness zones.	100%
Medium	in two or three EU plant hardiness zones.	0%
Low	in a single EU plant hardiness zone.	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

2.2 Host Range

The risk posed by a plant pest depends on both its ability to establish a viable, reproductive population and its potential for causing plant damage. For arthropods, risk is assumed to be correlated positively with host range. For pathogens, risk is more complex and is assumed to depend on host range, aggressiveness, virulence and pathogenicity; for simplicity, risk is rated as a function of host range.

Information / evidence: Provide reasoning then give judgment
As noted in 2.1 above, *A glabripennis* is highly polyphagous and feeds on various species from several plant families (Lingafelter & Hoebeke, 2002; Hérard *et al*., 2006; Sawyer 2008) (see also project pest datasheet). The main hosts include *Acer* (Aceraceae), *Populus*, *Salix* (Salicaceae) and *Ulmus* (Ulmaceae) (Lingafelter & Hoebeke, 2002; Wang 2004; Williams *et al.,* 2004; Haack 2006).

2.2: Host range		
Rating	**Description**	**Probability Assignment** [1]
High	Pest attacks multiple species among multiple plant families.	100%
Medium	Pest attacks multiple species within a single plant family.	0%
Low	Pest attacks a single species or multiple species within a single genus.	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

2.3 Dispersal potential

A pest may disperse after introduction to a new area. The following items should be considered:

- *reproductive patterns of the pest (e.g., voltinism, biotic potential)*
- *inherent powers of movement*
- *factors facilitating dispersal (wind, water, presence of vectors, human, etc.)*

Information / evidence: Provide reasoning then give judgment

Reproductive pattern
Anoplophora glabripennis requires 1 to 2 years to develop from egg to adult. The number of generations per year or the number of years to complete a life circle, respectively, is dependent on the climatic and geographic conditions and on the type of host. It has been estimated that in China about 80% of the individuals complete their life circle in one year and about 20% need two years. The adult females undergo a period of maturation feeding before copulation. This period lasts about 9 – 15 days as has been estimated by laboratory studies (Smith *et al*., 2002; Keena, 2002). Both sexes mate repeatedly and with different partners (Morewood *et al*., 2004). The average number of eggs laid by the females is 25 – 40 under natural conditions in China (Li & Wu, 1993). Under laboratory conditions the highest average number of eggs was 66.8 eggs per female at 25 ℃. I n the USA it is estimated that fecundity may vary in the range of 30 - 178 eggs per female (Keena, 2002; 2006) and is related with beetle size and age. In addition fecundity is strongly affected by the host tree and female food (Smith et al., 2002). For copulation *A.glabripennis* uses short distance pheromones to

find suitable partners (He & Huang, 1993; Zhang et al., 2002; Zhao & Yoshida, 1999). In 2003 a shortened life cycle of 1.5 years in Germany and elsewhere in Europe was reported due to the hot summer temperatures (T. Schröder, personal comm.). It is expected that a small number of beetles is sufficient to start a new population.

Inherent power of movement

Dispersal and spread is described in detail in the associated project datasheet. However, the following are key points:

A. glabripennis is polyphagous but usually stays on the tree from which it emerged. Adults move in response to the number of beetles present on the tree. The increasing abundance of beetles increases migration from a tree, but only short distance dispersal (Bancroft, 2005).

Adult beetles are capable of flying several hundred meters or more in a single flight to locate host trees. The average annual population dispersal distance measured by Wen *et al* . (1998) was 106.3 m, and this dispersal was positively correlated with wind velocity and temperature.

A. glabripennis tends to fly farther to find suitable host trees when no host trees are present in the surrounding area, whereas, when host trees are densely planted, little dispersal by adult *A. glabripennis* occurs (Huang, 1991).

The outbreak of *A. glabripennis,* first found in New York City, and the outbreak later found in New Jersey, are thought to have originated from the same point of entry where as outbreaks in Chicago and in Woodbridge (Canada) are thought not to have been caused by spread from the New York/ New Jersey outbreaks but instead resulted from new and separate entry events (Nowak *et al*., 2001). A study of the outbreak in New Jersey suggests that a low density introduction of *A. glabripennis* occurred and remained localized and undetected for many years and spread slowly until the beetle density on hosts became unsustainable at which time adults dispersed hundreds of meters to over 1 km (Sawyer, 2007).

Using mark–release–recapture methods, Smith *et al*., (2001) reported mean dispersal of 266m. Further mark–release–recapture studies demonstrated that, although 72% of beetles were recaptured within 300 m of release points, some beetles were recaptured up to 2,600 m away (Smith *et al*., 2004). Adults can disperse up to 3 km during their life span, although most remain near the tree where they emerged (Bancroft & Smith, 2005; Smith *et al.* 2001, Smith *et al.*, 2004). Spread / dispersal is positively associated with the abundance of beetles at origin (higher beetle density encourages dispersal) (Bancroft & Smith, 2005).

A detailed report modelling spread of *A. glabripennis* using a variety of quantitative models developed within EU project PRATIQUE and tested within the current project is provided as Annex 3 (separate file). Model output, in the form of a map produced by the most complex model, based on a dispersal kernel, is shown as Figure 6. The map considers spread over 30 years. A detailed explanation of the model and input parameters is provided in Annex 3.

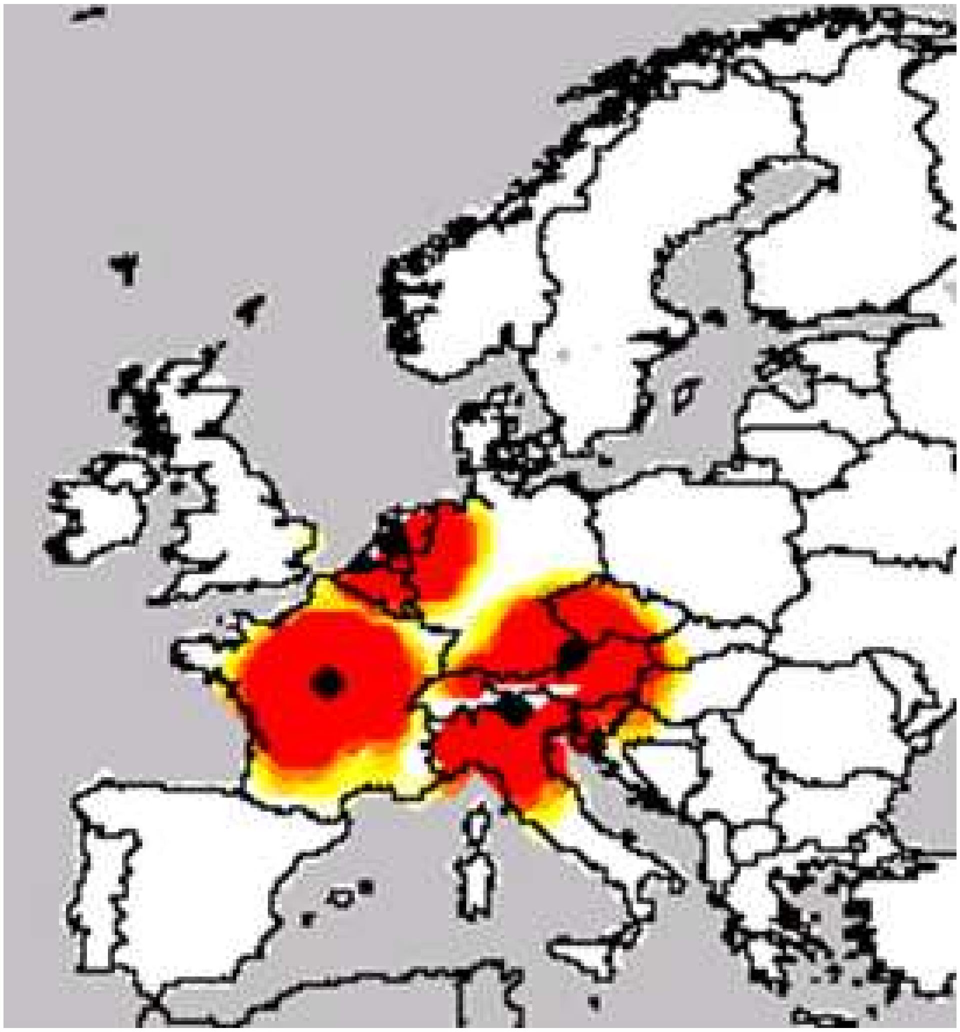

Figure 6: Output of a dispersal kernel model for *A. glabripennis* spreading from 4 outbreak sites over 30 years. See Annex 3 for details.
Colour represents % population abundance from white < 10^{-6} %, yellow, orange and red > 10%

Factors facilitating dispersal

Solid wood packing material (SWPM) such as pallets, are designed to be easily transported and moved with commercial transport vehicles. Observations in the USA suggest that beetles can be moved passively over large distances in/on transport vehicles when infested SWPM is moved (Sawyer, 2007). Infested SWPM could be carried hundreds of km across Europe in a few days via road, rail or air. However, based on the history of *A. glabripennis* spread in the USA, Canada and Europe, spread from outbreak sites via SWPM or infested firewood is not common but has been reported. In a scenario where there are no phytosanitary measures in place spread would likely be faster than that in North America or in Europe at present. Nowak *et al*. (2001) suggested infested firewood can be a means of spreading *A. glabripennis*, indeed *A. glabripennis* is suspected to have been spread by movement of infested firewood in Austria (Hoyer-Tomiczek *et al.,* 2005). In the USA an outbreak found near Amityville on Long Island, New York, is believed to have resulted from the movement of trees felled for firewood (Haack *et al.*, 1997), in Queens, Manhatten and Stanton and Prall's islands. Such spread would likely occur in the EU if there were no restrictions on the movement of infested wood.

2.3: Dispersal potential		
Rating	**Description**	**Probability Assignment** [1]
High	Pest has high biotic potential, e.g., many generations per year, many offspring per reproduction ("r-selected" species), AND evidence exists that the pest is capable of rapid dispersal , e.g., over 10 km/year under its own power; via natural forces, wind, water, vectors, etc., or human-assistance.	0%
Medium	Pest has either high reproductive potential OR the species is capable of rapid dispersal.	25%
Low	Pest has neither high reproductive potential nor rapid dispersal capability.	75%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

Conclusions
Dispersal is not rated "high" because *Anoplophora glabripennis* does not have both of the features that are required for it to rated in the high category, i.e. *A. glabripennis* does not have several generations per year, or many offspring per female and cannot spread over 10km per year naturally. However, dispersal over long distances via infested wood (SWPM or firewood) is possible but rare when the pest is officially controlled. In a scenario without controls in place spread via infested wood would not be so rare.

2.4 Potential Consequences

Introduced pests are capable of causing a variety of direct and indirect impacts. The remit of EFSA limits assessors to consider impacts on crop yield and quality (crop impacts) (2.4) and environmental impacts (see 2.5, next) e.g. impacts on ecosystem services or biodiversity itself. We recognise that other types of impacts, listed in ISPM 11, may occur.

Information / evidence: *Provide reasoning then give judgment*
Direct impacts on commercial forestry trees: Li & Wu (1993) recognised *A. glabripennis* as one of the most injurious longhorn beetles in China after reporting it causing very serious damage to *Populus* across China. Larval feeding destroys xylem and phloem, causing crown dieback and early senescence (leaves showing unseasonal yellowing) (Smith & Wu, 2008). In Germany Benker & Bögel (2006) noted that infested *Acer* showed less foliation compared to healthy ones. Eventually branches die and if a tree is infested with sufficient larvae it can be killed in 3 or more years. *Anoplophora glabripennis* "completely devastated" the man-made shelter-forest syestem (Luo *et al.*, 2003). Britton & Sun (2002) reported an estimate that one third of trees planted in the Sanbei belt project had been killed by *A. glabripennis*.

In China, poplar and other *A. glabripennis* hosts can be grown to produce timber. Timber standards in China divide wood into quality ranks according to the amount of bore holes in each 1m length of wood. The premium, 1st rank wood has no holes. The 2nd rank wood has 1 to 5 holes per m and the 3rd rank has more than 5 holes per metre. The value of timber decreases by 25% from 1st to 2nd rank. The difference in value between the 1st and 3rd rank wood is 46% (Gao *et al*., 1993). After dissecting wood from infested poplars, Gao *et al*. (1993) found that *A. glabripennis* could degrade 89% of the wood into 3rd grade. In Ningxia, one of the five most affected provinces, 50 million infested trees that were felled between winter 1991 and summer 1993 were so badly damaged that none of the wood from the trees could be sold. It was all burned causing estimated losses of US$ 37 million (Gao & Li, 2001; Hoebeke, 2007).

Anoplophora glabripennis only became a pest in China after the widespread planting of susceptible poplar and willow were used in reforestation projects across vast areas of China (Taketani, 2001). For example 20 million ha of *Populus* and *Salix* plantation were established in Sanbei. The impacts reported from timber crops in China are not likely to occur in Europe since large areas of hosts have not been planted in the same way as in China. Nevertheless, the EU has supported afforestation through Council Regulation EEC No. 2080/92 (for the years 1992-1999) and EC No. 1257/1999 (for the years 2000-2006), which has included the planting of poplar, as part of encouraging agricultural diversification. Between 1992 and 1997, over 519,300 ha of agricultural land was converted to forestry. Much of this (46%, approximately 238,900 ha) occurred in Spain. The United Kingdom, Ireland and Portugal strongly supported the diversification, converting more than 176,500 ha of farmland between them. The remaining EU Member States afforested almost 104,000 ha of agricultural land during this period. The species and types of trees planted varied between EU Member States. However, as a whole 40% was planted for conifers and 60% for broadleaf species, mixed plantations (over 75% of broadleaf) and fast-growing plantations (Sondag, 2000). Given that forests and other wooded areas occupy almost 40% of the total area of the EU, the extra planting driven by Council Regulations 2080/92 and 1257/1999 did not significantly increase the total forest area of the EU.

As a pest perhaps evolutionary adapted to "edge" habitats, there is some uncertainty as to the extent of damage that may be expected in commercial forestry. However, if forests are managed with wide spacing, fragmented, and grown in monoculture with rows of trees, then many "edges" are available to be exploited. In addition storms, ice- and snow damage have knocked down forest trees in recent years creating large areas with edges suitable for *A. glabripennis*. The speed at which damage will materialise will depend upon the pests' population development which in turn will be determined by summer temperatures.

There are currently little or no active measures to manage cerambycid beetles in broadleaved forestry trees in the EU (MacLeod *et al*., 2002). If there were no statutory phytosanitary intervention targeted against *A. glabripennis*, forest managers would probably not opt to establish controls until threats to timber yield and /or quality justified some intervention.

Table 2.4 has been completed with respect to anticipated impacts on forestry in the EU without statutory intervention.

2.4: Potential consequences		
Rating	**Description**	**Probability Assignment** [1]
High	The pest has a severe impact on the standing crop with significant host mortality; losses in storage may be total. Intervention by growers may not be possible or would be essential and expensive to counter yield and /or quality losses.	80%
Medium	The pest has a moderate impact on the standing crop but host mortality is rare; losses in storage may occur. Threat to yield and /or quality changes would justify some intervention by growers to reduce losses.	20%
Low	The pest is likely to have no or only minor impact on a standing crop and little effect on stored products. Yield and /or quality changes are within range of natural variation. No intervention is likely to be needed.	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

Although wood quality would be reduced by larval tunneling in infested wood, the greatest impact of *A. glabripennis* will probably be the potential environmental impact caused by damage to amenity (non-commercial) trees (see **2.5**, next section).

2.5 Environmental Impact

The assessment of the potential of a pest to cause environmental damage proceeds by considering the following four factors:

1. *Introduction of the pest is expected to cause significant, direct environmental impacts, e.g., ecological disruptions, reduced biodiversity.*
2. *Pest is expected to have direct impacts on endangered/threatened species listed by infesting/infecting a listed plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host.*
3. *Pest is expected to have indirect impacts on species that are listed in Annex II or IV of the EC Habitats Directive*[4] *or are key components of habitats listed in Annex I of the EC Habitats Directive.*
4. *Introduction of the pest would stimulate chemical or biological control programs which will disrupt existing biological or integrated systems for control of other pests or to have negative effects on the environment e.g. biodiversity (at various levels), reduce population sizes, or increase their fragmentation.*

Information / evidence: *Provide reasoning then give judgment*
In China Ru *et al*. (1999) compared *A. glabripennis* damage in *Populus* trees situated in different habitats. Trees along roads, streets and around villages were the most frequently and most heavily attacked. In urban regions, branches falling from trees weakened by *A. glabripennis* pose a danger to pedestrians and vehicles.

In the USA and Canada, *A. glabripennis* is presently a pest of amenity trees in the urban environment. More recently a large outbreak has been reported in a heavily wooded area around Winchester MA (USA). Outbreaks in Europe have occurred primarily amongst street trees. Killing amenity trees in public green areas, ornamental trees in private gardens and amenity trees along roadsides would represent a significant, direct environmental impact, causing disruption to the wildlife connected to such trees. However, no threatened or endangered species or habitats are expected to be impacted by *A. glabripennis*. Some chemical control, such as soil injection with imidacloprid to protect trees against *A. glabripennis* attack may be implemented. In New York both soil and trunk injection with imodacloprid is used to treat all uninfested trees within 800 meter around infested trees. Although only a few products are available for use in the EU against *A. glabripennis*, tree injection trials with imadocloprid have been carried out in Europe but not used in practice (Schroder & Anderson, 2010). If chemical control options were used as part of non-statutory control there would be impacts on non-target invertebrates.

In North America and Europe there are ongoing efforts to contain and eradicate outbreaks of *A. glabripennis*. As such the impacts that would otherwise occur are not being allowed to materialize due to phytosanitary interventions. If left unchecked, *A. glabripennis* would be

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[4] Council Directive 92/43/EEC (as amended) on the Conservation of natural habitats and of wild fauns and flora. Available at
http://www.central2013.eu/fileadmin/user_upload/Downloads/Document_Centre/OP_Resources/HABITAT_DIRECTIVE_92-43-EEC.pdf

expected to be able to eventually kill many hardwood trees, commonly found along roadsides and in urban and suburban areas around areas where the pest is introduced. In the longer term *A. glabripennis* could spread and find suitable habitat across much of Europe, including within forestry.

In a scenario where *A. glabripennis* spreads uncontrolled and reaches natural forests, ecosystem services provided by the forests are likely to be impacted. Table 2.5 lists ecosystem services potentially impacted by *A. glabripennis* in Europe.

Table 2.5: Ecosystem services potentially impacted by *A. glabripennis* in Europe in a scenario where there is no statutory intervention to reduce spread

Ecosystem services • **Detail**	**Potential pest impact**
Provisioning services • Timber	Larval tunnelling lowers quantity of high grade (undamaged) timber and reduces quality of infested timber (noted within economic impacts).
• Fuelwood	*A. glabripennis* could actually increase amount of wood used for fuel as timber is down-graded for burning. No significant impact.
Regulating services • Regulation of water regimes	If many trees in a single location are destroyed there could be local disturbance to water regimes. Woods and forests slow rainwater flow by intercepting it on leaves, branches, and trunks. Some of the water will then evaporate into the atmosphere, some will soak into the ground. When trees in forests die or are removed, rain water is intercepted less; rainwater can compact the ground surface and reduce infiltration, increasing runoff causing soil erosion.
• Climate regulation	Killing large areas of trees reduces local water recycling by reducing evapotranspiration. This could reduce local humidity. Large forests dampen local temperature extremes by providing shade and surface cooling. They also act as insulators, blocking winds and trapping warmth by day, radiating it at night. In the short term, *A. glabripennis* is not expected to destroy sufficient numbers of trees to cause such disturbance.
• Controlling air pollution	Trees remove many pollutants from the atmosphere, including nitrogen dioxide, sulfur dioxide, ozone, carbon monoxide, and particulate matter of ten microns or less. If *A. glabripennis* destroys many trees in urban areas, where the trees are important in limiting air pollution, then local air quality may suffer.
Cultural services • Tourism	Forests provide a wide range of recreational opportunities, including ecotourism.
• Amenity values	*A. glabripennis* could reduce amenity values by killing local trees. Houses close to woods or forests can be more desirable and attract a premium. Impacts are likely to be minor.
• Cultural value	Forests have important cultural value to some people.

Impacts on cultural services can be considered “social impacts” which fall outside the scope of EFSA remit, hence should not be taken into account when assessing the magnitude of consequences

No evidence of *A. glabripennis* having impacts on biodiversity could be found. However, outside of China and Korea, *A. glabripennis* is regarded as a quarantine pest and measures are taken to prevent potential impacts. Once infested hosts are killed or cut down for safety reasons (rather than during a phytosanitary eradication programme) they could be replaced with non-host trees. The range of trees planted in woodland, forestry or even in urban environments would be reduced with potential significant consequences for local biodiversity. Where many trees are lost from local habitats there is bound to be consequences to biodiversity.

In summary, there would be at least one significant environmental impact caused by *A. glabripennis*, e.g. ecological disruption caused by widespread destruction of tree hosts in the environment (factor 1 above). Additional environmental impacts would depend upon the pest management strategies adopted to combat the pest as part of non-statutory efforts to control the pest. Although unlikely, this could include chemical control programs which will have negative effects on the environment e.g. biodiversity.

2.5: Environmental impacts		
Rating	**Description**	**Probability Assignment** [1]
High	Two or more of the above would occur.	10%
Medium	One of the above would occur.	90%
Low	None of the above would occur; it is assumed that introduction of a non-indigenous pest will have some environmental impact (by definition, introduction of a non-indigenous species affects biodiversity).	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

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Introduction Potential

3.0 List and describe the pathways for pest entry into the EU

For each pathway copy 3.1 to 3.6 and give responses by pathway

The EPPO Plant Quarantine information Retrieval system (PQR) (EPPO, 2007) lists two broad categories of commodity potentially able to carry *Anoplophora glabripennis*:

1. non-squared wood
2. deciduous woody plants

however, there is evidence that squared wood in the form of wooden pallets, wooden crates and wooden packing material, collectively termed solid wood packaging material (SWPM) has distributed *A. glabripennis* from China (Haack *et al.*, 2010). In a review of *A. glabripennis* and *A. chinensis*, Haack *et al*. (2010) compared 219 *Anoplophora* interceptions from 18 countries for the period 1980 to 2008. 96% of diagnoses from SWPM, often associated with imported tiles, quarry rocks, steel and ironware, were *A. glabripennis*, whereas 99% of diagnoses from live plants such as bonsai and nursery stock were *A. chinensis*. Regarding those interceptions where the country of origin was known, 97% of interceptions in SWPM came from China. Thus SWPM, specifically from China, is seen as the primary pathway to be assessed. A search of European notifications of interceptions up to September 2010 did not show that *A. glabripennis* had been intercepted on live deciduous woody plants and is not considered as a pathway.

<u>Pathway to be assessed</u>

Pathway 1. Solid wood packaging material (SWPM) typically used to convey heavy industrial goods such as quarried rocks, slates and tiles from China.

3.1 Quantity of commodity imported annually

Quantity of commodity imported annually: The likelihood that an exotic pest will be introduced depends on the amount of the potentially-infested commodity that is imported. For qualitative pest risk assessments, the amount of commodity imported is estimated in units of tonnes, or other metric such as standard 40 foot long shipping containers.

Information / evidence: *Provide reasoning then give judgment*

A great deal of material exported from China is transported on pallets that originate in China. Brindley (2010) quotes a senior executive of a pallet company operating in China saying “A lot of the export from China to the USA and Europe is palletized today but using one-way [pallets]” i.e. pallets are made and sent from China, rather than reusing pallets that carry good into China. An estimated 17-22% of Chinese imports to the USA are carried in, or on, solid wood packaging material which is capable of transporting *A. glabripennis* (APHIS, 1998b).

The World Shipping Council produces industry statistics summarising the movement of shipping containers used to convey goods around the world. Data is provided in the form of TEUs, (Twenty-foot Equivalent Units, the industry standard to measure containers). In 2007 there were 7.9 million TEUs shipped from China to the EU[5]. In terms of the movement of containers between regions, this route is the second largest, only trade between China and the US was bigger, at 9.4 million TEUs.

[5] http://www.worldshipping.org/about-the-industry/global-trade/trade-routes

There are over 400 shipping services providing regularly scheduled services (usually weekly) that enable goods to move between ports along the many trade routes of the world. 35 services operate between China and Northern Europe[5].

Estimates from the US suggest that approximately 50% of maritime shipments and 9% of air shipments use solid wood packing material (USDA APHIS & Forest Service, 2000). However, more recent discussion on SWPM amongst the International Forestry Quaratine Research Group (IFQRG), as well as during discussions in preparation of revision of ISPM 15, has led the estimate of SWPM being associated with containers being raised to more than 80%. Thus the 50% published estimate seems to be rather low.

There is no reason to suggest such a proportion would differ for trade into the EU. Thus in the order of approximately 4 million shipping containers containing solid wood packing material could be expected to arrive in the EU annually from China.

3.1 Quantity of annual imports (Examples provided for tonnes and containers, other units can be used)			
Rating	**Tonnes imported into PRA area (per year)**	**Number of containers (per year)**	**Probability Assignment [1]**
High	> 1,000,000	>100 containers	100%
Medium	100 -1,000,000	10 - 100 containers	0%
Low	< 100	< 10 containers	0%
		Check sum =	100%

[1] spread your judgment according to your belief / evidence

3.2 Survive postharvest treatment:

For this sub-element, postharvest treatment refers to any manipulation, handling or specific phytosanitary treatment to which the commodity is subjected. Examples of postharvest treatments include culling, washing, chemical treatment, cold storage, etc. If there is no postharvest treatment, estimate the likelihood of this sub-element as High.

Information / evidence: *Provide reasoning then give judgment*

Solid wood packaging material is often made using wood from poplar trees (*Populus* spp.) because poplar grow relatively quickly and produce timber suitable for the manufacture of pallets, boxes, crates and dunnage, collectively termed solid wood packaging material (Heilman, 1999). *Anoplophora glabripennis* became a significant pest following the widespread planting of *Populus* and *Salix* in China. It is now a common pest in many parts of China, where *Ulmus* (elms) and *Acer* (maples) are also attacked (Gao & Li, 2001). Adults can be so abundant that in "*almost every locality every poplar tree was seriously injured*" (Gao *et al*., 1993). Britton & Sun (2002) reported that unpublished Chinese State Forestry statistics estimated that one third of trees planted in the Sanbei belt project had been killed by *A. glabripennis*. The key provinces where most *A. glabripennis* damage occurred was in Shaanxi, Gansu, Shanxi, Ningxia, and Inner Mongolia with *A. glabripennis* occupying approximately 330,000 ha in 1994 (Luo et al., 2003).

Since the introduction of *A. glabripennis* into North America and *Bursaphelenchus xylophilus* (pine wood nematode) into Europe, solid wood packaging material has been seen as a pathway through which quarantine pests and invasive species could be spread. Subsequently the IPPC developed guidelines to sanitize solid wood packing. The guidance was published as an international standard, ISPM No. 15, (IPPC, 2002; revised April 2009). ISPM 15 recommends that all international freight shipments using any wood packaging must be fumigated or heat treated (e.g. core wood reaches 56^{o}C for 30 minutes), prior to international shipping, to mitigate the risk of spreading plant pests. Once treated, wood packing is stamped with an approved IPPC stamp (Figure 7). Freight shipments that contain wood-packing materials can be checked in respect of compliance with ISPM 15 before being allowed to enter, or cross through, an IPPC country that has implemented ISPM 15 guidelines.

a) b)

Figure 7: (a) Design of the stamp used to mark solid wood packing material that has been treated to ISPM 15 standards. (b) what the stamp may look like in practice.
Source: http://internationalshippingusa.com/ISPM_15_Rules.aspx

Heat treatment or fumigation, if applied in the correct way, should ensure freedom from live *A. glabripennis*. However, as noted in the Executive summary, this assessment considers a scenario where there is no such risk reduction measure in place. Thus, it is assumed that SWPM is not treated and management practices do not reduce the likelihood of larval survival on the pathway.

Conclusions
In a scenario where there was no treatment of SWPM, the proportion of larvae surviving would not be reduced. Note that findings of live larvae in SWPM prior to the implementation of ISPM No. 15 supports such a conclusion (Table 3.4).

3.2: Likelihood of surviving post harvest treatments		
Rating	**Description** (likelihood of survival is ....)	**Probability Assignment** [1]
High	> 10% (greater than one in ten survive)	100%
Medium	Between 0.1% - 10% (between one in one thousand to one in ten survive)	0%
Low	< 0.1% (less than one in one thousand survive)	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

3.3 Survive shipment

Estimate survival during shipment; assume standard shipping conditions.

Information / evidence: *Provide reasoning then give judgment*
Broadly, four modes of transport could be used to convey goods using solid wood packing material from China to Europe.

(i) By sea - mainly container ships
(ii) By air - cargo and passenger planes carrying palletized goods
(iii) By road - mainly articulated vehicles (lorries / trucks)
(iv) By rail - trains via railways

90% of the world's trade is moved by sea (IMO, 2009). Interceptions of *A. glabripennis* have generally been associated with wood packaging material carrying imports such as steel, ironware, tiles, and quarry products. Such goods are very unlikely to be transported using airfreight, trucks or rail from China to Europe.

Focussing on sea transport, Figure 8a shows the primary global maritime routes. Figure 8b shows mean annual temperatures at sea level. Clearly the major shipping routes from China to Europe take ships through tropical seas with annual mean air temperatures around 20^{o}C. There is no need for the heavy industrial goods and quarry material (the type of goods on which previous interceptions have occurred) to be carried in temperature controlled conditions.

Zhao *et al.* (1993) studied mortality factors for each life of *A. glabripennis* in two species of growing *Populus*. The key mortality factors were natural enemies, mechanical damage, and low temperature. The early larval stages were the most vulnerable stage in the life cycle, suffering between 38 and 46% mortality. Egg mortality was 10 to 14%, mortality amongst later larvae was 25 to 41%, pupal mortality was 4%. Given that during transport larvae are inside a container on board a ship and inside the wood of solid packing material, larvae will be very well protected from natural enemies and low temperatures. However some larval mortality would still be expected. Those that do not die would be expected to continue to develop assuming larvae experience ambient temperatures during transport.

Detailed information about the life cycle and time taken for development of *A. glabripennis* eggs, larvae and pupae is available in the project datasheet. At constant temperatures of around 18^{o}C most larvae will take approximately 20 weeks to mature; at 25^{o}C most larvae will take approximately 11 weeks to mature (Keena & Moore, 2010).

Container ships take around two to four weeks to travel between the major container handling ports of China (Shanghai, Hong Kong, Shenzen, Guangzhou, Qingdao, Tianjin) and Europe (Rotterdam, Antwerp, Hamburg, Bremerhaven, Valencia, Felixstowe)[6,7]

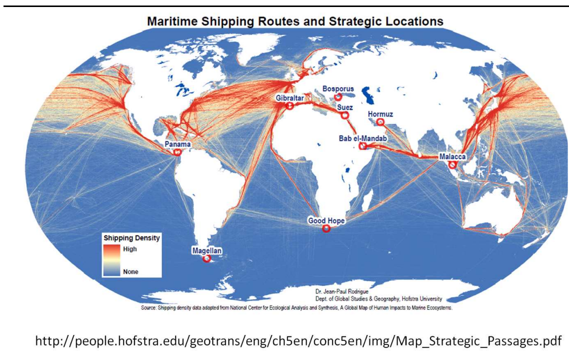

Figure 8a: Primary maritime shipping routes
Source: http://www.technologyreview.com/blog/arxiv/24667/

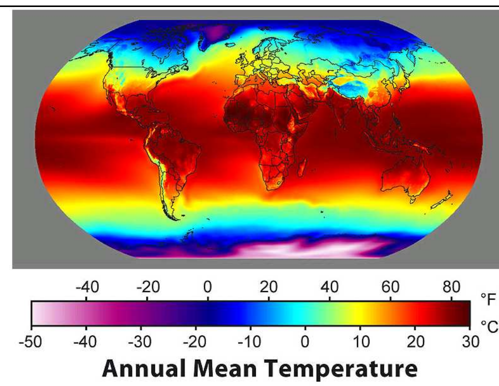

Figure 8b: Global annual mean surface temperature
Source: http://en.wikipedia.org/wiki/ File:Annual_Average_Temperature_Map.jpg

[6] http://www.container-transportation.com/emma-maersk.html

[7] http://en.wikipedia.org/wiki/List_of_world%27s_busiest_container_ports

Interception data from North America, Europe, Australia and New Zealand (Table 3.4) indicates that *A. glabripennis* larvae and pupae survive and adults can successfully emerge following international movement of solid wood packing material from China. As well as finding live adults, damage to solid wood packing has been reported, the damage being consistent with that caused by *A. glabripennis*.

Conclusions
Applying the information above into Table 3.3, it is concluded that the majority of *A. glabripennis* which began moving on the pathway would be able to survive and continue to develop within SWPM. Larvae develop slowly, taking up to between 1 and 2, perhaps 3, years to develop, yet SWPM can be transported from China to EU in a few weeks. Whilst being shipped, larvae will be afforded some protection by SWPM. Live interceptions in the EU also confirm that survival during transport is possible.

3.3: Likelihood of surviving during shipping		
Rating	**Description** (likelihood of survival is ....)	**Probability Assignment** [1]
High	> 10% (greater than one in ten survive)	80%
Medium	Between 0.1% - 10% (between one in one thousand to one in ten survive)	20%
Low	0.1% (less than one in one thousand survive)	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

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3.4 Not be detected at the port of entry

Unless specific protocols are in place for special inspection of the commodity in question, assume standard inspection protocols for like commodities. If no inspection is planned, estimate this sub-element as high.

Information / evidence: Provide reasoning then give judgment

Haack *et al*. (2010) summarised interceptions of *A. glabripennis* and *A. chinensis* from regions around the world and categorised findings as either at ports of entry or post entry. Table 3.4 is derived from data presented in Haack *et al.* (2010).

Table 3.4: Interceptions of *A. glabripennis* at point of entry (first number) and post entry (second number) in Europe and elsewhere 1992-2008 Source: data from Haack *et al*., 2010

Year	Europe	USA	Canada	Australia	New Zealand	Sum
1992		0-1	2-0			2-1
1993						
1994	0-1					0-1
1995			0-1		1-0	1-1
1996			2-0			2-0
1997	0-1	6-0	10-1			16-2
1998	0-9	24-0	3-0			27-9
1999	0-4		3-0		0-1	3-5
2000	0-5	2-0	1-1		0-1	3-7
2001	0-1	1-0	1-1		1-0	3-2
2002	0-2		4-1			4-3
2003	0-2	2-0	1-0			3-2
2004	0-7	4-0	3-0		0-1	7-8
2005	1-6	1-1		0-1		2-8
2006				1-0	1-0	2-0
2007	1-1	1-0		1-0		3-1
2008	1-8	5-0	2-0	0-1		8-9
Totals:	3-47	46-2	32-5	2-2	3-3	86-59
Sum	50	48	37	4	6	
% detections at entry	6.0	95.8	86.5	50.0	50.0	
% post entry	94.0	4.2	13.5	50.0	50.0	

The very large volume of imports that use solid wood packaging prevents EU plant health inspectors from inspecting all individual shipments. Another factor reducing inspection is that fact that shipping manifests do not identify whether solid wood packaging is used to convey goods, thus officials cannot identify which imports will contain wooden packaging. In addition the containerization of shipments and speed of distribution limits access by inspectors to goods. Taking the UK as an example, 40% of all containers arrive in UK at Felixstowe docks, one of the busiest container ports in Europe. There are between 5,000 and 6,000 quayside moves per day (ship to shore). Typically 4,000 containers per day depart by road, 1,000 depart by rail to deliver goods across the UK and wider into Europe. Approximately 3.6% of non-EU containers are inspected for some reason, but not all are for plant health purposes. Phytosanitary inspectors examine approximately 2,000 containers per year, approximately 25 per week, although more will be inspected during the potato import season (Atkinson, 2009). With more than 25,000 containers arriving from all around the world per week, not just from China, and with 25 plant health inspections per week, the likelihood that any one container is inspected is less than one in one thousand. The difficulty with inspecting large numbers of imported containers is not only an EU problem. Inspectors from the USDA

Animal Plant and Health Inspection Service examine up to 2% of cargo arriving at maritime ports, airports and border crossings as part of the effort to mitigate phytosanitary risks (Work *et al.,* 2005).

In a scenario where *A. glabripennis* is not regarded as a quarantine pest by the EU, and if SWPM were not regulated, there would be no inspections made and hence infested SWPM are very likely to be able to enter the area undetected. However, given that some finds have been made by workers in warehouses (rather than by NPPO phytosanitary inspectors), the likelihood of avoiding detection completely is not 100%.

Conclusions
Table 3.4 above shows that in Europe, the vast majority of *A. glabripennis* finds (94%) are not made at the port of entry.

3.4: Likelihood pest will not be detected at port of entry		
Rating	**Description** (likelihood of no detection is ....)	**Probability Assignment** [1]
High	> 10% (greater than one in ten will not be detected)	95%
Medium	Between 0.1% - 10% (between one in one thousand to one in ten will not be detected)	5%
Low	< 0.1% (less than one in one thousand will not be detected)	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

3.5 Imported or moved subsequently to an area with an environment suitable for survival

Consider the geographic location of likely markets and the proportion of the commodity that is likely to move to locations suitable for pest survival. Even if infested commodities enter the EU, perhaps not all final destinations will have suitable climatic conditions for pest survival.

Information / evidence: Provide reasoning then give judgment
Interception records show that *A. glabripennis* finds have been made on solid wood packaging material typically used to convey heavy industrial goods and landscaping materials such as quarried rocks, slates and tiles. Industrial goods are likely to be destined for industrial sites in urban environments, whilst landscaping materials could well be distributed to “garden centres” and plant nurseries. Such businesses are often on the edges of towns or in the rural environment. Solid wood packaging material from which adults could emerge, could therefore be distributed widely across the EU. Section 2.1 (climate and host interaction) has already shown that much of the EU has climate suitable for the development of *A. glabripennis*.

3.5: Likelihood commodity that will be moved to suitable environment for pest survival (same as % of commodity moved to suitable environment)		
Rating	**Description** (likelihood, or amount moved to suitable environment is ....)	**Probability Assignment** [1]
High	> 10% (greater than one in ten)	90%
Medium	Between 0.1% - 10% (between one in one thousand to one in ten)	10%
Low	< 0.1% (less than one in one thousand)	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

3.6 Come into contact with host material suitable for reproduction

Even if the final destinations of infested commodities are suitable for pest survival, suitable hosts must be available in order for the pest to survive. Consider the complete host range of the pest species.

Information / evidence: Provide reasoning then give judgment
Having emerged adult beetles are able to fly to find suitable hosts (see 2.3 dispersal). Sections 2.1 and 2.2 have already shown that hosts occur widely across the EU. SWPM is very likely to be moved to with an environment suitable for survival, e.g. to areas where hosts plants occur, even though not in great numbers, and where climate is suitable. Outbreaks in Europe (Austria, France, Germany, Italy, Netherlands) have shown that *A. glabripennis* has been able to locate host plants. To date all outbreaks have been found in urban areas, on street trees or trees near importers of Chinese products and in private gardens.

Adult *A. glabripennis* have been reported from warehouses and hence not been successful at locating / transferring to host material suitable for reproduction.

3.6: Likelihood pest will transfer to host material where it can reproduce		
Rating	**Description** (likelihood of pest transfer is ....)	**Probability Assignment** [1]
High	> 10% (greater than one in ten)	75%
Medium	Between 0.1% - 10% (between one in one thousand to one in ten)	25%
Low	< 0.1% (less than one in one thousand)	0%
	Check sum =	100%

[1] spread your judgment according to your belief / evidence

If there are multiple pathways, repeat steps 3.1 to 3.6 for each pathway.

- *Enter your scores for likelihoods into the Excel spreadsheet “Method 4 input table.xls” and send to Willem Roelofs (willem.roelofs@fera.gsi.gov.uk).*
- *Willem will return the results of combining scores to you indicating the overall introduction potential for inclusion in the risk assessment document.*

3.7 Potential for introduction via individual pathways

(Include results from Willem)

Past interceptions of *A. glabripennis* in Chinese SWPM provides evidence that the pathway is real. The result of combining scores to individual questions (3.1 to 3.6) relating to likelihood of entry, using a BBN (Method 4 Handbook.doc, Roelofs & MacLeod, 2010) is shown graphically in Figure 9. It suggests that the probability of introduction tends towards the higher end of likelihood.

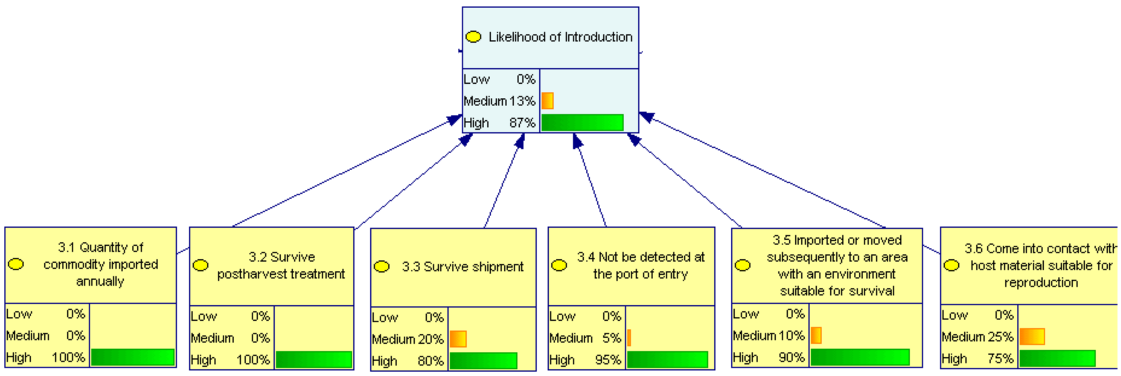

Figure 9: Graphical representation of combining scores for questions 3.1 to 3.6, using a BBN to give an overall likelihood for introduction.

A sensitivity analysis could be performed by changing scores to individual questions to examine the impact on overall likelihood of introduction. Equally, the conditional probability table in the BBN could be altered to see what effect that has on output.

3.8 Overall potential for introduction *(Include results from Willem)*

This combines all pathways that have been considered. However, since this assessment only considered one pathway, the result for 3.8 is the same as that in 3.7.

See 3.7.

4.0 Overall pest risk

A combination of Consequences of introduction (2.1 to 2.5) with potential for introduction (3.0 to 3.8) (Include results from Willem)

There are a number of ongoing *A. glabripennis* outbreaks being dealt with by NPPOs in the EU. Without measures in place to inhibit further introductions, this assessment concludes that the likelihood that infested SWPM from China will carry *A. glabripennis* to the EU and lead to further introductions of the pest is high. Without phytosanitary intervention, introduced *A. glabripennis* will be able to infest and subsequently destroy many hardwood trees, commonly found across Europe in the urban and suburban environment, as well as in forestry. As a pest perhaps evolutionary adapted to “edge” habitats, there is some uncertainty as to the extent of damage that may be expected in commercial forestry. However, if forests are managed with wide spacing, fragmented, and grown in monoculture with rows of trees, then many “edges” are available to be exploited. In addition storms, ice- and snow damage have knocked down forest trees in recent years creating large areas with edges suitable for *A. glabripennis*. The speed at which damage will materialise will depend upon the pests’ population development which in turn will be determined by summer temperatures.

A BBN that combines individual risk elements is shown as Figure 10. The BBN suggests overall risk, “expected pest risk”, is mostly within a category “high”, but is also somewhat “medium”, with a very small amount “low”. Exactly what high, medium and low means has not been defined. Comparison with other pests would be useful.

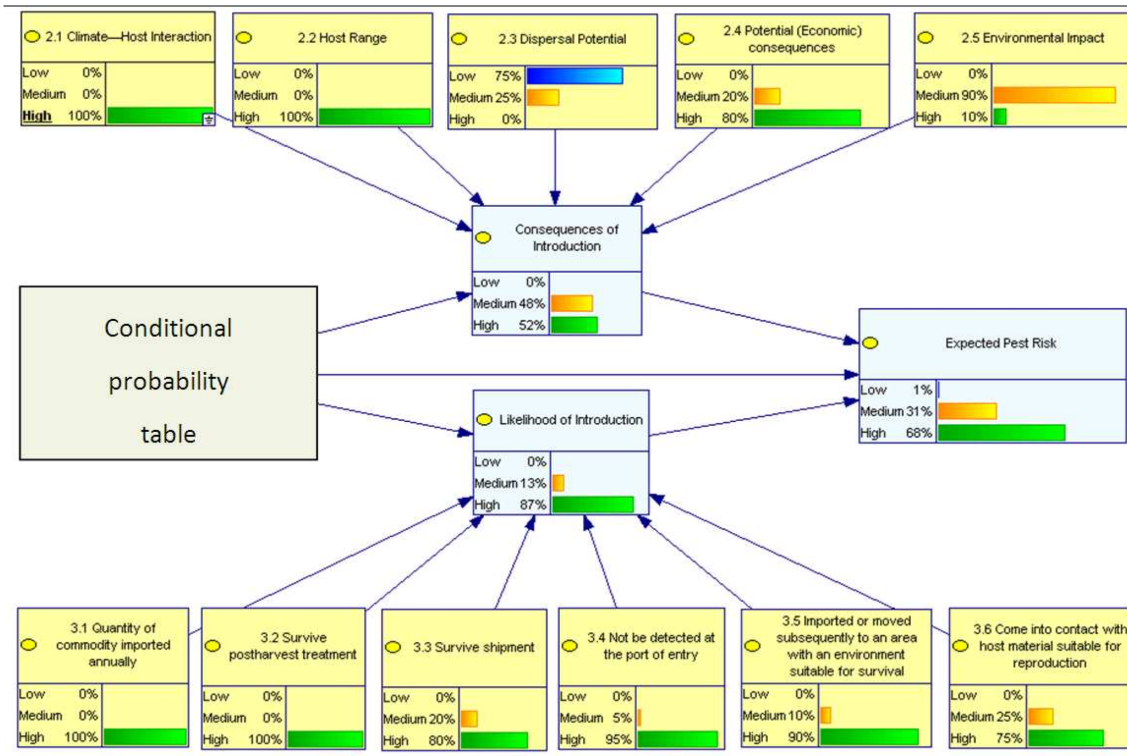

Figure 10: Graphical representation of combining consequences of introduction (2.1 to 2.5) with potential for introduction (3.0 to 3.6), using a BBN to determine an overall risk rating.

5.0 Conclusion

At present *Anoplophora glabripennis* satisfies the IPPC definition of a quarantine pest for the EU. Without intervention, the pest is highly likely to be introduced via SWPM from China. Hosts are widely available across the EU. The climate in southern and central Europe is suitable for development within one or two years. Further north development would take longer or may not be possible due to insufficient summer temperatures. Many hosts that are an important feature in urban and suburban landscapes, as well as in EU forestry could be killed by larvae feeding internally. With no active measures to manage cerambycid beetles in broadleaved trees in the EU there is every prospect that *A. glabripennis* would eventually become a significant pest.

Supporting documentation

References

- Please see Annex 1 (separate file).

EU Outbreaks

- A map showing the location of *Anoplophora glabripennis* outbreaks within the EU as at January 2011; please see Annex 2 (separate file).

Quantitative spread models

- A detailed report modelling spread of *A. glabripennis* using a variety of quantitative models developed within EU project PRATIQUE and tested within the current project is provided as Annex 3; please see Annex 3 (separate file).

Uncertainties

- A list of uncertainties that have a bearing on determining risk is provided as Annex 4; please see Annex 4 (separate file).