FORMAT FOR A PRA RECORD (version 3 of the Decision support scheme for PRA for quarantine pests)

	European and Mediterranean Plant Protection Organisation		
	Organisation Européenne et Méditerranéenne pour la Protection des Plantes		
	Guidelines on Pest Risk Analysis		
	Lignes directrices pour l'analyse du risque phytosanitaire		
	Decision-support scheme for quarantine pests Version N°3		
PEST RISK ANALYSIS FOR: Bursaphelenchus xylophilus *(Steiner & Buhrer) Nickle*			
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Date:	2009-05-18/20		ANNEX I: PRA 1996

Stage 1: Initiation

1 Give the reason for performing the PRA	Other reason	
1b If other reason, specify		The PRA for *Bursaphelenchus xylophilus* (Pine Wood Nematode - PWN) has been performed by EPPO for the territory of EU (of that time) in 1996 and published in the EPPO Bulletin (v.26, pp. 199-249). The pest was included in the EPPO A1 list absent from the territory of the organization.

		Revision of this PRA has been done for the following reasons: 1) the pest has established in Portugal and its phytosanitary status for the EPPO territory has changed 2) new data have been gathered on natural and man-assisted capacities of spread of the pest 3) new data have been gathered on the pest impact 4) under the new EPPO procedure on conducting PRA, it is necessary to perform it for the whole of the EPPO region 5) the pest is being considered for inclusion in the EPPO A2 list
2a Enter the name of the pest	*Bursaphelenchus xylophilus* (Steiner & Buhrer) Nickle	Synonyms: *Aphelenchoides xylophilus* (Steiner & Buhrer) *Bursaphelenchus lignicolus* (Mamiya & Kiyohara)
2b Indicate the type of the pest	nematode	
2c if other, specify		
2d Indicate the taxonomic position	Nematoda: Aphelenchoididae, Parasitaphelenchinae (Hunt 2008; EPPO/EPPT, 2009) EPPO code: BURSXY	Common names: pine wood nematode (English) nématode du bois de pin, nématode du pin (French) Kiefernholznematode (German) сосновая стволовая нематода, сосновая древесная нематода (Russian)
3 Clearly define the PRA area	EPPO region	
4 Does a relevant earlier PRA exist?	yes	The PRA for *Bursaphelenchus xylophilus* (Pine Wood Nematode - PWN) has been performed by EPPO for the territory of EU (of that time) in 1996 and published in the EPPO Bulletin (Evans *et al*., 1996).
5 Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?	not entirely valid	
5b Explain		The pest has established in Portugal, a single incursion in Spain has been reported and its phytosanitary status for the EPPO region has changed. New data are available on natural and man-

		assisted capacities of spread of the pest. New data are available on the pest impact. Under the new EPPO procedure on conducting PRA, it is necessary to perform it for the whole of the EPPO region.
6 Specify the host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants) present in the PRA area.		PWN prefers *Pinus* species, but is also able to attack other Coniferae: *Abies*, *Picea*, *Larix*, *Cedrus* and *Pseudotsuga*. These genus are considered as PWN host plants. Its vectors in the genus *Monochamus* can also attack trees of above mentioned species and some other Coniferae: *Juniperus*, *Chamaecyparis*, *Cryptomeria* and sometimes *Tsuga* (OEPP/EPPO, 1986; EPPO/CABI, 1996; Evans *et al*., 1996), but it is uncertain whether these genera are hosts for PWN. They may become infested. Neither *Thuja* nor *Taxus* are regarded as hosts of PWN and its vectors. The EU Directive 2006/133 EC includes plants of *Abies*, Cedrus, *Larix*, *Picea*, *Pinus*, *Pseudotsuga* and *Tsuga* and all coniferous wood and bark except *Thuja* as hosts of PWN.
7 Specify the pest distribution		*B. xylophilus* is believed to be native in North America and has been spread to Asia (Japan, China, Taiwan, Korea) and Portugal (Europe) (OEPP/EPPO, 1986; EPPO/CABI, 1996; Evans *et al*., 1996). *B. xylophilus* is widespread in Canada and USA (Ryss *et al*., 2005; Sutherland 2008) and there is a single report of its presence in Mexico (Dwinell, 1993). It occurs in practically all states/provinces of Canada and USA where pine and other conifer forests exist. The northernmost limit to its distribution in North America is uncertain. In Japan, *B. xylophilus* is now widespread in three of the four main islands, Kyushu, Shikoku and Honshu, but has not yet been reported from the prefectures Hokkaido and Aomori (Futai, 2008). It has spread into China (Zhao *et al*, 2008), Korea (Shin 2008) and Taiwan during the past 35 years and is thought to have reached these locations from Japan. In all these new Asian areas, *B. xylophilus* has become associated with *M. alternatus* as principal vector (Nakamura-Matori 2008). In China, it is restricted to the provinces of Jiangsu, Anhui, Fujian, Jiangxi, Guangxi, Guizhou, Hubei, Hunan, Guangdong, Shandong, Sichuan, Yunnan, Zhejiang and Chonquing City (Zhao *et al*, 2008; Robinet *et al*, 2009). In the Republic of Korea it is present in 54 districts, counties, and cities in 11 provinces (Shin 2008; Shin et al. 2009). Pine wilt symptoms are evident in all these locations. There is a record of the presence of *B. xylophilus* in dying pines in Nigeria but this has not been confirmed by specialist taxonomists (Khan & Gbadegesin 1991). In the EPPO region, PWN has established in continental Portugal where his main vector is *Monochamus galloprovincialis* (Mota et al. 1999, Sousa et al. 2001), and there is a single recorded incursion in Spain.

Stage 2: Pest Risk Assessment - Section A : Pest categorization

8 Does the name you have given for the organism correspond to a single taxonomic entity which can be adequately distinguished from other entities of the same rank?	Yes (Nickle *et al*, 1981, Ryss *et al*, 2005, Braasch et al. 2009)	There are keys available for morphological determination of the organism (Nickle *et al*, 1981, Hunt, 1993). Additionally there are several molecular methods in use for its identification (EPPO, 2009). So there are methods available to clearly distinguish the organism from other species of the same genus ore other genera.
10 Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?	yes (the organism is considered to be a pest)	While native pine trees in North America do not suffer from pine wilt disease because of co-evolutionary development of both host trees and nematode, non native pine trees are affected by pine wilt disease. In Japan, although it has been managed for decades, PWN causes an annual loss of pine trees (*Pinus densiflora*, *P. thunbergii*, *P. luchuensis*) of approximately one million cubic meters (Suzuki, 2002). In Portugal since the detection of PWN several 100.000 dying pine trees have been cut because of PWN infestation.
12 Does the pest occur in the PRA area?	yes	
13 Is the pest widely distributed in the PRA area?	not widely distributed	In the PRA area, PWN has established only in continental Portugal (Mota et al. 1999, Ministe´rio da Agricultura, 2008), and one single infested tree has been found in Spain in 2008 (Anonymous, 2008). The pest is under official control in EU countries.
14 Does at least one host-plant species (for pests directly affecting plants) or one suitable habitat (for non parasitic plants) occur in the PRA area (outdoors, in protected cultivation or both)?	yes	All genera of PWN hosts (and hosts of its vectors) are present in the PRA area: *Pinus*, *Abies*, *Picea*, *Larix*, *Cedrus* and *Pseudotsuga* (Evans *et al*., 1996)
15a Is transmission by a vector the only means by which the pest can spread?	no	Vector transmission is by far the most important way of spread. *B. xylophilus* can be moved with plants, wood etc. but without the vector insect there is only a theoretical and extremely low likelihood of transmission to new host trees. Nevertheless some non-vector ways of transmission are theoretically possible, such as root transmission and soil/water transmission but these have not been confirmed under field conditions (Evans *et al*., 1996). The only demonstrated means of transmission in the field conditions is by its vectors in the genus

		Monochamus. However, there is some support from experiments that the nematode could enter wounds in susceptible trees, either from wood to wood contact or from migration from chips or other infested material in contact with roots (since it can survive in wood, including wood waste, chips and bark). Though this has never been proven under practical conditions there are a few research results from experimental trials which support this theory (Mamiya & Shoji 1989; Halik & Bergdahl 1992). It is therefore considered (here and further in the text) as a theoretical possibility. In addition there are some reports from seedlings tests that transmission from infested trees to non infested trees through soil and by root grafting occurred (Eriko et al. 1998; Evans et al. 1996). This possibility has also been demonstrated in experiments, but has never been reported in field conditions. So, the risk of non-vector transfer and spread of PWN could be considered to be extremely low and not proven under field conditions.
16 Does the known area of current distribution of the pest include ecoclimatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?	yes	Climatic comparisons (Kulinich & Kolossova, 1993, 1995; Evans *et al*., 1996, Braasch & Enzian 2003) shows that many regions in PRA area have ecoclimatic conditions comparable with those of current distribution of the pest, especially when the pest exists as a saprophyte and does not cause pine wilt (e.g. in Canada).
17 With specific reference to the plant(s) or habitats which occur(s) in the PRA area, and the damage or loss caused by the pest in its area of current distribution, could the pest by itself, or acting as a vector, cause significant damage or loss to plants or other negative economic impacts (on the environment, on society, on export markets) through the effect on plant health in the PRA area?	yes	It is clear, that PWN is able to cause significant damage to plants in the PRA area (Kulinich & Kolossova, 1993, 1995; Evans *et al*., 1996; Mota et al 1999). This damage would be expressed in tree mortality in the southern part of the EPPO region (as demonstrated in Portugal) and in restrictions to trade in its northern part. In Portugal, almost 24 mln euros during 2001 – 2009 have been spent to control PWN (CIRCA information). In Spain, almost 344 thousand euros have been spent in 2009 and almost 3 mln euros will be spent in 2010.
18 Summarize the main elements leading to this conclusion.		The pest has established in the PRA area (EPPO region) but is not widely distributed there (and under official control in EU countries) and is likely to spread to other parts of this area but will not cause mortality in the more northerly parts. Hosts of the pest are present throughout the PRA area, PWN is causing serious damage in Portugal and it is very likely to cause serious economic damage in other parts of the EPPO region where climatic and soil conditions are suitable.

		PWN has established in continental Portugal and its proximity poses more risks for some other EPPO countries, in particular for EU countries as plant products in principle may move freely (without phytosanitary certification) inside EU. Therefore, EU imposed specific measures regarding all pathways originating from Portugal are in place. For non-EU EPPO countries, the risk of conifer commodities originating from Portugal is not different compared to those from other PWN-infested areas (e.g. for Russia, the risk of conifer commodities originating from China, Japan and Korea is similar to those from Portugal).

Stage 2: Pest Risk Assessment - Section B : Probability of entry of a pest

1.1 Consider all relevant pathways and list them (one by line) **Relevant pathways are those with which the pest has a possibility of being associated (in a suitable life stage), on which it has the possibility of survival, and from which it has the possibility of transfer to a suitable host. Make a note of any obvious pathways that are impossible and record the reasons.**		Possible pathways are: 1) Plants for planting (except seeds) of host species (including bonsai plants) (Evans *et al*, 1996) 2) Cut branches (including Christmas trees) of host species 3) Wood (except particle wood and waste wood) of host species (including any wood products made from raw untreated coniferous wood) 4) Particle wood and waste wood of host species 5) Coniferous wood packaging material 6) Isolated bark of host species Other pathways discussed 1) Seeds and cones of host species There is no report up to now that *B. xylophilus* has been isolated from cones or seeds. Fresh green cones may be a possible commodity to harbour nematodes as *Monochamus* species use them for maturation feeding (Hellrigl, 1971). Mature cones are dry. Size and morphology of the cones and seeds alone rules out the possibility of vector carriage. There is no evidence to suggest that *B. xylophilus* could be found in seeds or cones, although it is known that some nematodes can be associated with coniferous seeds. Potential transfer to Europe could occur if *B. xylophilus* was present because the cones could contain fungal growth similar to that noted in chip piles. However, it seems extremely unlikely that transfer from the commodities to susceptible trees could occur in the absence of a vector final pathway. The risks from this pathway are unknown but are likely to be negligible. 2) Hitchhiking *Monochamus* beetles Beetles of *Monochamus* emerging from PWN-infested trees/wood are able to carry PWN and transmit it to non-infested trees during maturation feeding. Theoretically, hitchhiking beetles could present a risk of introducing PWN to new areas/countries but the lack of information on hitchhiking *Monochamus* risk would require expert judgement to answer most of questions in the corresponding

		section of PRA. The risks from this pathway are unknown but are likely to be negligible.
1.2 Estimate the number of relevant pathways, of different commodities, from different origins, to different end uses.	Many Low uncertainty	

1.4 Pathway :	1) Plants for planting (except seeds) of host species (including bonsai plants) Low uncertainty	**1) Plants for planting (except seeds) of host species (including bonsai plants)** The fact that PWN has established in Portugal poses more risks for some other EPPO countries, in particular for EU countries as plants for planting in principle may move freely (without phytosanitary certification) inside EU. For non-EU EPPO countries, the risk of conifer plants for planting originating from Portugal is not different compared to those from other infested areas.
1.4a Is this pathway a commodity pathway ?	yes	
1.4b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	Likely Medium uncertainty	Maturation feeding by *Monochamus* spp. could introduce *B. xylophilus* into conifer plants. Plants for planting (including bonsai) could be infested during maturation feeding of vector insects (*Monochamus* beetles) or theoretically by transmission from infested materials (e.g. chips or bark mulch around roots) (Halik & Bergdahl, 1987, 1992; Kiyohara & Tokushige 1971). Large coniferous trees for planting could be infested with vector insects (*Monochamus* beetles) but only if the trees were sufficiently stressed to allow successful oviposition by the female beetles (they do not oviposit in healthy trees). Bonsais are extremely specialized forms of ‘plants for planting’ and the same constraints apply, with the additional factor that the trees are kept for long periods before being transported, during which time any nematodes present are likely to have killed susceptible trees or to have declined in resistant trees. Living bonsai is unlikely to carry PWN vectors since *Monochamus* spp. do not oviposit in healthy living trees. Large coniferous trees for planting accompanied with soil would be the highest risk because of the possible presence of PWN introduced by maturation feeding and, to a lesser extent depending on whether the trees were stressed enough, by the presence of breeding *Monochamus* spp.
1.5		

How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	moderately likely Medium uncertainty	Under suitable climatic conditions, infested plants for planting could accumulate high quantity of nematodes, but in this case the probability that the plants stay symptomless is rather low and such plants are removed from trade. The risks of transfer to new locations remains low because of the probability that only healthy plants would be selected for transportation and any that were likely to succumb to pine wilt disease would do so quickly after inoculation by *Monochamus* spp. However, under climatic conditions of lower temperatures the number of nematodes could stay low and the plants remain symptomless.
1.6 How large is the volume of the movement along the pathway?	Low Low uncertainty	Movement of plants for planting of PWN host species from infested areas is prohibited to EU countries and restricted to most non-EU EPPO countries. Nevertheless, 5,5 tonnes of plants for planting have been imported to EU from countries of PWN distribution (Canada, China, Japan, Koreas and USA) in 2006, 36,9 tonnes in 2007 and 5,2 tonnes – in 2008 (EUROSTAT, October 2009) (These data includes also non-coniferous plants, separate date on coniferous plants not being available). Inside the EU, 325,5 tonnes of plants for planting have been moved from Portugal in 2006, 475,4 tonnes in 2007 and 544,2 tonnes – in 2008 (EUROSTAT, October 2009) (These data includes also non-coniferous plants separate date on coniferous plants not being available). The international trade of large coniferous trees for planting accompanied with soil is subject of increased interest but is normally prohibited by most EPPO countries, but this would be the highest risk category and could be allowed in intra-Community trade in the EU (there are presently restrictions according to Commission Decision 2006/133/EC). Trade in bonsais is small relative to other categories of wood.
1.7 How frequent is the movement along the pathway?	Rarely Low uncertainty	The intensity of import of plants for planting (except bonsai and potted plants) depends on the season but this import continues during the entire year.
1.8 How likely is the pest to survive during transport /storage?	very likely Low uncertainty	Survival and reproduction is possible and, given the right combination of tree species, temperature and soil moisture, death of the tree from pine wilt could result (Evans, Evans & Ikegami, 2008). The conditions of transportation of plants for planting are suitable for survival of these plants and thus for survival of PWN. Living plants imported for planting are, with the exception of special trade in relatively large trees and bonsai, generally small (smaller than 2 cm in diameter) and are thus, unlikely to be able to carry *Monochamus* spp. However, *M. galloprovincialis* the vector of PWN in Portugal is able to breed in branches with diameters as small as 2 cm. In all cases, oviposition will only take place if the tree is

		dead or dying.
1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?	Likely Low uncertainty	The conditions of transportation of plants for planting are suitable for reproduction of PWN but the speed of multiplication depends on temperatures maintained during transit. *B. xylophilus* reproduces in 12 days at 15°C, 6 days at 20°C and 3 days at 30°C (Evans *et al*, 1996). Extrapolating results with mature pines, it is reasonable to assume that nematode survival and reproduction could be expected for several years if the tree did not die from pine wilt. Living plants imported for planting are, with the exception of special trade in relatively large trees and bonsai, generally small (smaller than 2 cm in diameter) and are thus, unlikely to be able to support breeding of *Monochamus* spp.
1.10 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	likely Medium uncertainty	It is possible that trees which have received PWN inoculum by maturation feeding of PWN vectors and which are symptomless may be exported. PWN-infested plants of some Coniferae moved during the dormant period are not likely to show wilt symptoms and therefore PWN would remain undetected. Some PWN-infested *Pinus* plants transported during the growing season may show wilt symptoms if the temperatures are high enough and therefore may be detected by phytosanitary inspectors. *Monochamus* spp. could be detected only if there are obvious signs of their presence (grub holes, borings, etc.) and this would only be associated with dying or dead trees. Large trees can receive nematode inoculum, potentially remain symptomless for longer periods especially in cooler areas, and, if dying or dead, support breeding by *Monochamus* spp.
1.11 How widely is the commodity to be distributed throughout the PRA area?	widely Low uncertainty	The conditions suitable for growing PWN (and their vectors) host plants are widely present in PRA area: central, eastern and northern parts of EPPO region, mountain areas, etc. Therefore, these plants could be widely distributed in the PRA area.
1.12 Do consignments arrive at a suitable time of year for pest establishment?	Yes Low uncertainty	Plants for planting are intended to be planted and grown (or to stay planted). Therefore, the time of arrival is suitable both for them and for PWN (and for PWN vectors).
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	Moderately likely	Normally, plants for planting are too small for the development of PWN vectors (*Monochamus*), except rather rare cases of large plants for planting. The probability that young PWN-infested *Pinus*

	Medium uncertainty	plants die before they grow up is very high, but dependent on environmental conditions. Probability of root transmission of PWN is theoretical. Nevertheless, there is some possibility that symptomless plants (especially in northern areas) are able to carry PWN (Bergdahl & Halik, 2003). If the plants reached the EPPO region (or imported from Portugal to other EPPO countries) and still contained nematodes, the risk of transfer into the general forest ecosystem depends on survival and reproduction of *B. xylophilus* in the tree and for the tree to become suitable for *Monochamus* spp. breeding. If the tree dies quickly after being planted it may still be too small to support the vector. Longer survival of the tree would be accompanied by reduction of *B. xylophilus* populations but over a considerable time period (e.g. 13 years in the USA after inoculation to living pine trees) (Bergdahl & Halik 2003). The likelihood that living trees will be planted in proximity to existing trees in Europe adds a further possible pathway by potentially introducing nematodes originating from the symptomless imported tree. The root system of infested trees seems to be an important reservoir of nematodes. Root grafts, which occur in many species of pine, would offer a theoretical possibility for local spread of PWN. This pathway represents low innate risk. Transfer *of B. xylophilus* from a living bonsai to surrounding trees is unlikely because they would not support vector breeding since *Monochamus* spp. do not oviposit in healthy living trees. The likelihood of transfer by other means is only theoretical. The risks from this pathway are insignificant. So, only in a rare case when both PWN and its vectors (but only when trees are dying or dead) are present in imported plants for planting, the transfer of PWN from the pathway to a suitable host is likely to occur. When only PWN is present in imported plants for planting, its transfer is possible only if these plant are large enough and stressed enough (but still alive) for *Monochamus* infestation and development. In such a case the transfer is unlikely.
1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	very likely Low uncertainty	The intended use is planting and growing. It is very likely to aid survival and transfer of the PWN if the tree survives long enough to support eventual vector breeding.

1.4 Pathway :	2) Cut branches of host species	**2) Cut branches of host species**

	Low uncertainty	
1.4a Is this pathway a commodity pathway?	yes	
1.4b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	Likely High uncertainty	It is possible that *Monochamus* spp. could perform their maturation feeding on branches (including Christmas trees) before they are cut and, thus, introduce *B. xylophilus* into these branches. Cut branches, by virtue of thin bark and small diameter wood (less than 2 cm), except the case of Christmas trees, are normally unlikely to support *Monochamus* spp. breeding and therefore this is generally not a very usual pathway for the vector. However, *M. galloprovincialis* the vector of PWN in Portugal is able to breed in branches with diameters as small as 2 cm. Christmas trees can be larger and could support breeding by *Monochamus* if the trees are discarded in areas where the vector lives and the bark is still suitable for oviposition. It is also possible that *Monochamus* spp. could perform their maturation feeding on branches before they are cut and, thus, introduce *B. xylophilus* into the branches. In the case of Christmas trees, the commodity is harvested not long before Christmas (outside flight period) and are less likely to be infested by *Monochamus*. After they are disposed of, these trees could present risk only when they are very large: *Monochamus* beetles do not usually lay eggs if trees have been cut several months before the flight period (the bark deteriorates and is not suitable for oviposition).
1.5 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	Likely Low uncertainty	It is known from various studies, that PWN can live and reproduce in large quantities for considerable periods in branches of living trees, even when the tree is generally regarded as resistant to pine wilt (Bergdahl, 2008).
1.6 How large is the volume of the movement along the pathway?	Minimal Low uncertainty	There is, in fact, very little international trade in this commodity from areas of PWN distribution which is restricted for given conifer species by many EPPO countries (on account of quarantine pests other than *B. xylophilus*). No coniferous cut branches has been imported to EU from countries of PWN distribution (Canada, China, Japan, Koreas and USA) in 2006 and in 2007, and only 5,2 tonnes – in 2008 – from China (EUROSTAT, October 2009). Inside the EU, only 100 kg of coniferous cut branches have been

		moved from Portugal in 2006, and no movement has been recorded in 2007 and 2008 (EUROSTAT, October 2009). The import of Christmas trees from outside of EPPO region is very small. No Christmas trees have been imported to EU from countries of PWN distribution (Canada, China, Japan, Koreas and USA) in 2006 and in 2007, and only 100 kg – in 2008 – from China (EUROSTAT, October 2009). No movement of Christmas trees from Portugal inside the EU has been recorded in 2006, 2007 and 2008 (EUROSTAT, October 2009).
1.7 How frequent is the movement along the pathway?	very rarely Low uncertainty	The movement of coniferous cut branches (including Christmas trees) in international trade is very limited: countries usually provide themselves with coniferous cut branches (including Christmas trees) in the internal market. In the case of Christmas trees, the commodity is harvested not long before Christmas and its movement is seasonal.
1.8 How likely is the pest to survive during transport /storage?	very likely Medium uncertainty	The conditions of transportation of cut branches are suitable for survival of these branches and thus for survival of PWN. The third dispersal stage is a long term survival stage of PWN and could survive and develop in cut branches. Cut branches imported are, with the exception of Christmas trees, generally small (smaller than 2 cm in diameter) and are thus, unlikely to carry *Monochamus* spp. However, *M. galloprovincialis* the vector of PWN in Portugal is able to breed in branches with diameters as small as 2 cm. In the case of Christmas trees, the commodity is harvested not long before Christmas (outside flight period) and is unlikely to carry PWN vectors.
1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?	very likely Medium uncertainty	The conditions of transportation of cut branches are suitable for reproduction of PWN but the speed of multiplication depends on temperatures maintained during transit. *B. xylophilus* reproduces in 12 days at 15°C, 6 days at 20°C and 3 days at 30°C (Evans *et al*, 1996). Cut branches will rapidly lose any resistance arising from oleoresin pressure but PWN could reproduce on any remaining living cells or on fungi which rapidly occur while the moisture content of the wood is still suitable for them to grow (e.g. blue stain fungi such as *Ophiostoma* and *Ceratocystis* species). Overall, cut branches represent a suitable resource for extended nematode breeding. The time frame for nematode multiplication will depend on the size of the branch, and the survival time may be considerable due to the survival capacity of the third dispersal stage. Cut branches imported are, with the exception of Christmas trees, generally small (smaller than 2 cm

		in diameter) and are thus, unlikely to be able to support breeding of *Monochamus* spp. However, *M. galloprovincialis* the vector of PWN in Portugal is able to breed in branches with diameters as small as 2 cm.
1.10 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	Very likely Medium uncertainty	There would be no external symptoms of the PWN presence. *Monochamus* spp. could be detected only if there are obvious signs of their presence (grub holes, borings, etc.).
1.11 How widely is the commodity to be distributed throughout the PRA area?	Widely Medium uncertainty	The end use does not limit the likely distribution of the commodity.
1.12 Do consignments arrive at a suitable time of year for pest establishment?	Yes Medium uncertainty	Part of consignments of PWN-infested cut branches could arrive at a suitable time for completion of PWN vectors breeding (if present in the material) or for possible introduction direct from the branches to the soil, etc (very low risk, see 1.13 below). In the case of Christmas trees, the commodity arrives at the time, which is not suitable for establishment of PWN and its vectors.
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	Unlikely Low uncertainty	PWN-infested cut branches, by virtue of thin bark and small diameter wood (< 2 cm), are very rarely able to support *Monochamus* spp. breeding and therefore this is not a very usual pathway for the vector. However, *M. galloprovincialis* the vector of PWN in Portugal is able to breed in branches with diameters as small as 2 cm. The method of final disposal of the commodity may pose some theoretical risk, particularly if the infested material is chipped and used as mulch, which could lead to a theoretically possible transmission through roots (e.g. Halik & Bergdahl, 1992). Thus, only in extremely rare cases when both PWN and its vectors are present in imported cut branches, is the transfer of PWN from the pathway to a suitable host likely to occur. In cases when only PWN is present in imported cut branches, its transfer is possible only if they are large Christmas trees made available for *Monohamus* infestation and completion of their development by the way of their disposal. This pathway therefore represents very low innate risk, but is dependent also on the size of the cut material so that larger branches represent higher risks than smaller.

1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	Unlikely Medium uncertainty	Cut branches of conifers are usually used for decoration purposes, which does not aid the transfer of PWN to suitable hosts. The method of final disposal of the commodity may pose some risk (see 1.13 above). Only the method of final disposal of the commodity (and not its intended use) may pose some theoretical risk, particularly if the infested material is chipped and used as mulch, which could lead to a theoretically possible transmission through roots (e.g. Halik & Bergdahl, 1992).

1.4 Pathway :	3) Wood (except particle wood and waste wood) of host species Low uncertainty	**3) Wood (except particle wood and waste wood) of host species** Three categories of wood are united in this pathway: • *Round wood with bark* • *Roundwood without bark* • *Sawn wood* In practice there were cases of interception of PWN vectors in furniture made from raw wood. This commodity and other raw wood products could be considered together with untreated wood and could present similar risk.
1.4a Is this pathway a commodity pathway ?	yes	
1.4b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	very likely Low uncertainty	Introduction of *B. xylophilus* into a tree can be by maturation feeding or by oviposition. In both cases survival of the nematode is possible but, following transmission by feeding, the likelihood of spread of the nematode into the trunk of the tree depends on the susceptibility of the tree, infestation being restricted to the branches in native North American *Pinus* spp. (see Stage 2, A, 10). The presence of both *Monochamus* spp. and *B. xylophilus* is highly likely in any kind of wood (round wood with or without bark as well as sawn wood) that is harvested from areas containing the organisms. *Monochamus* spp. will only infest weakened or freshly dead/felled trees with bark present to enable successful oviposition and larval development. This applies to freshly cut trees (Wingfield, 1983; Luzzi et al., 1984) and to standing trees damaged by pine-wilt disease or other biotic and abiotic factors. This is extremely likely in pine-wilt areas where there is a superabundance of breeding material. In non pine-wilt areas, the likelihood of *Monochamus* spp. presence is dependent on other factors, such as tree harvesting programs, fire, drought, wind throw and snow break, that would weaken trees. The early larval stages of *Monochamus* spp. feed on the cambium

		and the presence of bark is essential for their development. The development of later stages occurs within wood and does not require bark presence. At these later stages of development, debarking and sawing do not exclude PWN and its vector presence in the wood but wood with bark presents the longest period for infestation by *Monochamus* spp. The process of debarking, however, will tend to reduce the survival of any *Monochamus* spp. present but is less likely to affect any *B. xylophilus* already introduced into the wood. Once inside the wood, the vector larvae are protected from physical damage during the debarking process, but may still be at a disadvantage because they require to feed on the cambium virtually until pupation. However, it can be assumed that any larvae large enough to enter the wood completely and to develop the U-shaped tunnel characteristic of *Monochamus* spp. have the potential to complete development to the adult stage. The process of sawing reduces the survival of populations of *Monochamus* spp. present because some of the individuals will be killed during sawing and others will be discarded with the rounded outer portion of the stem. Even those that survive the sawing process may be more vulnerable as a result of greater exposure to adverse conditions, such as surface drying of the wood and partial exposure to surface damage. The duration of the life cycle is such that emergence in the PRA area following even an extended period in transportation is probable. Introduction of *B. xylophilus* into a tree can be by maturation feeding or by oviposition. In both cases survival of the nematode is possible but, following transmission by feeding, the likelihood of spread of the nematode into the trunk of the tree depends on the susceptibility of the tree, infestation being restricted to the branches in most native North American *Pinus* spp. growing in areas where wilt expression is not observed. It is likely that other *Pinus* species and other conifer species would support asymptomatic survival of PWN under certain climatic conditions, but further work is needed to confirm this. Latent infections and ability to live saprophytically are key biological characteristics of PWN. All kinds of wood (round wood with or without bark as well as sawn wood) are equally likely to be associated with PWN and are likely to be associated with its vectors, wood with bark being the most likely.
1.5 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	Likely Low uncertainty	Infested wood (round wood with or without bark as well as sawn wood) could contain high quantity of PWN and *Monochamus*. Round wood with bark is more likely to carry high concentration of PWN.
1.6		

How large is the volume of the movement along the pathway?	Massive Low uncertainty	The import of coniferous wood from areas infested with PWN is likely to be massive but subjected to required phytosanitary treatment. 32016 tonnes of coniferous wood were imported to EU from countries of PWN distribution (mainly from Canada, China and USA) in 2006, 78808 tonnes in 2007 and 29976 tonnes – in 2008 (EUROSTAT, October 2009). Inside the EU, 239 tonnes of coniferous wood were moved from Portugal in 2006, 195 tonnes were moved in 2007, and 120717 tonnes (mainly *Pinus sylvestris* wood) – in 2008 (EUROSTAT, October 2009). These data show significant increases of coniferous wood exports from Portugal to other EU countries in 2008.
1.7 How frequent is the movement along the pathway?	very often Low uncertainty	The import of coniferous wood from areas infested with PWN is likely to be very frequent. The import of coniferous wood to EU and intra-EU movement of coniferous wood from Portugal is distributed more or less homogeneously throughout of the year (EUROSTAT, October 2009).
1.8 How likely is the pest to survive during transport /storage?	very likely Low uncertainty	There is no reason for serious mortality of PWN and *Monochamus* vectors during transport/storage of all kinds of wood (round wood with or without bark as well as sawn wood). If the nematode and *Monochamus* are present in the wood, they are capable of surviving and reproducing for at least one year and can thus be expected to be present on arrival in the PRA area (Kobayashi, Yamane & Ikeda, 1984). *Monochamus* vectors present in wood could take up to 2 years to complete their life cycles (Linit, 1988). PWN could survive for significantly longer periods (HE) (there is evidence that *Bursaphelenchus mucronatus* can survive for up to 10 years in dry wood, Karin Nordin and Sanja Manduric (Swedish Board of Agriculture), pers. comm., 2009). The overall likelihood of *Monochamus* spp. survival in sawn wood is lower than that for round wood but, because trees tend to receive multiple attacks in the field, not all larvae are likely to die and thus there is still a high probability of survival of some *Monochamus* in at least one of the pieces cut from an infested trunk. This is evidenced by the discovery of *Monochamus* spp. in wood imported to EU under the previous Mill Certificate of Debarking and Grub hole Control program.
1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?	very likely Low uncertainty	There are no factors preventing an increase in prevalence of PWN during transport/storage of all kinds of wood (round wood with or without bark as well as sawn wood). If the nematode is present in wood, it is capable of surviving and reproducing for at least one year and possibly considerably longer (see point 1.8) and can thus be expected to be present on arrival in the PRA area. Once *Monochamus* species have reached a certain live stage and entered the wood, desiccation of the wood to a moisture content less than 20% does not prevent completion of their life-cycle even if they do not increase their prevalence. Sawn wood will remain suitable for completion of the larval

		development of *Monochamus* spp. during the duration of any transfer to the EPPO region. The continuing presence of bark provides the fullest opportunity for larvae of *Monochamus* spp. to complete development and emerge as adults; thus, round wood with bark provides better conditions for PWN vectors development than other kinds of wood.
1.10 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	very likely Medium uncertainty	The nematode is very likely to survive and remain undetected in all kinds of wood (round wood with or without bark as well as sawn wood) during existing management procedures. *Monochamus* spp. could be detected only if there are obvious signs of their presence (grub holes, borings, etc.). Even while *Monochamus* larvae are present in the wood, galleries are packed with frass which may be difficult to distinguish from solid wood.
1.11 How widely is the commodity to be distributed throughout the PRA area?	very widely Low uncertainty	Coniferous wood (round wood with or without bark as well as sawn wood) is widely used in the PRA area and is likely to be very widely distributed there.
1.12 Do consignments arrive at a suitable time of year for pest establishment?	Yes Low uncertainty	Coniferous wood (round wood with or without bark as well as sawn wood) is moved in international trade throughout the year to the PRA area and some consignments are likely to be imported at a suitable time for pest establishment.
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	Likely Medium uncertainty	If the nematode is present in wood (round wood with or without bark as well as sawn wood), it is capable of surviving and reproducing for at least one year and possibly considerably longer (see point 1.8) and can thus be expected to be present on arrival in PRA area. *Monochamus* spp. present in wood could, thus, emerge carrying *B. xylophilus* and could transfer the nematode to suitable trees. The presence of bark, provided it is still suitable for oviposition, could represent an increased risk because native *Monochamus* spp. might be attracted to the tree and lay eggs. Completion of development of these *Monochamus* spp. would represent a very high risk since there would be every opportunity for further transfer to native trees. That is why wood with bark presents the highest risk of PWN transfer from the pathway to a suitable host. If no *Monochamus* spp. is present in the imported round wood without bark or sawn wood, the nematode could only theoretically be transferred to trees by physical contact with suitable breeding substrates in the PRA area. The presence and dissemination of the material in the PRA area would present a constant risk of coming into contact with native trees and/or vectors. The possibilities of direct transfer of *B. xylophilus* from wood to host plants in the importing country have been considered by some authors (Magnusson, 1986) but have been demonstrated only in experiments.

		The characteristics of *B. xylophilus* (its mobility, resistance to adverse conditions, large numbers in infested wood, relationships with vectors, theoretical possibility of non-vector assisted transmission, ability to colonize different types of wood and other substrates) indicate that, under a suitable set of circumstances, the nematodes could theoretically be introduced to the PRA area by means of wood infested only with nematodes (i.e. without the vector). Such an event has not been demonstrated in nature, even in the known areas of *B. xylophilus* distribution, but there exists experimental evidence for all the necessary steps (Evans *et al*, 1996). Any nematodes successfully introduced in this way would, however, have to become associated with a *Monochamus* species in the PRA area to ensure continued survival and dispersal. For this reason, it is virtually impossible that *B. xylophilus* could be successfully established by this means in areas where *Monochamus* spp. are absent. But in the PRA area *Monochamus* spp. are widespread. These pathways (round wood without bark and sawn wood) represent a high risk of successful vector transfer but, because native European *Monochamus* spp. cannot add to this risk because they will only lay eggs in wood with fresh bark or bark with a suitable moisture content, is of a lower overall risk than round wood with bark. When volumes of trade are taken into account, the risk could become rather significant so that even a very small initial infestation level multiplies up to a large number of infested pieces of wood. Information from outbreaks of pine wilt disease outside the native range of PWN shows that major jumps in the distribution of the disease have been associated with carriage of *B. xylophilus* and *Monochamus*-infested wood, presumably with bark, into previously uninfested areas (Robinet et al. 2009). This pathway, by providing a number of different potential ways of final transfer to EPPO forests, represents a very high innate risk of transfer and establishment. Thus, in cases when both PWN and its vectors are present in imported wood (round wood with or without bark as well as sawn wood), the transfer of PWN from the pathway to a suitable host is likely to occur. In cases when only PWN is present in imported wood, its transfer is possible only if this wood is with bark and fresh enough for *Monochamus* infestation and development.
1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	moderately likely Medium uncertainty	If no *Monochamus* spp. are present in the imported wood, the nematode could only theoretically be transferred to trees by physical contact with suitable breeding substrates in Europe. This would depend on the end use of the commodity. In the case of round wood with bark, it is possible that the wood would be square-sawn, the outer rounded wood with bark being regarded as low value wood for burning, chipping or carcassing. Such wood and the sawdust produced on cutting would contain nematodes, which could survive for a considerable period of time. Some imported wood (round wood with or without bark as well as sawn wood) goes directly to processing and transformation, but some is stored before being processed and represents phytosanitary risk of vector transfer of PWN.

1.4 Pathway :	4) Particle wood and waste wood Low uncertainty	**4) Particle wood and waste wood** Three categories of wood are united in this pathway: • *Wood chips* • *Other particle wood* • *Waste wood*
1.4a Is this pathway a commodity pathway?	yes	
1.4b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	very likely Medium uncertainty	The PWN is very likely to be associated with particle and waste wood produced from wood that is harvested from areas containing the organism. The process of chipping wood will kill the majority of *Monochamus* spp. that may be present in the wood, depending on the chip size.
1.5 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	Likely Medium uncertainty	Infested wood could contain high quantities of PWN but depending on size very low quantities of *Monochamus* spp.
1.6 How large is the volume of the movement along the pathway?	Major Medium uncertainty	166169 tonnes of coniferous chips and particle wood were imported to EU from countries of PWN distribution (mainly from Canada and USA) in 2006, 165604 tonnes in 2007 and 202218 tonnes – in 2008 (EUROSTAT, October 2009). Inside the EU, 9822 tonnes of coniferous chips and particle wood were moved from Portugal in 2006, 5110 tonnes in 2007, and 6576 tonnes – in 2008 (EUROSTAT, October 2009). The industry is seeking to import huge amounts of chips for running power plants. 535189 tonnes of waste wood were imported to EU from countries of PWN distribution (mainly from Canada and USA) in 2006, 522332 tonnes in 2007 and 690502 tonnes – in 2008 (EUROSTAT, October 2009) (These data includes also non-coniferous waste wood separate date on coniferous waste wood not being available). Inside the EU, 48614 tonnes of waste wood were moved from Portugal in 2006, 165604 tonnes in 2007, and 202218 tonnes – in 2008 (EUROSTAT, October 2009) (These data includes also non-coniferous waste wood separate date on

		coniferous waste wood not being available). Import into the EU is restricted up to now as the required phytosanitary treatment (heat treatment) is too cost intensive and for the alternative fumigation treatment there are no treatment schedules available at the moment except for phosphine treatment in USA, for which efficacy is not clear. The use of particle and waste wood is increasing (for bioenergy and other purposes).
1.7 How frequent is the movement along the pathway?	Often Medium uncertainty	The import of coniferous particle and waste wood to EU and intra-EU movement of coniferous particle and waste wood from Portugal is distributed more or less homogeneously throughout of the year (EUROSTAT, October 2009).
1.8 How likely is the pest to survive during transport /storage?	very likely Low uncertainty	PWN is very likely to survive and reproduce during transport/storage whereas *Monochamus* vectors could be unable to completer development and are unlikely to survive unless they are present in larger pieces of wood or in later stages of their development (pre-pupae and pupae).
1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?	very likely Medium uncertainty	PWN is very likely to survive and reproduce during transport/storage. There is ample evidence that *B. xylophilus* reproduces successfully in wood chip piles and could be present in larger numbers at the end of transportation than at the start (Tomminen et al. 1991). Dauer juveniles have been demonstrated to occur in wood chips and to increase as a response to abrupt changes in temperatures (Tomminen et al. 1991). Waste wood (especially big pieces) is perfectly suitable for PWN development and reproduction. Any PWN vectors that survive the initial chipping process will be unlikely to complete development because the wood will tend to be too small to support the full larval and pupal development. In the bigger pieces of waste wood the probability to support full larval (if in a late stage of development) and pupal development is higher.
1.10 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	very likely Medium uncertainty	The nematode is very likely to survive and remain undetected during existing management procedures. *Monochamus* spp. could be detected only if there are obvious signs of their presence (grub holes, borings, etc.).
1.11 How widely is the commodity to be	Widely	Coniferous particle and waste wood is widely used in the PRA area and is likely to be widely

distributed throughout the PRA area?	Medium uncertainty	distributed there. No statistical data is available.
1.12 Do consignments arrive at a suitable time of year for pest establishment?	Yes Medium uncertainty	Coniferous particle and waste wood is moved in international trade throughout the year to the PRA area and some of consignments are likely to be imported at a suitable time for pest establishment. No statistical data is available.
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	moderately likely High uncertainty	Even though PWN was reported to be associated with a number of other cerambycid and weevil species emerging from nematode-infested plant material, only *Monochamus* spp. have been recorded to successfully transmit PWN between trees (Evans et al 1996). The great majority of vectors are absent from this pathway, unless they are accidental 'hitchhikers'. There is therefore very low theoretical risk of vector transfer with wood chips. The probability of PWN vectors being present in larger dimension waste wood is higher. Therefore, the overall risk of vector transfer of PWN from the pathway to a suitable host is limited. There is some experimental evidence for transfer of nematodes from wood chips to susceptible trees when chips are buried among wounded or unwounded tree roots (Kiyohara & Tokushige 1971; Mamiya & Shoji 1989; Halik & Bergdahl 1992). There is also experimental evidence that nematodes from chips can move to freshly cut tree stumps (Braasch, 1996). Movement to adjacent trees may be theoretically possible by root grafting (Malek & Appleby 1984; Eriko *et al*, 1998; Evans et al. 1996) but permanent establishment of *B. xylophilus* depends on interaction with *Monochamus* spp. for transfer between trees without root contact within and between forest blocks. This route of transmission therefore presents a low theoretical risk. Thus, only in rare cases when both PWN and its vectors are present in imported particle and waste wood, the transfer of PWN from the pathway to a suitable host is likely to occur. In cases when only PWN is present in imported particle and waste wood, its vector transfer is not possible because this wood is not suitable for *Monohamus* infestation and development.
1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	Unlikely High uncertainty	Most usual intended use is for processing which reduces the risk. The main intended uses of particle and waste wood are its use as mulch and as biofuel or for production of particle boards or as pulp for paper production. The use as biofuel or for processing to another end product does not aid transfer to a suitable host. If end uses include the use of wood chips as soil-covering mulch and as a surface layer on paths, this theoretically increases the probability of PWN-infested chips coming into contact with native trees in the PRA area.

1.4 Pathway :	5) Coniferous wood packaging material Low uncertainty	**5) Wood packaging material** According to ISPM No 15 "wood packaging material" covers all forms of wood packaging material that may serve as a pathway for pests posing a pest risk mainly to living trees. They cover wood packaging material such as crates, boxes, packing cases, dunnage[1], pallets, cable drums and spools/reels, which can be present in almost any imported consignment, including consignments that would not normally be subject to phytosanitary inspection. The following articles are of sufficiently low risk to be exempted from the provisions of the standard[2]: - wood packaging material made entirely from thin wood (6 mm or less in thickness), which does not completely guarantee the absence of PWN but exclude the presence of its vectors - wood packaging made wholly of processed wood material, such as plywood, particle board, oriented strand board or veneer that has been created using glue, heat or pressure, or a combination thereof - barrels for wine and spirit that have been heated during manufacture - gift boxes for wine, cigars and other commodities made from wood that has been processed and/or manufactured in a way that renders it free of pests - sawdust, wood shavings and wood wool - wood components permanently attached to freight vehicles and containers.
1.4a Is this pathway a commodity pathway?	no	Wood packaging material (WPM) in use is not a commodity itself. It is regulated internationally by ISPM No 15. To prevent phytosanitary risks of introduction of PWN to new areas with WPM, it is considered sufficient to follow this international standard. WPM not in use could be moved in international trade as commodity, in this case it is regulated as wood.
1.4b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	very likely Medium uncertainty	The presence of both *Monochamus* spp. and *B. xylophilus* is highly likely in any kind of wood (including WPM) that is harvested from areas containing the organisms.

[1] Consignments of wood (i.e. timber/lumber) may be supported by dunnage that is constructed from wood of the same type and quality and that meets the same phytosanitary requirements as the wood in the consignment. In such cases, the dunnage may be considered as part of the consignment and may not be considered as wood packaging material in the context of this standard.
[2] Not all types of gift boxes or barrels are constructed in a manner that renders them pest free, and therefore certain types may be considered to be within the scope of this standard. Where appropriate, specific arrangements related to these types of commodities may be established between importing and exporting NPPOs.

1.5 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices, treatment of consignments?	Likely Medium uncertainty	Infested wood could accumulate high quantity of nematodes and rather high quantity of *Monochamus*.
1.6 How large is the volume of the movement along the pathway?	Massive Low uncertainty	WPM is widely used throughout the World in international trade to accompany different kinds of consignments. It is subjected to ISPM No 15 requirements.
1.7 How frequent is the movement along the pathway?	very often (even more) Low uncertainty	The use of WPM accompanying different kinds of consignments is very frequent in international trade throughout the World.
1.8 How likely is the pest to survive during transport /storage?	very likely Medium uncertainty	There is no reason for serious mortality of PWN and *Monochamus* vectors during transport/storage unless WPM is treated according to the ISPM No 15. *Monochamus* vectors during transport/storage could lack space for development and their mortality could be higher. *Monochamus* vectors present in wood would complete their life cycle during up to 2 years, the PWN could survive substantially longer (there is evidence that *Bursaphelenchus mucronatus* can survive up to 10 years in dry wood).
1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?	very likely Medium uncertainty	There are no factors preventing increase in prevalence of PWN during transport/storage unless WPM is treated according to ISPM No 15. *Monochamus* vectors during transport/storage could lack space for development and their mortality could be higher. If the nematode is present in WPM, it is capable of surviving and reproducing for at least one year and possibly considerably longer (see point 1.8).
1.10 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	very likely Low uncertainty	The nematode is very likely to survive (unless WPM is treated according to ISPM No 15) and remain undetected during existing management procedures. *Monochamus* spp. could be detected only if there are obvious signs of their presence (grub holes, borings, etc.).
1.11 How widely is the commodity to be distributed throughout the PRA area?	very widely (even more) Low uncertainty	Coniferous WPM is widely used in the PRA area and is likely to be very widely distributed there.
1.12 Do consignments arrive at a suitable time of	Yes	Coniferous WPM is moved in international trade throughout the year to the PRA area and some of consignments are likely to be imported at a suitable time for pest establishment.

year for pest establishment?	Low uncertainty	
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	Likely Medium uncertainty	The risk of the pests transfer to suitable hosts is likely with non-treated WPM because of large volume of the pathway and the lack of control on its disposal or end use. Thus, only in rare cases when both PWN and its vectors are present in imported non-treated WPM, is the transfer of PWN from the pathway to a suitable host likely to occur (unless WPM is treated according to ISPM No 15). When only PWN is present in imported WPM, its vector transfer is not possible because this wood is not suitable for *Monohamus* infestation and development. The risk stays theoretical.
1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	moderately likely Medium uncertainty	The intended use and reuse of WPM does not aid the transfer but because of large volume of the pathway and the lack of control on its disposal or end use the risk of vector transfer of PWN persists while the WPM is fresh-made and the risk of non-vector transfer is only theoretical.

1.4 Pathway :	6) Isolated bark of host species Low uncertainty	**6) Isolated bark of host species**
1.4a Is this pathway a commodity pathway ?	yes	
1.4b How likely is the pest to be associated with the pathway at origin taking into account factors such as the occurrence of suitable life stages of the pest, the period of the year?	Likely Medium uncertainty	PWN is likely to be associated with bark from PWN-infested trees. Although larvae of *Monochamus* spp. require the inner bark to feed they are unable to complete development without boring into wood. There is therefore no risk of vector transfer via isolated bark.
1.5 How likely is the concentration of the pest on the pathway at origin to be high, taking into account factors like cultivation practices,	Likely Medium uncertainty	Infested bark could contain high quantity of PWN but not *Monochamus*.

treatment of consignments?		
1.6 How large is the volume of the movement along the pathway?	Moderate Medium uncertainty	Although data is lacking, the use of coniferous bark is increasing according to expert opinion.
1.7 How frequent is the movement along the pathway?	Often Medium uncertainty	No statistical data is available.
1.8 How likely is the pest to survive during transport /storage?	very likely Medium uncertainty	*B. xylophilus* will survive and reproduce in the inner bark layer in live cambial, wood cells and in fungi growing on the bark substrate. Bark that has not been composted represents the highest risk within this category because it will not have been subjected to the high temperatures associated with the composting process.
1.9 How likely is the pest to multiply/increase in prevalence during transport /storage?	very likely Medium uncertainty	*B. xylophilus* will reproduce in the inner bark layer in live cambial and wood cells. It will also reproduce on any suitable fungi present on the bark.
1.10 How likely is the pest to survive or remain undetected during existing management procedures (including phytosanitary measures)?	very likely Medium uncertainty	The PWN is very likely to survive and remain undetected during existing management procedures.
1.11 How widely is the commodity to be distributed throughout the PRA area?	very widely Medium uncertainty	Coniferous bark is widely used in the PRA area and is likely to be very widely distributed there.
1.12 Do consignments arrive at a suitable time of year for pest establishment?	Yes Medium uncertainty	Coniferous bark is moved in international trade throughout the year to the PRA area and some consignments are likely to be imported at a suitable time for pest establishment.
1.13 How likely is the pest to be able to transfer from the pathway to a suitable host or habitat?	Unlikely	The vectors are absent from this pathway. This pathway therefore has risks lower than those for wood chips. The similar constraints for further transmission of the nematode to mature trees suitable

	High uncertainty	for vector transfer apply. The only significant international trade in bark is for use as mulch in agriculture, horticulture and gardening. The non-vector transmission represents even lower theoretical risk than that for wood chips: non-vector transmission has only been demonstrated in experiments, but has never been reported in field conditions. Only PWN could be present in imported bark, its vector transfer is not possible and non-vector transfer is theoretical.
1.14 How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) to aid transfer to a suitable host or habitat?	moderately unlikely High uncertainty	The only significant international trade in bark is for use as mulch in agriculture, horticulture and gardening. This intended use increases the risk of PWN transfer to a suitable host but this risk (of non-vector transfer) itself is only theoretical.

Stage 2: Pest Risk Assessment - Section B : Probability of establishment

1.16 Estimate the number of host plant species or suitable habitats in the PRA area. Answer given to question 6 :	Many Low uncertainty	Most of *Pinus*, *Abies*, *Picea* and *Larix* species are known hosts of PWN. Some other conifers could also be infested. Large numbers of these tree species are present in the PRA area. (Kindel 1995; Schütt *et al*. 2004; Robinet, publication in preparation).
1.17 How widespread are the host plants or suitable habitats in the PRA area? (specify)	very widely Low uncertainty	The host plants of PWN are very widely spread in the PRA area (Schütt et al. 2004; Kindel 1995).
1.18 If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?	very likely Low uncertainty	*Monochamus* species are required for the pest spread and are widely distributed in the PRA area on different coniferous trees (Hellrigl, 1971, Bense, 1995).
1.19		

How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?	largely similar Medium uncertainty	Most of the EPPO region has climatic conditions similar to the current area of PWN distribution including its native range in North America where environmental conditions are generally unsuitable for wilt expression and the nematode remains in its saprophytic phase (Evans et al. 1996).
1.20 How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?	largely similar Medium uncertainty	Large part of the EPPO region has abiotic factors (including soil types, range of slopes, etc.) similar to the current area of PWN distribution but they do not much affect PWN establishment.
1.21 If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?	N/A Low uncertainty	
1.22 How likely is it that establishment will occur despite competition from existing species in the PRA area?	very likely Low uncertainty	Local wood nematode species (e.g. *Bursaphelenchus mucronatus*) are unlikely to be an obstacle for PWN establishment. Due to greater competitiveness of PWN, *Bursaphelenchus mucronatus* will not reduce significantly the risk of establishment of PWN (Vincent et al., 2007). It is more the other way round: it is believed that habitats suitable for other *Bursaphelenchus* species in Conifers (especially *B. mucronatus*) are an indicator that those areas are also suitable for *B. xylophilus* (Evans *et al*, 1996).
1.23 How likely is it that establishment will occur despite natural enemies already present in the PRA area?	very likely Low uncertainty	It is extremely unlikely that natural enemies existing in the PRA area (if any) could be an obstacle for PWN establishment. Natural enemies include mainly generalists, such as woodpeckers and predatory beetles. Those affect the vector beetles and may reduce their populations. However when forest calamities occur such as forest fires, *Monochamus* species can built up a high population in a short time (Hellrigl, 1971). In Portugal up to now no natural enemies have been observed which significantly reduce the vector beetle population. There has been only little research on natural enemies of the nematode itself. As the multiplication rate in an infested tree is so high it seems to be unlikely that natural enemies can significantly reduce a *B. xylophilus* population.
1.24 To what extent is the managed environment in the PRA area favourable for establishment?	highly favourable Medium uncertainty	Apart of known susceptible native pine species grown commercially in the PRA area a number of American conifer species from the native range of the pest are also grown. Depending on silvicultural practice, host material suitable for breeding of Monochamus species may occur in the

		forest: e.g. if pines during thinning are left on site and are not removed from the stands.
1.25 How likely is it that existing pest management practice will fail to prevent establishment of the pest?	Likely Medium uncertainty	Existing forest pest management practices in the PRA area can not prevent establishment of PWN particularly because they lead to increased abundance of breeding material for the vectors.
1.26 Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?	Very likely Medium uncertainty	Key biological characteristics of this pest are its ability to establish in trees without symptom expression, and its capacity to live saprophytically (Futai, 2003; Yang *et al*, 2003; Takeuchi & Futai, 2007; Futai & Takeuchi, 2008, Myers, 1986, Mamyia, 2003, Halik & Bergdahl, 1994; Bergdahl & Halik, 2003). These characteristics should be taken into account in designing survey and eradication measures (Schröder *et al*., 2009). Late detection of initial establishment and the difficulty of preventing spread by the vector (naturally or by human assistance) make it very difficult to eradicate (which is confirmed by experience of China, Korea, Taiwan and Portugal (Mota, Futai & Vieira, 2009).
1.27 How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?	Likely Medium uncertainty	The ability of PWN to have both a saprophytic and a pathogenic phase (Wingfield 1987), its high reproductive rate, its close relationships with *Monochamus* vectors and its capacity to survive adverse conditions all aid its establishment.
1.28 How likely are relatively small populations to become established?	very likely Medium uncertainty	Based on the carrying capacity of vectors in the genus *Monochamus*, few (10s to low hundreds) specimens transmitted to a host tree are sufficient to enable a PWN population to establish in that tree (Akbulut & Linit, 1999).
1.29 How adaptable is the pest?	High Medium uncertainty	The wide geographical range in North America and experience of introductions to China, Japan, Korea, Taiwan and Portugal shows high adaptability capacities of PWN.
1.30 How often has the pest been introduced into new areas outside its original area of distribution? Specify the instances if possible in the comment box.	Often Low uncertainty	There are several recorded cases of introduction of PWN to new countries (Japan, China, Korea, Taiwan, Portugal) and to new areas inside countries (e.g. in China, Japan and Portugal) (Mota, Futai & Vieira, 2009). There is no evidence for establishment of *Monochamus* spp. in exotic locations outside their native ranges (Evans et al. 1996); one reason for this could be that females must be mated repeatedly in

		order to lay fertile eggs. Synchrony of emergence of both males and females of the same species is therefore a necessity for establishment of exotic *Monochamus* spp. in Europe.
1.31a Do you consider that the establishment of the pest is very unlikely?	no	
1.31b How likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment) ?	N/A	
1.31c The overall probability of establishment should be described.		The establishment of PWN in new areas of the EPPO region is highly likely, which is shown by experience in Portugal and non-EPPO countries and by climate comparison with the area of current distribution as well as widespread availability of *Monochamus* spp.

Stage 2: Pest Risk Assessment - Section B : Probability of spread

1.32 How likely is the pest to spread rapidly in the PRA area by natural means?	Likely Medium uncertainty	Natural spread takes place by *Monochamus* vector assistance. In an epidemic situation (particularly in China and Japan), the rate of disease spread has been estimated to be between 2 and 15 km per year in Japan (Takasu *et al*, 2000; Togashi, Shigesada, 2006) and an average of 7.5 km per year in China (Robinet *et al*, 2009). This results from a combination of beetle flight and human-assisted local movement of infested wood. Detailed studies of the flight capabilities of *Monochamus* spp, especially *M. alternatus* in Japan and China, indicates that most flight is very local (up to 100 m) but that longer distance flight (various estimates between 1.8 and 3.3 km) can also take place. The evidence for this come from a number of studies on flight capabilities of *Monochamus* spp. that show the following distances (unless stated all studies refer to *M. alternatus*): • up to 2.4 km in experiment period (a release-recapture experiment in which one beetle from 756 released reached 2.4 km; 75,5% of the beetles recaptured within 100 meter (Ido & Kobayashi, 1977); • 3.3 km/flight across open sea (Kawabata, 1979); • 2 km/flight (Fujioka, 1993); • 1.8 km/experiment period in average (Takasu et al., 2000); • 2.3 km/flight (*M. carolinensis*) (Linit & Akbulut, 2003);

		• 7 – 20 m/week (Togashi, 1990a); • 10-50 m/flight (Shibata, 1986). No data have been published on flight capabilities of European species of *Monochamus*, although a small release-recapture experiment was done by Sousa *et al* (2001) within the EU PHRAME (Plant Health Risk and Monitoring Evaluation) project. This indicated that most beetles stayed close to the release point but that, within about 78 days a small number had flown over 200 m to an adjacent forest block. Based on these reports, it is reasonable to conclude that potential spread of PWN by natural means in the EPPO region by *Monochamus* vectors (*M. galloprovincialis, M. sutor, M. sartor, M. urussovi, M. saltuarius* and *M. impluviatus*) would be of up to 3 km per flight season.
1.33 How likely is the pest to spread rapidly in the PRA area by human assistance?	very likely Low uncertainty	The recent analysis and modelling of PWN spread in China has shown that the rate of long distance spread has been between 111 and 339 km per year and was strongly correlated with factors such as human population density and transport routes (Robinet et al., 2009). In general, in the absence of measures, PWN is able to spread very fast and over long distances with human assistance, mainly with national movement of untreated WPM, host wood and plants for planting.
1.34 Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?	Likely Medium uncertainty	Key biological characteristics of this pest are its ability to establish in trees without symptom expression, and its capacity to live saprophytically. Symptomless trees of non-pine coniferous and even some *Pinus* species could occur in the part of the EPPO region where PWN has been shown to kill *Pinus* hosts. These characteristics should be taken into account in designing survey and containment measures. Late detection of new infestations and the difficulty of preventing spread by the vector (naturally or by human assistance) make it very difficult to contain (which is confirmed by experience of China, Korea and Portugal).
1.34c The overall probability of spread should be described.		Spread of PWN and its vectors in the PRA area is likely without eradication/containment measures, which should be based on biological characteristics of the pest and its vectors, particularly the capacity of PWN to be present in host trees that are not exhibiting symptoms of wilt expression and the breeding of some *Monochamus* spp.(e.g. *M. galloprovincialis*) in small diameter woody debris. These must be accounted for in detection surveys.

Stage 2: Pest Risk Assessment - Section B : Conclusion of introduction and spread and identification of endangered areas

1.36a Conclusion on the probability of introduction and spread. (Your conclusions from the previous modules will appear in the box bellow.)		In order of priority, the probability of entry of PWN and its vectors is: 1) untreated coniferous wood packaging materials (but the implementation of ISPM No 15 reduces this risk to an acceptable level), 2) wood, 3) plants for planting, 4) particle and waste wood, 5) cut branches, 6) isolated bark. Nevertheless the risk of PWN entry, but not necessarily establishment, with those commodities is substantial. The establishment of PWN in new areas of the EPPO region is highly likely, which is shown by experience in Portugal and non-EPPO countries and by climate comparison with the area of current distribution as well as widespread availability of *Monochamus* spp. Spread of PWN in the PRA area is likely without eradication/containment measures, which should be based on biological characteristics of the pest.
1.36b Based on the answers to questions 1.16 to 1.34 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.		Coniferous plants are present in all EPPO countries. PWN is likely to establish throughout the distribution range of suitable hosts in the PRA area. Tree damage will be different in different parts of the EPPO region, but even in areas where direct damage will be negligible, the presence of the pest will have important impacts on international trade. So, the whole of the PRA area where host plants are present is considered as an endangered area. Climate change is likely to increase the zones within the PRA area where PWN can result in wilt expression in susceptible host trees. Previous indications were that the 20^{o}C July or August isotherms would delimit the area of wilt expression (De Guiran 1990) and new process modelling methods are now being used to refine this gross assumption (Evans, Evans & Ikegami, 2008). The impact of climate change on productivity of existing and future forests must be taken into account and include possible effects of PWN and other biotic damaging agents.

Stage 2: Pest Risk Assessment - Section B : Assessment of potential economic consequences

2.1 How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?	Massive Low uncertainty	The current area of PWN includes the area of the pest origin (North America) and the areas where it has been introduced (Japan, China, Korea, Portugal). While the negative effect in the area of origin is low, the negative effects in other parts of the current area are massive. Very few host trees in the native area of origin succumb to the disease but the impact on export markets is substantial. It is clear that PWN is able to cause significant damage to plants in the PRA area (Kulinich & Kolossova, 1993, 1995; Evans *et al*., 1996; Mota et al 1999). This damage would be expressed in tree mortality in the southern part of the EPPO region (as demonstrated in Portugal) and in restrictions to trade in its northern part. In Portugal, almost 24 mln euros during 2001 – 2009 were spent to control/eradicate PWN (CIRCA information). In Spain, almost 344 thousand euros were spent in 2009 and almost 3 mln euros will be spent in 2010.
2.2 How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?	Massive Low uncertainty	In areas where wilt expression is predicted there will be significant tree mortality. Simulation presented in the final report of the EU PHRAME project (QLK5-CT-2002-00672) suggests that up to 90% of susceptible pine trees could die in the Setubal region of Portugal.
2.3 How easily can the pest be controlled in the PRA area without phytosanitary measures?	Impossible Low uncertainty	The experience in countries where PWN has been introduced shows that, even with the application of phytosanitary measures, PWN control is very difficult once the infested area has reached a certain size.
2.4 How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?	Major Medium uncertainty	An increase in production costs is likely to be major due to costs of phytosanitary and control measures, commodity treatments, early replanting compared with expected rotation age, possible changes of tree species to be grown and other costs. In Japan, tens of millions of dollars have been spent for PWN control annually (Kulinich, Kolossova, 1993). In Portugal, almost 24 mln euros during 2001 – 2009 were spent to control/eradicate PWN (information SANCO). In Spain, almost 344 thousand euros were spent in 2009 and almost 3 mln euros will be spent in 2010.
2.5 How great a reduction in consumer demand is the pest likely to cause in the PRA area?	Minor Medium uncertainty	Consumer demand is unlikely to change but may lead to substitution of supply.

2.6 How important is environmental damage caused by the pest within its current area of distribution?	Major Medium uncertainty	The current area of PWN includes the area of the pest origin (North America) and the areas where it has been introduced (Japan, China, Korea, Taiwan, and Portugal). While the negative effect on the environment in the area of pest origin is low, the negative effects on the environment in other parts of the current area are massive, with enormous tree mortality and changes to the choice of tree species, etc. Such effects would alter ecosystem processes and services significantly in the PRA area where pines are key species.
2.7 How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?	Major Medium uncertainty	While the negative effects on the environment in those areas where pine wilt will not be expressed is likely to be low, the negative effects on the environment in other parts of the potential area are likely to be massive.
2.8 How important is social damage caused by the pest within its current area of distribution?	Moderate High uncertainty	The extensive mortality and premature felling of substantial numbers of coniferous trees in areas affected by PWN has influenced the recreational role of forests and parks and their amenity value as well as attractiveness for tourists.
2.9 How important is the social damage likely to be in the PRA area?	Moderate High uncertainty	The extensive mortality and premature felling of substantial numbers of coniferous trees in areas affected by PWN in the PRA area will influence the recreational role of forests and parks and their amenity value as well as attractiveness for tourists.
2.10 How likely is the presence of the pest in the PRA area to cause losses in export markets?	Likely Low uncertainty	PWN is classified as a quarantine pest for many countries. These countries prohibit import of untreated PWN host plant commodities from areas of the pest distribution. The introduction of PWN into EPPO countries may result in losses in export markets because of increases of phytosanitary costs and capacity problems in carrying out phytosanitary measures.
2.16a	go to 2.16	
2.16 Referring back to the conclusion on endangered area (1.35) : Identify the parts of the PRA area where the pest can establish and which are economically most at risk.		Coniferous plants are present in all EPPO countries. PWN is likely to establish throughout the distribution range of suitable hosts in the PRA area. Tree damage will be different in different parts of the EPPO region, but even in areas where direct damage will be negligible, the presence of the pest will have important impacts on international trade. Thus, the whole of the PRA area where host plants are present is considered as an endangered area.

Stage 2: Pest Risk Assessment - Section B : Degree of uncertainty and Conclusion of the pest risk assessment

2.17 Degree of uncertainty: list sources of uncertainty		The main uncertainties arise from the lack of information available on the risk of infestation of "secondary" hosts (such as *Juniperus*, *Tsuga*, etc.) and "secondary" commodities (such as bark or cut branches) by PWN and especially by its *Monochamus* vectors. *Juniperus*, *Chamaecyparis* and *Cryptomeria* could be hosts of *Monochamus* but not of PWN: the lack of evidence creates some uncertainty. Considerable uncertainties remain concerning transmission of PWN from certain consignments to suitable hosts and its possible transmission to trees in the absence of vectors. These involve consignments that do not carry *Monochamus* and cannot be attacked by *Monochamus* because non-vector transmission has only been demonstrated in experiments, but has never been reported in field conditions. Although there is substantial information on flight capacities of *M. alternatus* and *M. carolinensis*, there is only fragmentary information on flight distances for *Monochamus* spp. in the EPPO region. Other uncertainties (e.g. on the degree of social damage) are not important for overall conclusions on the phytosanitary risks involved.
2.18 Conclusion of the pest risk assessment		PWN can be considered as a quarantine pest for the PRA area: the probability of its entry is high, it is likely to be able to establish in all parts of the PRA area that have coniferous hosts and, where climatic and soil conditions are suitable, to cause important economic, social and environmental damage there. Climate change is likely to increase the zones within the PRA area where PWN can result in wilt expression in susceptible host trees and thus in direct economic, social and environmental damage.

Stage 3: Pest Risk Management

3.1 Is the risk identified in the Pest Risk Assessment stage for all pest/pathway combinations an acceptable risk?	no	See data in the Pest Risk Assessment part of the PRA.
3.2a Pathway :	1) Plants for planting (except seeds) of host species (including bonsai	This pathway includes all coniferous PWN host plants for planting.

	plants)	
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 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 box notes)	yes	Different EPPO countries have different phytosanitary measures restricting the import of coniferous plants for planting (e.g. prohibitions for some origins, pest-free areas for some pests, freedom from some pests, freedom from cones, freedom from attached soil, etc.). In some cases (e.g. in case of prohibition of plants for planting import from countries/areas where PWN occurs) these measures could be efficient against PWN introduction.)
3.13 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	PWN is too small to be visible. To see it under a microscope, special preparation and testing are needed. Symptoms could be visible but are not pest-specific: pine wilt could arise for other reasons.
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	yes possible measure: specified testing	This testing requirement is not sufficient when used alone. The plants should have been tested and found free from *Bursaphelenchus xylophilus* and its vectors and should be produced under vector-proof conditions according to EPPO National Regulatory Control System No 9/1.
3.15 Can the pest be reliably detected during post-entry quarantine?	no	Post-entry testing of small plants for planting would kill these plants and prevent their intended use. Post-entry testing of large plants for planting will detect PWN too late to prevent its spread.
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?	no	Although the pest can be destroyed by heat treatment, methyl-bromide fumigation or burning, these treatments will kill plants for planting and therefore can not be recommended.
3.17 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	no	PWN is present in any part of the plant.

not relevant for pest plants)		
3.18 Can infestation of the consignment be reliably prevented by handling and packing methods?	no	If plants for planting are infested with PWN, this fact can not be changed by handling and packing methods. Infestation in transit could be prevented by carriage within sealed containers or packaging if the consignment is transported through territories infested both by PWN and its vectors.
3.19 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	If plants for planting are infested with PWN, the end use (which is planting or keeping planted by definition) and distribution do not reduce risk.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	no	In order to prevent infestation of a tree with *Monochamus* beetles, insecticide treatment throughout the whole flight period (May to end October) would be necessary. This would most probably not prevent nematodes to enter susceptible trees during maturation feeding. There is no insecticide treatment available to combat the nematodes inside a tree.
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	Some research has been done on breeding PWN-tolerant *Pinus* varieties (Kasuya, Sakura & Kishi 1990; Toda & Kurinobu 1999). Some conifers are more tolerant to PWN. But this measure is not regarded as reliable and will not prevent introduction.
3.22 Can infestation of the commodity be reliably prevented by growing the crop in specified conditions (e.g. protected conditions such as screened greenhouses, physical isolation, sterilized growing medium, exclusion of running water, etc.)?	yes	Growing in specified vector-proof conditions could ensure place of production freedom of plants for planting, but this measure could not be regarded as efficient alone and should be combined with testing.
3.23 Can infestation of the commodity be reliably prevented by harvesting only at certain times of the year, at specific crop ages or growth	no	

stages?		
3.24 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	Coniferous plants for planting are not produced under certification schemes.
3.25 Has the pest a very low capacity for natural spread?	no	
3.26 Has the pest a low to medium capacity for natural spread?	no	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: pest-free area.	The spread of PWN occurs with *Monochamus* vectors. Capacities of this spread could be classified as "medium to high" according to vector flight capacities. The non-vector spread is only theoretical.
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Only area freedom could be reliably guaranteed based on the requirements outlined in ISPM No 4.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	no	Portugal experience shows that even a very intensive survey and phytosanitary measures do not make successful eradication of PWN easily achievable. In principle, PWN eradication is possible but very complicated and expensive. It could not be considered as an effective measure alternative to phytosanitary measures taken in the exporting country and in transit.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	no	Any of identified measures taken alone could not reduce the risk to an acceptable level and should be combined.
3.32		

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	
3.32b List the combination of measures		The pest-free area requirement in combination with measures preventing the infestation of the commodity in transit (transportation outside of *Monochamus* flight period, or through areas not infested with *Bursaphelenchus xylophilus*, or in sealed containers or packaging to prevent infestation) could reduce the risk to an acceptable level. The pest-free area requirement could be replaced by testing plants for PWN freedom in combination with production under vector-proof conditions, and always in combination with measures preventing the infestation of the commodity in transit mentioned above.
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The proposed combinations of measures restrict international trade requiring origin in PWN free area in the exporting country or growing them in vector-proof conditions and tested for PWN freedom, and measures preventing the infestation of the commodity in transit (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) but they do not stop it and they are the least restrictive possible.
3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		Considering the huge risk associated with PWN introduction and potential economic losses, the proposed combinations of measures are cost effective and do not have undesirable social or environmental effects.
3.36 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	

3.2a Pathway :	2) Cut branches of host species (including Christmas trees)	This pathway includes all coniferous PWN host cut branches (including Christmas trees). The end use and disposal of cut branches should be controlled.
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 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 box notes)	yes	Different EPPO countries have different phytosanitary measures restricting the import of coniferous cut branches (e.g. prohibitions for some origins, pest-free areas for some pests, freedom from some pests, freedom from cones, etc.).
3.13 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	PWN is too small to be visually detected. To see it under a microscope, special preparation and testing are needed. Branches or Christmas trees with visible sympoms will not be traded as they are losing theis ornamental value.
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	Yes possible measure: specified testing.	This testing requirement is not sufficient when used alone. The cut branches should have been tested and found free from *Bursaphelenchus xylophilus* and its vectors, and must come from a pest-free place of production whose immediate vicinity was free from *Bursaphelenchus xylophilus*.
3.15 Can the pest be reliably detected during post-entry quarantine?	no	Applying a certain period of post-entry quarantine would compromise the intended use of the cut branches/Christmas trees.
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?	no	Although the pest can be destroyed by heat treatment, methyl-bromide fumigation or burning, these treatments will also destroy cut branches or decrease their ornamental value (necessary for their intended use) and therefore can not be recommended.
3.17		

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	PWN is present in any part of the plant.
3.18 Can infestation of the consignment be reliably prevented by handling and packing methods?	no	Infestation in transit could be prevented by carriage within sealed containers or packaging if the consignment is transported through territories infested both by PWN and its vectors.
3.19 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	If cut branches are infested with PWN, the end use and distribution can not reduce risk.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	no	In order to prevent infestation of a tree with Monochamus beetles insecticide treatment throughout the whole flight period (May to end October) would be necessary. This would most probably not prevent nematodes to enter susceptible trees during maturation feeding. There is no insecticide treatment available to combat the nematodes inside a tree.
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	Some research has been done on breeding PWN-tolerant *Pinus* varieties (Kasuya, Sakura & Kishi 1990; Toda & Kurinobu 1999). Some conifers are more tolerant to PWN. But this measure is not regarded as reliable and will not prevent introduction.
3.22 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	Growing in specified vector-proof conditions could ensure place of production freedom of cut branches, but this measure could not be regarded as efficient alone and should be combined with testing for PWN freedom. But these measures are not considered practical for cut branches.
3.23		

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	
3.24 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	
3.25 Has the pest a very low capacity for natural spread?	no	
3.26 Has the pest a low to medium capacity for natural spread?	no	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: pest-free area.	The spread of PWN occurs with *Monochamus* vectors. Capacities of this spread could be classified as “medium to high” according to vector flight capacities. The non-vector spread is only theoretical.
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Only area freedom could be reliably guaranteed based on the requirements outlined in ISPM No 4.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	No	Portugal experience shows that even a very intensive survey and phytosanitary measures do not make successful eradication of PWN easily achievable. In principle, PWN eradication is possible but very complicated and expensive. It could not be considered as an effective measure alternative to phytosanitary measures taken in the exporting country and in transit.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	no	Any of identified measures taken alone could not reduce the risk to an acceptable level and should be combined.

3.32 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	
3.32b List the combination of measures		The pest-free area requirement in combination with measures preventing the infestation of the commodity in transit (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) could reduce the risk to an acceptable level. The pest-free area requirement could be replaced by testing the consignments in combination with place of production and immediate vicinity freedom, always in combination with measures preventing the infestation of the commodity in transit mentioned above.
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The proposed combinations of measures restrict international trade requiring origin in PWN free area in the exporting country and measures preventing the infestation of the commodity in transit (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) but they do not stop it and they are the least restrictive possible.
3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		Considering the huge risk associated with PWN introduction and potential economic losses, the proposed combinations of measures are cost effective and do not have undesirable social or environmental effects.
3.36 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	

3.2a Pathway :	3) Wood (except particle wood and waste wood) of host species	This pathway includes all coniferous PWN host wood except particle wood and waste wood.
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 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 box notes)	yes	Different EPPO countries have different phytosanitary measures restricting the import of coniferous wood (e.g. prohibitions for some origins, pest-free areas for some pests, freedom from some pests, freedom from grub holes, debarking, heat treatment, etc.).
3.13 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	PWN is too small to be visually detected. To see it under a microscope, special preparation and testing are needed. On the traded wood, there are no visible symptoms of PWN infections.
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	no	Reliable testing method is available but testing all volume is not practical.
3.15 Can the pest be reliably detected during post-entry quarantine?	no	
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?	yes possible measure: specified treatment.	Three treatments are effective against PWN: (1) heat treatment (by using a reliable method/process to achieve 56ºC in the core of wood for at least 30 min), (2) methyl-bromide fumigation (according to the EPPO Phytosanitary Procedure No 10/7) and (3) irradiation according to PM 10/8. Debarking could prevent infestation if PWN-free consignment is transported through or stored on territories infested both by PWN and its vectors.
3.17 Does the pest occur only on certain parts of the plant or plant products (e.g. bark,	no	PWN is present in any part of the plant.

flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)		
3.18 Can infestation of the consignment be reliably prevented by handling and packing methods?	no	Infestation in transit could be prevented by carriage within sealed containers or packaging if the consignment is transported through territories infested both by PWN and its vectors.
3.19 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	If wood is infested with PWN, the end use and distribution can not reduce risk.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	no	
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	Some research has been done on breeding PWN-tolerant *Pinus* varieties (Kasuya, Sakura & Kishi 1990; Toda & Kurinobu 1999). Some conifers are more tolerant to PWN. But this measure is not regarded as reliable and will not prevent introduction.
3.22 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	The crop consists of coniferous trees which are usually grown in forests. Those trees cannot be produced under protected conditions.
3.23 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	

3.24 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)?	N/A	
3.25 Has the pest a very low capacity for natural spread?	no	
3.26 Has the pest a low to medium capacity for natural spread?	no	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: pest-free area.	The spread of PWN occurs with *Monochamus* vectors. Capacities of this spread could be classified as “medium to high” according to vector flight capacities. The non-vector spread is only theoretical.
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Only area freedom could be reliably guaranteed based on the requirements outlined in ISPM No 4.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	No	Portugal experience shows that even a very intensive survey and phytosanitary measures do not make successful eradication of PWN easily achievable. In principle, PWN eradication is possible but very complicated and expensive. It could not be considered as an effective measure alternative to phytosanitary measures taken in the exporting country and in transit.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	no	Any of identified measures taken alone could not reduce the risk to an acceptable level and should be combined.
3.32 For those measures that do not reduce the risk to an acceptable level, can two or more	yes	

measures be combined to reduce the risk to an acceptable level?		
3.32b List the combination of measures		The pest-free area requirement in combination with debarking or other measures preventing the infestation of the commodity in transit or during storage (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) could reduce the risk to an acceptable level. Heat treatment or methyl-bromide fumigation[3] or irradiation could reduce the risk to an acceptable level in combination with debarking or other measures preventing the infestation of the commodity in transit or during storage.
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The proposed measures and combinations of measures restrict international trade requiring origin in PWN free area in the exporting country, heat treatment, irradiation or fumigation of the commodity and measures preventing the infestation of the commodity in transit (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) but they do not stop it and they are the least restrictive possible.
3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		Considering the huge risk associated with PWN introduction and potential economic losses, the proposed measures and combinations of measures are cost effective and do not have undesirable social or environmental effects.
3.36 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	

3.2a Pathway :	4) Particle wood and	This pathway includes all coniferous particle wood and waste wood of coniferous host plants.

[3] Prior removal of bark must be carried out for the efficacy of methyl bromide treatment

	waste wood of host species	
3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 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 box notes)	yes	Different EPPO countries have different phytosanitary measures restricting the import of coniferous particle and waste wood (e.g. prohibitions for some origins, pest-free areas for some pests, freedom from some pests, debarking, heat treatment, fumigation, etc.).
3.13 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	PWN is too small to be visually detected. To see it under a microscope, special preparation and testing are needed. On the traded particlr wood and waste wood, there are no visible symptoms of PWN infections.
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	yes possible measure: specified testing	This testing is possible in theory but difficult in practice. Wood chips tend to be imported in large quantities and could encourage development and breeding of PWN. Testing of particle wood and waste wood is more feasible than testing other wood (see above) because only large peaces of wood (suitable for development of PWN vectors) require testing.
3.15 Can the pest be reliably detected during post-entry quarantine?	no	
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?	yes possible measure: specified treatment.	One treatment is effective against PWN: heat treatment (by using a reliable method/process). If PWN-free particle and waste wood originate from debarked wood, it could prevent further infestation if consignments are transported through or stored in territories infested both by PWN and its vectors.
3.17 Does the pest occur only on certain parts of the plant or plant products (e.g. bark,	no	

flowers), which can be removed without reducing the value of the consignment? (This question is not relevant for pest plants)		
3.18 Can infestation of the consignment be reliably prevented by handling and packing methods?	no	Infestation in transit could be prevented by carriage within sealed containers or packaging if the consignment is transported through territories infested both by PWN and its vectors.
3.19 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	If particle/waste wood is infested with PWN, the end use and distribution can not effectively reduce risk. If it is imported outside of *Monochamus* flight period (e.g. during winter) and processed before *Monochamus* flight period starts, there is no risk of PWN introduction, but it may not be feasible for NPPOs to ensure that all imported particle/waste wood is completely processed before *Monochamus* flight period.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	no	
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	Some research was done for breeding PWN-tolerant *Pinus* varieties (Kasuya, Sakura & Kishi 1990; Toda & Kurinobu 1999). Some research has been done on breeding PWN-tolerant *Pinus* varieties. Some conifers are more tolerant to PWN. But this measure is not regarded as reliable and will not prevent introduction.
3.22 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	
3.23 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	

3.24 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)?	N/A	
3.25 Has the pest a very low capacity for natural spread?	No	
3.26 Has the pest a low to medium capacity for natural spread?	No	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: area freedom	The spread of PWN occurs with *Monochamus* vectors. Capacities of this spread could be classified as "medium to high" according to vector flight capacities. The non-vector spread is only theoretical.
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Only area freedom could be reliably guaranteed based on the requirements outlined in ISPM No 4.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	No	Portugal experience shows that even a very intensive survey and phytosanitary measures do not make successful eradication of PWN easily achievable. In principle, PWN eradication is possible but very complicated and expensive. It could not be considered as an effective measure alternative to phytosanitary measures taken in the exporting country and in transit.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	No	
3.32 For those measures that do not reduce the risk	yes	

to an acceptable level, can two or more measures be combined to reduce the risk to an acceptable level?		
3.32b List the combination of measures		The pest-free area requirement in combination with production from debarked wood or other measures preventing the infestation of the commodity in transit (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) could reduce the risk to an acceptable level. Heat treatment could reduce the risk to an acceptable level in combination with production from debarked wood or measures preventing the infestation of the commodity in transit.
3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The proposed measures and combinations of measures restrict international trade requiring origin in PWN free area in the exporting country, heat treatment or irradiation of the commodity and measures preventing the infestation of the commodity in transit (transportation outside of PWN vectors flight period, or through areas not infested with PWN, or in sealed containers or packaging to prevent infestation) but they do not stop it and they are the least restrictive possible.
3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		Considering the huge risk associated with PWN introduction and potential economic losses, the proposed measures and combinations of measures are cost effective and do not have undesirable social or environmental effects.
3.36 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	

3.2a Pathway :	6) Isolated bark of host species	This pathway includes all coniferous bark.

3.2 Is the pathway that is being considered a commodity of plants and plant products?	yes	
3.12 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 box notes)	yes	Different EPPO countries have different phytosanitary measures restricting the import of coniferous bark (e.g. prohibitions for some origins, pest-free areas for some pests, freedom from some pests, heat treatment, fumigation, etc.).
3.13 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	
3.14 Can the pest be reliably detected by testing (e.g. for pest plant, seeds in a consignment)?	yes possible measure: specified testing.	This testing is possible in theory but not practical used alone. Testing of bark is however more feasible than testing of wood (see above). Sampling procedures may limit the confidence level of detection if PWN is present
3.15 Can the pest be reliably detected during post-entry quarantine?	no	
3.16 Can the pest be effectively destroyed in the consignment by treatment (chemical, thermal, irradiation, physical)?	yes Possible measure: specified treatment.	One treatment of bark is effective against PWN: heat treatment (by using a reliable method/process).
3.17 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	
3.18		

Can infestation of the consignment be reliably prevented by handling and packing methods?	no	There is no risk of infestation of bark in transit both by PWN and its vectors.
3.19 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	If isolated bark is infested with PWN, the end use and distribution can not reduce risk.
3.20 Can infestation of the commodity be reliably prevented by treatment of the crop?	no	
3.21 Can infestation of the commodity be reliably prevented by growing resistant cultivars? (This question is not relevant for pest plants)	no	Some research has been done on breeding PWN-tolerant *Pinus* varieties (Kasuya, Sakura & Kishi 1990; Toda & Kurinobu 1999). Some conifers are more tolerant to PWN. But this measure is not regarded as reliable and will not prevent introduction.
3.22 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	
3.23 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	
3.24 Can infestation of the commodity be reliably prevented by production in a certification scheme (i.e. official scheme for the production	N/A	

of healthy plants for planting)?		
3.25 Has the pest a very low capacity for natural spread?	no	
3.26 Has the pest a low to medium capacity for natural spread?	no	
3.27 The pest has a medium to high capacity for natural spread	yes Possible measure: pest-free area.	The spread of PWN occurs with *Monochamus* vectors. Capacities of this spread could be classified as “medium to high” according to vector flight capacities. The non-vector spread is only theoretical.
3.28 Can pest freedom of the crop, place of production or an area be reliably guaranteed?	yes	Only area freedom could be reliably guaranteed based on the requirements outlined in ISPM No 4.
3.29 Are there effective measures that could be taken in the importing country (surveillance, eradication) to prevent establishment and/or economic or other impacts?	No	Portugal experience shows that even a very intensive survey and phytosanitary measures do not make successful eradication of PWN easily achievable. In principle, PWN eradication is possible but very complicated and expensive. It could not be considered as an effective measure alternative to phytosanitary measures taken in the exporting country and in transit.
3.31 Does each of the individual measures identified reduce the risk to an acceptable level?	yes	The pest-free area requirement could reduce the risk to an acceptable level. Heat treatment could reduce the risk to an acceptable level.
3.32 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?	N/A	
3.32b List the combination of measures		

3.34 Estimate to what extent the measures (or combination of measures) being considered interfere with international trade.		The proposed measures restrict international trade requiring origin in PWN free area in the exporting country or heat treatment of the commodity but they do not stop it and they are the least restrictive possible.
3.35 Estimate to what extent the measures (or combination of measures) being considered are cost-effective, or have undesirable social or environmental consequences.		Considering the huge risk associated with PWN introduction and potential economic losses, the proposed measures and combinations of measures are cost effective and do not have undesirable social or environmental effects.
3.36 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	

3.41 Consider the relative importance of the pathways identified in the conclusion to the entry section of the pest risk assessment		Pathways in order of their importance: 1) Coniferous wood packaging material - the risk is managed by ISPM No 15, 2) Wood (except particle and waste wood) of host species, 3) Plants for planting (except seeds) of host species (including bonsai plants), 4) Particle and waste wood of host species, 5) Cut branches (including Christmas trees) of host species, 6) Isolated bark of host species

Summary of Pest Risk Management stage

Plants for planting (except seeds) of Coniferae host species	PC[4] and, if appropriate, RC[5]
Plants for planting (except seeds) of host species originating in countries where *Bursaphelenchus xylophilus* occurs	Pest-free area for *Bursaphelenchus xylophilus* or[6] The plants should have been tested and found free from *Bursaphelenchus xylophilus* and its vectors and produced under vector-proof conditions according to EPPO National Regulatory Control System No 9/1 AND Transported outside of *Monochamus* flight period or Not transported through areas infested with *Bursaphelenchus xylophilus* or Transported in sealed containers or packaging to prevent infestation

Cut branches of Coniferae host species	PC and, if appropriate, RC
Cut branches (including Christmas trees) of host species originating in countries where *Bursaphelenchus xylophilus* occurs	Pest-free area for *Bursaphelenchus xylophilus* or Tested and found free from *Bursaphelenchus xylophilus* and its vectors and must come from a pest-free place of production whose immediate vicinity was free from *Bursaphelenchus xylophilus* AND Transported outside of *Monochamus* flight period or Not transported through areas infested with *Bursaphelenchus xylophilus*

[4] PC – Phytosanitary Certificate
[5] RC – Re-export Phytosanitary Certificate
[6] Simple «or» signify the choice between two options, «OR» in capitals – choice between two sections, the same apply to simple «and» and «AND» in capitals

	or Transported in sealed containers or packaging to prevent infestation

Wood of Coniferae host species	**PC and, if appropriate, RC**
Wood (including squared wood, but excepting packaging wood, particle wood and waste wood) of host species originating in countries where *Bursaphelenchus xylophilus* occurs	Fumigated according to EPPO Phytosanitary Procedure PM 10/7[7] OR Pest-free area for *Bursaphelenchus xylophilus* or Heat treated (commodity is heated until the minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of the wood (including at its core) ~~core temperature reached at least 56°C for at least 30 min~~ according to an officially recognized technical specification) or Irradiation treatment according to EPPO Phytosanitary Procedure PM 10/8 AND Debarking or Transported outside of *Monochamus* flight period or Not transported through areas infested with *Bursaphelenchus xylophilus* or Transported in sealed containers or packaging to prevent infestation
Particle wood (sawdust, chips, particles) and waste wood (shavings, scrap) of host species originating in countries where *Bursaphelenchus xylophilus* occurs	Pest-free area for *Bursaphelenchus xylophilus* or Heat treatment (commodity is heated until the ~~core~~minimum temperature ~~reached at least~~of 56°C for a minimum~~t~~ duration~~least~~ of 30 continuous minutes throughout the entire profile of the wood (including at its core) according to an officially recognized technical specification) AND

[7] Prior removal of bark must be carried out for the efficacy of methyl bromide treatment

	Originating from debarked wood or Transported outside of *Monochamus* flight period or Not transported through areas infested with *Bursaphelenchus xylophilus* or Transported in sealed containers or packaging to prevent infestation
Wood packaging material of Coniferae	Requirements of ISPM No 15

Isolated bark of Coniferae	PC and, if appropriate, RC
Isolated bark of Coniferae originating in countries where *Bursaphelenchus xylophilus* or its vectors occur	Pest-free area for *Bursaphelenchus xylophilus* or Heat treatment (commodity is heated until the minimum temperature of 56°C for a minimum duration of 30 continuous minutes throughout the entire profile of the wood (including at its core) ~~core temperature reached at least 56°C for at least 30 min~~ according to an officially recognized technical specification)

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ANNEX I

Previous PRA for *Bursaphelenchus xylophilus* (Evans et al, 1996)

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DATASHEETS\Nemato