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Pest risk analysis

PEST RISK ASSESSMENT SCHEME FOR QUARANTINE PESTS

SIROCOCCUS CLAVIGIGNENTI-JUGLANDACEARUM

DRAFT

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DECISION-MAKING SCHEME

Stage 1: Initiation

Reason for PRA: The fungus *Sirococcus clavigignenti-juglandacearum* is causing severe tree mortality on *Juglans cinerea* (butternut) in North America. Natural infection of *Juglans nigra* and *Juglans ailantifolia* var. *cordiformis* has been found in the USA. The pathogen does not occur in Europe and could present a threat to *Juglans* species. *S. clavigignenti-juglandacearum* has been put on the EPPO Alert List.

Identify pest **This section examines the identity of the pest to ensure that the assessment is being performed on a real identifiable organism and that the biological and other information used in the assessment is relevant to the organism in question.**		
1. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank? **if yes** **if no**	Go to 3 Go to 2	**Yes** ***Sirococcus clavigignenti-juglandacearum*** Fungi. Class: Coelomycetes. Subdivision: Deuteromycotina or Fungi Imperfecti. Order: Sphaeropsidales. Family: Phialosporae. Genus: *Sirococcus*; anamorphic fungus
2. Attempt to redefine the taxonomic entity so that the criteria under 1 are satisfied. Is this possible? **if yes** **if no**	Go to 3 Go to 22	--
The PRA area **The PRA area can be a complete country, several countries or part(s) of one or several countries.** 3. Clearly define the PRA area.	Go to 4	**Germany** **including a less detailed assessment for the EPPO region**
Earlier analysis **The pest, or a very similar pest, may have been subjected to the PRA process before, nationally or internationally. This may partly or entirely replace the need for a new PRA.**		

4. Does a relevant earlier PRA exist? **if yes** **if no**	 Go to 5 Go to 7	**No**
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 Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest)? **if entirely valid** **if partly valid** **if not valid**	 End Go to 6 Go to 7	**--**
6. Proceed with the assessment, but compare as much as possible with the earlier assessment.	Go to 7	**--**
Stage 2: Pest Risk Assessment		
Section A: Pest categorization (qualitative criteria of a quarantine pest)		
Geographical criteria **This section considers the geographic distribution of the pest in the PRA area.**		
7. Does the pest occur in the PRA area? **if yes** **if no**	 Go to 8 Go to 9	**No**

8. Is the pest of limited distribution in the PRA area? *Note*: 'of limited distribution' means that the pest has not reached the limits of its potential range either in the field or in protected conditions; it is not limited to its present distribution by climatic conditions or host-plant distribution. There should be evidence that, without phytosanitary measures, the pest would be capable of additional spread. **if yes** **if no**	 Go to 18 Go to 22	--
Potential for establishment **For the pest to establish, it must find a widely distributed host plant in the PRA area (do not consider plants which are accidental/very occasional hosts or recorded only under experimental conditions). If it requires a vector, a suitable species must be present or its native vector must be introduced. The pest must also find environmental conditions suitable for survival, multiplication and spread, either in the field or in protected conditions.**		
9. Does at least one host plant grow to a substantial extent in the PRA area, in the open, in protected conditions or both? **if yes** **if no**	 Go to 10 Go to 22	**Yes** ***Juglans regia* (susceptible in laboratory experiments)** ***Juglans nigra*** **(other *Juglans* species including *J. cinerea* in small amounts)** Laboratory experiments by Ostry (1997) indicated, that *S. clavigignenti-juglandacearum* might be able to survive on *Carya illinoensis*, *Carya ovata*, *Prunus serotina*, *Quercus alba*, *Q. rubra* and *Q. velutina*, presenting a potential source of inoculum. (References for susceptible hosts: Kuntz et al., 1979, Orchard et al., 1982, Ostry, 1997, Ostry et al., 1997)

10. Does the pest have to pass part of its life cycle on a host plant other than its major host (i.e. obligate alternate host plant)? **if yes** **if no**	 Go to 11 Go to 12	**No**
11. Does the alternate host plant also occur in the same part of the PRA area as the major host plant? **if yes** **if no**	 Go to 12 Go to 22	**--**
12. Does the pest require a vector (i.e. is vector transmission the only means of dispersal)? **if yes** **if no**	 Go to 13 Go to 14	**No,** **but dispersal is probably essentially increased by insects, especially different families of Coleoptera (e.g. Halik and Bergdahl 2002), probably also birds (Ostry and Woeste, 2004).**
13. Is the vector (or a similar species which is known or suspected to be a vector) present in the PRA area or likely to be introduced? If in doubt, a separate assessment of the probability of introduction of the vector (in section B1) may be needed. **if yes** **if no**	 Go to 14 Go to 22	**Beetles found in the USA serving as vectors for the fungus belong to several families, indicating that spread by insects is not restricted specifically. It is therefore possible, that – even if those species identified to carry the fungus in the USA are not present in the PRA area – other beetle species (e.g. from the families of Cerambycidae and Curculionidae) present in the PRA area could act as vectors.**
14. Does the known geographical distribution of the pest include ecoclimatic zones comparable with those of the PRA area? **if yes** **if no**	 Go to 18 Go to 15	**Yes** **The fungus has spread over the USA and Canada, including areas ecoclimatically very similar to the PRA area.**

15. Is it probable, nevertheless, that the pest could survive and thrive in a wider ecoclimatic zone that could include the PRA area? **if yes** **if no**	 Go to 18 Go to 16	--
16. Could the ecoclimatic requirements of the pest be found in protected conditions in the PRA area? **if yes** **if no**	 Go to 17 Go to 22	--
17. Is a host plant grown in protected conditions in the PRA area? **if yes** **if no**	 Go to 18 Go to 22	--

Potential economic importance

Economic impact principally concerns direct damage to plants but may be considered very broadly, to include also social and environmental aspects. The effect of the presence of the pest on exports from the PRA area should also be allowed for.

In deciding whether economically important damage or loss to plants may occur, it is necessary to consider whether climatic and cultural conditions in the PRA area are conducive to damage expression, which is not always the case even if both host and pest survive under these conditions.

Note: when performing a PRA on a pest that is transmitted by a vector, consider also any possible damage that the vector may cause.

18.	With specific reference to the host plant(s) which occur(s) in the PRA area, and the parts of those plants which are damaged, does the pest in its present range cause significant damage or loss? **if yes** **if no**	Go to 21 Go to 19	**Probably yes.** **This question is difficult to answer, as *S. clavigignenti-juglandacearum*, though causing damage on *J. nigra* (as a host plant present in the USA and the PRA area) it is not nearly as damaging as it is to *J. cinerea*, which is of minor significance in the PRA area.** **It is not known how European proveniences of *J. nigra* and *J. regia* would react to the fungus. As it has been found that both species are highly susceptible to the fungus in laboratory experiments (Orchard et al., 1982), the precautionary approach should be applied.** **Areas of walnut cultivation in Europe could be at risk.**
19.	Could the pest, nevertheless, cause significant damage or loss in the PRA area, considering ecoclimatic and other factors for damage expression? **if yes** **if no**	Go to 21 Go to 20	--
20.	Would the presence of the pest cause other negative economic impacts (social, environmental, loss of export markets)? **if yes** **if no**	Go to 21 Go to 22	--
21.	**This pest could present a risk to the PRA area**	**Go to section B**	**Yes**
22.	**This pest does not qualify as a quarantine pest for the PRA area** and the assessment can stop. However, if this is the first time that the decision-making scheme has directed you to this point, it may be worth returning to the question that led you here and continuing through the scheme in case the remaining questions strongly indicate categorization as a possible quarantine pest. In this latter case, seek a second opinion to decide whether the answers which led you to this point could be given a different reply.		--

Section B: Quantitative evaluation

1. Probability of introduction

Introduction, as defined by the FAO Glossary of Phytosanitary Terms, is the entry of a pest resulting in its establishment.

Entry **List the pathways that the pest could be carried on.** *Note*: a pathway can be any form of human activity that could transport the pest from a particular origin, e.g. plants and plant products moving in trade, any other traded commodity, containers and packing, ships, planes, trains, road transport, passengers, mail, etc. Note that similar means of pest transport from different origins can present greatly different probabilities of introduction, depending on the concentration of the pest in the area of origin. The pathways given should be only those already in operation, or proposed.		**(1) Seeds of *Juglans* species** **As the fungus is seed borne on *J. cinerea* and *J. nigra* (Orchard, 1984, Innes, 1997), the commercial movement of unprocessed seed could be an effective pathway.** **(2) Fruit of *Juglans* species** **As the fungus is seed borne, also fruit for consumption can be infested, but as far as known, no butternuts and black walnuts are imported to Europe for consumption. Butternut is not a commercial nut species and the small market for nut production of black walnut most likely limits its availability (Michael Ostry, pers. comm.). The only *Juglans* fruit being commercially imported is the Persian walnut (*J. regia*), which is produced nearly entirely in California (Beede and Hasey 1998, Thomas Walberg, Horst Walberg Trockenfrucht Import GmbH, pers. comm., Michael Ostry, North Central Research Station, Minnesota, USA, pers. comm.). Natural infestation of *J. regia* has not been observed up to now. Additionally, the fungus is not known to occur in California and as a precaution, quarantine on importing *Juglans* species from the eastern U.S. to California was put in place (Ostry and Woeste, 2004).** **(3) Plants of *Juglans* species for planting. Nursery stock and other progative material (scion wood)** **As butternuts are not easily transplanted, they are not common nursery plants, and therefore plants for planting are not a frequent pathway. Scion wood may carry the pathogen without any visible symptoms, but if infected scion wood was grafted it is quite sure that that portion would die. Spread by scion wood has not been reported (Cree, 1995), nevertheless there might be a potential danger in shipping the pathogen into new areas on infected scion wood (Michael Ostry, North Central Research Station, Minnesota, USA, pers. comm.).**

Listing of pathways continued		**(4) Wood of *Juglans* species.** **Raw wood and wood products may theoretically serve as a pathway, but butternut and walnut wood have a high value, are sold in low numbers and are usually kiln-dried. This considerably reduces the potential for butternut wood and wood products to serve as commercial pathways for introduction of butternut canker (Cree, 1995). Logs with bark and firewood from dead or dying butternuts have a high potential of carrying and spreading the fungus (Tisserat and Kuntz, 1983a). The extent of international movement of unprocessed butternut wood products is unknown, but expected to be very low. Until some years ago, walnut wood has been imported to Germany primarily from the USA and southeastern Europe. Nowadays, import is very low (Klaus Schwarz, Gesamtverband Holzhandel e.V., Germany, pers. comm.).** **(1) - (4) from infested areas in the USA and Canada. Though species other than *J. cinerea* are susceptible to the pathogen, there is only a very low natural infection rate of these species (only single plants; Kuntz et al., 1979, Ostry et al., 1997). Therefore, the pathways will mostly be significant for *J. cinerea* as long as the infection rate on other species will not increase. Nevertheless, also *J. nigra* as a pathway should be considered, as it is the only other species, where infected seeds have been found. Also, it has to be kept in mind that *J. regia* and *J. nigra* were highly susceptible in laboratory experiments.** **In the following, only pathways (1), (3), and (4) will be considered, as pathway (2) is not relevant.**
1.1 How many pathways could the pest be carried on? **(few = 1; many =9)**	**3**	**The score is based on consideration of host plants, traded commodities, areas of origin (see MacLeod and Baker, 2003, for an assignment of scores).**

1.2	For each pathway, starting with the most important pathway identified above (i.e. that which carries the greatest trade or which is most likely to act as a means of introduction) and then in descending order of importance, answer questions 1.3 – 1.13. If one of the questions 1.3a, 1.5a, 1.7a or 1.12a is answered by 'no', the pathway could **not** act as a means of entry for the pest, and the scheme will return directly to this point, omitting later questions. Use expert judgement to decide how many pathways to consider.	**Go to 1.3**	
1.3a	Could the pest be associated with the pathway at origin? *Note*: does the pest occur in the area of origin? Is the pest in a life stage which would be associated with commodities, containers, or conveyances? **if yes** **if no**	 **Go to 1.3b** **Go to 1.2**	**(1) Seeds Yes** **(3) Plants Yes** **(4) Wood Yes**
1.3b	How likely is the pest to be associated with the pathway at origin? **(not likely = 1; very likely = 9)**	**8-9**	**Generally, it is very likely, that butternut seeds, propagative material and wood originating from (heavily) infested areas harbour the fungus, but see question 1.6. The rate of infestation in American and Canadian Nurseries is not known, but has been observed (e.g. Innes and Rainville, 1996). As the fungus spreads easily by air and insects, there is no reason why butternuts which are grown openly in nurseries in areas where the fungus occurs in the wild should not be infested.** **For other *Juglans* species from areas where butternut canker is present, it is difficult to predict, but probably quite low.**
1.4	Is the concentration of the pest on the pathway at origin likely to be high? **(not likely = 1; very likely = 9)**	**7-8**	**Butternut seeds, propagative material and wood originating from (heavily) infested areas could harbour the fungus in high concentrations, but see question 1.6.** **For other *Juglans* species from areas where butternut canker is present, it is difficult to predict, but probably quite low.**

1.5a Could the pest survive existing cultivation or commercial practices? *Note*: these are practices mainly in the country of origin, such as pesticide application, removal of substandard produce, kiln-drying of wood. **if yes** **if no**	 **Go to 1.5b** **Go to 1.2**	**(1) Yes** **(3) Yes** **(4) No if wood is bark-free and kiln-dried. The fungus is usually restricted to the bark and sapwood region of the tree, heartwood is generally not affected (Cree, 1995). Wood for packaging material is in future to be subjected to the IPPC Standard ISPM # 15: Guidelines for regulating wood packaging material in international trade. Therefore, even in the unlikely case that butternut or other wood infected with *S. clavigignenti juglandacearum* is used as packaging material, the fungus would not survive the required treatment.** **In Canada more than 90% of all butternut wood sold is kiln-dried and mostly derived from local trees for local use, only a small amount is moved over greater distances (Cree, 1995).**
1.5b How likely is the pest to survive existing cultivation or commercial practices? **(not likely = 1; very likely = 9)**	**(1) 9** **(3) 9** **(4) 1**	**(3) If wood is kiln-dried, survival of *S. clavigignenti-juglandacearum* is not likely.**

1.6 How likely is the pest to survive or remain undetected during existing phytosanitary procedures? *Note*: existing phytosanitary measures (e.g. inspection, testing or treatments) are most probably being applied as a protection against other (quarantine) pests; the assessor should bear in mind that such measures could be removed in the future if the other pests were to be re-evaluated. The likelihood of detecting the pest during inspection or testing will depend on a number of factors including: • ease of detection of the life stages which are likely to be present. Some stages are more readily detected than others, for example insect adults may be more obvious than eggs; • location of the pest on the commodity - surface feeders are more readily detected than internal feeders; • symptom expression - many diseases may be latent for long periods, at certain times of the year, or may be without symptoms in some hosts or cultivars and virulent in others; • distinctiveness of symptoms - the symptoms might resemble those of other pests or sources of damage such as mechanical or cold injury; • the intensity of the sampling and inspection regimes; • distinguishing the pest from similar organisms. **(not likely = 1; very likely = 9)**	**(1) 9** **(3) 4** **(4) a 1** **(4) b 4**	**(1) Seeds. Infestation of seeds is not visible, infested seeds are sound and edible (Kuntz et al. 1979). It is therefore very likely that seeds from infested areas are highly infested.** **(3) Plants. It is not very likely that plants already diseased for a longer time are shipped, because the disease is visible then. Nevertheless, score 4 is given, because newly infected trees do not display any symptoms until the fungus starts to colonize and kill the inner bark. Therefore, an early infection is easily overseen Beginning cankers are only found if the bark was removed (Kuntz et al., 1979).** **(4) (a) Wood packaging material: This will be subjected to ISPM # 15 in future.** **(4) (b) Other wood material. It is not very likely, that high quality wood is shipped without treatment and with bark. Nevertheless, if this happens exceptionally, fresh infections might be overseen. Wood from *Juglans* species - as long as it is no wood packaging material - is not subjected to species specific measures (see EC Council Directive 2000/29/EC).**
1.7a Could the pest survive in transit? *Note*: consideration should be given to: • speed and conditions of transport; • vulnerability of the life-stages likely to be transported; • whether the life cycle is of sufficient duration to extend beyond time in transit; • the number of individuals likely to be associated with a consignment. Interception data can be used to estimate the ability of a pest to survive in transit. **if yes** **if no**	**Go to 1.7b** **Go to 1.2**	**Yes.** **The fungus is able to sporulate on standing or felled dead trees for at least 20 months (Tisserat and Kuntz 1982, 1984). Outside its host, conidia can survive for at least 8 hours in cool and cloudy weather. The pathogen remains viable in diseased tissue and in culture down to 0°C and below (Tisserat and Kuntz, 1983c).** **The fungus can survive in the cotyledons of infected seed stratified at 4°C up to 18 months (Prey et al. 1997). There is no exact information how long it would survive in stored seeds.**

1.7b	How likely is the pest to survive in transit? **(not likely = 1; very likely = 9)**	**9**	**see 1.7a**
1.8	Is the pest likely to multiply during transit? **(not likely = 1; very likely = 9)**	**(1) 1** **(3) 5** **(4) 1**	**(1) Seeds. Multiplication is unlikely.** **(3) Plants. If conditions during transit favor the multiplication (moist and not too cold).** **(4) Wood. It is assumed that shipping conditions would not favor multiplication.**
1.9	How large is movement along the pathway? *Note*: the volume of material being moved. **(not large = 1; very large = 9)**	**1-2** **uncertain**	**For Canada, the volume of butternut material moving has been estimated low (Cree, 1995, and pers. comm.).** **For USA, volume is not known, research for information is still in process. At least for butternut, it is estimated to be low.**
1.10	How widely is the commodity to be distributed throughout the PRA area? *Note*: the more scattered the destinations, the more likely it is that the pest might find suitable habitats. **(not widely = 1; very widely = 9)**	**8**	**Seeds and propagative material: mostly to areas climatically suitable. This would be at least within half of the PRA area.**
1.11	How widely spread in time is the arrival of different consignments? *Note*: introduction at many different times of the year will increase the probability that entry of the pest will occur at a life stage of the pest or the host suitable for establishment. **(not widely = 1; very widely = 9)**	**5**	**This score is given, because the frequency of arrival of the relevant consignments is estimated at up to 4 months of the year (see MacLeod and Baker, 2003).**

1.12a Could the pest transfer from the pathway to a suitable host? *Note*: consider innate dispersal mechanisms or the need for vectors, and how close the pathway on arrival is to suitable hosts. **if yes** **if no**	 **Go to 1.12b** **Go to 1.2**	**(1) Seeds. Yes.** **Has been observed in nurseries and laboratory experiments (Innes, 1997; Orchard 1984).** **(3) Plants. Yes.** **Dispersal with splashes of rain and wind (Kuntz et al., 1979, Tisserat and Kuntz, 1983b), and insect vectors (see Section A, question 12).** **Butternut trees planted in parks and gardens may act as bridgeheads in the case the fungus is introduced.** **In laboratory experiments, the fungus could persist in cankers on large branches of *J. nigra* up to three years after inoculation, thus possibly serving as a source of inoculum to other susceptible host plants. (Orchard, 1984). Laboratory experiments by Ostry (1997) indicated, that *S. clavigignenti-juglandacearum* might be able to survive on *Carya illinoensis*, *Carya ovata*, *Prunus serotina*, *Quercus alba*, *Q. rubra* and *Q. velutina*, presenting as well a potential source of inoculum.** **(4) Wood. This could theoretically happen, but is very unlikely.**
1.12b How likely is the pest to be able to transfer from the pathway to a suitable host? **(not likely = 1; very likely = 9)**	**(1) 9** **(3) 9** **(4) 1-2**	**(1), (3) This is very likely if infected *Juglans* seeds/plants were sown/planted in the vicinity of host plants, and possibly even, if host plants are far away. In the USA, an effective long distance transfer of conidia has lead to the fact that the fungus has become widespread very rapidly.** **Spread by infected seeds and seedlings on nursery stock is possible and has already taken place in Québec, Canada (Innes, 1997).** **(4) only if infected wood is not correctly disposed of.**

1.13 Is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste) likely to aid introduction? *Note*: consider whether the intended use of the commodity would destroy the pest or whether the processing, planting or disposal might be done in the vicinity of suitable hosts. **(not likely = 1; very likely = 9)**	**(1) 9** **(3) 9** **(4) 1-2**	**(1) and (3) are intended for sowing/planting.** **(4) infected remains of wood if not correctly disposed of.**
Establishment		
1.14 How many host-plant species are present in the PRA area? **(one or very few = 1; many = 9)**	**3**	***Juglans regia* (susceptible only in laboratory experiments)** ***J. nigra* (natural infection observed in North America)** ***J.* x *intermedia* (susceptible only in laboratory experiments)** ***J. cinerea* (natural infection observed in North America)** ***J. ailantifolia* (susceptible only in laboratory experiments)** ***J. ailantifolia* var *cordiformis* (natural infection observed in North America)** **(score according to MacLeod and Baker, 2003)**
1.15 How extensive are the host plants in the PRA area? **(rare = 1; widespread = 9)**	***Juglans regia* 5**	***Juglans regia* (scattered within half of the PRA area; Frank Klingenstein, Federal Agency for Nature Conservation, Bonn, Germany, pers. comm., Floraweb, 2003)**
	***Junglans nigra* 2**	***Juglans nigra* rare and not established**
	***Juglans intermedia* 2**	***Juglans intermedia* rare and not established**
	***Juglans cinerea; ailantifolia* 1**	**Single plants of other Juglandaceae in parks, not established**

1.16 If an alternate host is needed to complete the life cycle, how extensive are such host plants in the PRA area? **(rare = 1; widespread = 9)**		--
1.17 *[1]If a vector is needed for dispersal, how likely is the pest to become associated with a suitable vector? *Note*: is the vector present in the PRA area, could it be introduced or could another vector be found? **(not likely = 1; very likely = 9)**	**7**	**It is quite likely, that – even if those beetle species identified to carry the fungus in the USA (see Section A, question 12) are not present in the PRA area – other beetle species could act as vectors, as there are several families of Coleoptera, which are vectors for the fungus in the USA, occurring also in Germany/Europe. There seems to be no narrow specification for vectors. Birds might also act as vectors.**
1.18 (Answer this question only if protected cultivation is important in the PRA area.) Has the pest been recorded on crops in protected conditions elsewhere? **(no = 1; often = 9)**		--
1.19 How likely are wild plants (i.e. plants not under cultivation, including weeds, volunteer plants, feral plants) to be significant in dispersal or maintenance of populations? **(not likely = 1; very likely = 9)**	**(9)**	**Depends on the point of view, whether host plants in parks and solitary trees in non-cultivated land are considered as wild plants. If yes, butternut, and possibly other Juglandaceae could act as bridgeheads for further dispersal of the fungus.**
1.20 *How similar are the climatic conditions that would affect pest establishment in the PRA area and in the area of origin? *Note*:_the climatic conditions in the PRA area to be considered may include those in protected cultivation. **(not similar = 1; very similar = 9)**	**9**	**A detailed climate analysis has not been done because it is not considered to be necessary. Butternut and *S. clavigignenti-juglandacearum* occur in areas of North America, which are climatically comparable to Germany and other parts of central Europe. Plants possibly at risk (esp. *Juglans regia* and *J. nigra*) grow mostly in central and southern Germany (as well as several other European countries). They need mild winters without late frosts, and a not too dry climate.**

[1] Questions marked with an asterisk are to be considered as more important than the others in the same section.

1.21 How similar are other abiotic factors in the PRA area and in the area of origin? *Note*:_the major abiotic factor to be considered is soil type; others are, for example, environmental pollution, topography/orography. **(not similar = 1; very similar = 9)**	**9**	**Butternut and *S. clavigignenti-juglandacearum* occur in areas of North America, which are comparable to Germany and other parts of central Europe.** ***J. regia* is not tolerant to shade and prefers profound, nutrient rich, well-drained neutral to slightly chalky loams. It can grow up to an elevation of 800 m, in the Alps up to 1200 m. These factors are present in the PRA area.**
1.22 How likely is the pest to have competition from existing species in the PRA area for its ecological niche? **(very likely = 1; not likely = 9)**	**9**	**In the area of (secondary?) origin, no such competition has been observed. Though there is no information available, it is assumed, that this is true for the PRA area as well.** **Remark: the expression "area of (secondary?) origin is used, because the only existing range of the fungus that is known is North America. Though it is not known, from which area the fungus has been introduced, it is very likely, that it has been introduced to the USA (e.g. Furnier et al. 1999) at first, and from there to Canada.**
1.23 How likely is establishment to be prevented by natural enemies already present in the PRA area? **(very likely = 1; not likely = 9)**	**9**	**Also in area of (secondary?) origin no natural enemies are known.**
1.24 *If there are differences in the crop environment in the PRA area from that in the area of origin, are they likely to aid establishment? *Note*:_factors that should be considered include time of year that the crop is grown, soil preparation, method of planting, irrigation, whether grown under protected conditions, surrounding crops, management during the growing season, time of harvest, method of harvest, etc. **(not likely = 1; very likely = 9)**	**--**	**Not relevant**

1.25 Are the control measures which are already used against other pests during the growing of the crop likely to prevent establishment of the pest? **(very likely = 1; not likely = 9)**	**9**	
1.26 *Is the reproductive strategy of the pest and duration of life cycle likely to aid establishment? *Note*: consider characteristics which would enable the pest to reproduce effectively in a new environment, such as parthenogenesis/self-crossing, duration of the life cycle, number of generations per year, resting stage, etc. **(not likely = 1; very likely = 9)**	**9**	**The fungus reproduces by clonal growth. It can produce masses of conidia.**
1.27 How likely are relatively low populations of the pest to become established? **(not likely = 1; very likely = 9)**	**9**	**There is evidence, that the fungus was introduced as a single isolate into the United States. Nevertheless, the pathogen has spread rapidly across the United States and Canada (e.g. Davis et al., 1992, USDA, 1995, Anderson, 1996, Harrison et al., 1998).**
1.28 How probable is it that the pest could be eradicated from the PRA area ? **(very likely = 1; not likely = 9)**	**9**	**Because of the difficulty of detection and control of the fungus and the rapid spread, eradication is not likely to be successful.**
1.29 How genetically adaptable is the pest? *Note*: is the species polymorphic, with, for example, subspecies, pathotypes? Is it known to have a high mutation rate? This genotypic (and phenotypic) variability facilitates the pest's ability to withstand environmental fluctuations, to adapt to a wider range of habitats, to develop pesticide resistance and to overcome host resistance. **(not adaptable = 1; very adaptable = 9)**	**uncertain, but probably adaptability is low**	**In the area of (secondary?) origin, no such adaptation has been observed. All studied isolates were very similar: The lack of genetic diversity was confirmed by RAPD-PCR (Ostry and Skilling, 1995, Ostry, 1997, Furnier et al. 1999).** **In any case, more research is needed on the genetics of the fungus (Michael Ostry, North Central Research Station, Minnesota, USA, pers. comm.).**

1.30 *How often has the pest been introduced into new areas outside its original range? *Note*: if this has happened even once before, it is important proof that the pest has the ability to pass through most of the steps in this section (i.e. association with the pathway at origin, survival in transit, transfer to the host at arrival and successful establishment). If it has occurred often, it suggests an aptitude for transfer and establishment. **(never = 1; often = 9)**	**3**	**The fungus has been introduced from the country of (secondary?) origin to a neighbouring country (Canada) on the same continent by natural and human-assisted spread from the infected areas in the United States to adjacent areas in Canada (Ken Harrison, Disease Identification Officer Natural Resources Canada, Canadian Forest Service, pers. comm.)** **(Score according to MacLeod and Baker, 2003)**
2. Economic impact assessment **Identify the potential hosts in the PRA area, noting whether wild or cultivated, field or glasshouse. Consider these in answering the following questions. When performing a PRA on a pest that is transmitted by a vector, consider also any possible damage that the vector may cause.** **According to the pest and host(s) concerned, it may be appropriate to consider all hosts together in answering the questions once, or else to answer the questions separately for specific hosts.** **Note that, for most pest/crop/area combinations, precise economic evaluations are lacking. In this section, therefore, expert judgement is asked to provide an evaluation of the likely scale of impact. Both long-term and short-term effects should be considered for all aspects of economic impact.**		
2.1 *How important is economic loss caused by the pest within its existing geographic range? **(little importance = 1; very important = 9)**	**2**	**Though economic value of butternut of good quality is only second to walnut (Peterson, 1977), there is no large commercialisation of this tree in the USA or Canada (Cree, 1995).** Remark: The value of amenity trees and the economic loss due to their infestation is not considered here.
2.2 How important is environmental damage caused by the pest within its existing geographic range? *Note*: environmental damage may be impact on ecosystem health, such as effects on endangered/threatened species, keystone species or biodiversity. **(little importance = 1; very important = 9)**	**8**	**Numbers of butternut trees have been dramatically reduced in the United States. Butternut is therefore listed under Category 2 on the list of endangered and threatened plants (Federal Endangered Species Act of 1973), but this category has been eliminated and currently butternut has no official listing status. In Canada, butternut is listed as an endangered species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in November 2003 (Ostry and Woeste, 2004).**

2.3 How important is social damage caused by the pest within its existing geographic range? *Note*: social effects could be, for example, damaging the livelihood of a proportion of the human population, or changing the habits of a proportion of the population (e.g. limiting the supply of a socially important food). **(little importance = 1; very important = 9)**	**1**	
2.4 *How extensive is the part of the PRA area likely to suffer damage from the pest? *Note*: the part of the PRA area likely to suffer damage is the *endangered area*, which can be defined ecoclimatically, geographically, by crop or by production system (e.g. protected cultivation). **(very limited = 1; whole PRA area = 9)**	**8**	**Germany: 7-8 within half of the PRA area (score according to MacLeod and Baker, 2003). For *J. regia* see the distribution map in the annex. *J. nigra* is growing significantly in plantations in the forest districts of Groß-Gerau (17,1 ha) and Halle (0,2 ha) (Wolfgang Schmeil, Deutsche Kontrollvereinigung für forstliches Saat- und Pflanzgut e.V., pers. comm.).** **For Hungary, Balkans, France, Italy, Turkey and possibly other parts of Europe: 8-9**
Spread potential is an important element in determining how fast economic impact is expressed and how readily a pest can be contained.		
2.5 *How rapidly is the pest liable to spread in the PRA area by natural means? **(very slowly = 1; very rapidly = 9)**	**9**	**In the USA and Canada, the fungus has spread very rapidly across the native range of butternut, though distribution of butternut is very scattered.**
2.6 How rapidly is the pest liable to spread in the PRA area by human assistance? **(very slowly = 1; very rapidly = 9)**	**uncertain; very rapidly if infected butternuts are planted widely in the PRA area**	**This depends on planting/sowing of infected trees/seeds and the susceptibility of European proveniences of *Juglans* species.**

2.7 How likely is it that the spread of the pest could be contained within the PRA area? *Note*: consider the biological characteristics of the pest that might allow it to be contained in part of the PRA area; consider the practicality and costs of possible containment measures. **(very likely = 1; not likely = 9)**	**8**	**Spread by rain splashes, wind and possibly insects (see Section A, question 12). Containment would be nearly impossible, but spread could be slowed down by the elimination of infected trees.**
2.8 *Considering the ecological conditions in the PRA area, how serious is the direct effect of the pest on crop yield and/or quality likely to be? *Note*: the ecological conditions in the PRA area may be adequate for pest survival but may not be suitable for significant damage on the host plant(s). Consider also effects on non-commercial crops, e.g. private gardens, amenity plantings. **(not serious = 1; very serious = 9)**	**high uncertainty**	**Up to now, damage on *Juglans* species other than *J. cinerea* has occurred in North America but is very low. On the other hand, the susceptibility of European proveniences of *Juglans* species to the pathogen is not known, but could be very high. This has e.g. occurred with the European proveniences of *Quercus robur* and *Q. petraea*: in experiments European proveniences were a lot more susceptible to the fungus *Ceratocystis fagacearum* than the American proveniences (Pinon, 1997, Schröder et al., 2002).** **Remark: As a precaution, the USA has put a quarantine on importing *Juglans* species from the eastern U.S. to California, because the fungus is not known to occur in California.**
2.9 How likely is the pest to have a significant effect on producer profits due to changes in production costs, yields, etc., in the PRA area? **(not likely = 1; very likely = 9)**	**high uncertainty**	**This depends on the susceptibility of European proveniences of *Juglans* species to the fungus. If plantations in Europe are at risk, effects on producer profits are very likely.**
2.10 How likely is the pest to have a significant effect on consumer demand in the PRA area? *Note*: consumer demand could be affected by loss in quality and/or increased prices. **(not likely = 1; very likely = 9)**	**high uncertainty**	**This depends on the susceptibility of European proveniences of *Juglans* species to the fungus. If plantations in Europe are at risk, effects on prices of wood and fruit are very likely.**

2.11	How likely is the presence of the pest in the PRA area to affect export markets? *Note*: consider the extent of any phytosanitary measures likely to be imposed by trading partners. **(not likely = 1; very likely = 9)**	**high uncertainty 1-2 for Germany, up to 9 for other European countries**	**Again, this depends on the susceptibility of European proveniences of *Juglans* species to the fungus. If plantations in Europe are at risk, effects on export markets are very likely.**
2.12	How important would other costs resulting from introduction be? *Note*: costs to the government, such as research, advice, publicity, certification schemes; costs (or benefits) to the crop protection industry. **(little importance = 1; very important = 9)**	**high uncertainty 1-2 for Germany, up to 9 for other European countries**	**Again, this depends on the susceptibility of European proveniences of *Juglans* species to the fungus. If plantations in Europe are at risk, costs for research (e.g. for control), establishment of pest free areas etc. might be high.**
2.13	How important is the environmental damage likely to be in the PRA area? **(little importance = 1; very important = 9)**	**high uncertainty** **5**	**Score 5 provided that European waltnuts are susceptible in the wild: The walnut is an aesthetic element of the European landscape and should be protected from a cultural point of view.** **From a strict nature conservation point of view, a threat to biodiversity in Europe is not given, as the susceptible *Juglans* species are not native to this area. On the other hand, at least *J. regia*, is (paradoxically) defined to be native in Germany according to the Federal Nature Conservation Act, because it is established in the wild for several generations (BnatSchG, 2002). Therefore, it comes under the overall regulation that wild native plants have to be protected.**
2.14	How important is the social damage likely to be in the PRA area? **(little importance = 1; very important = 9)**	**1**	

2.15 How probable is it that natural enemies, already present in the PRA area, will affect populations of the pest if introduced? **(very likely = 1; not likely = 9)**	**9**	**In the area of (secondary?) origin, no natural enemies are known.**
2.16 How easily can the pest be controlled? *Note*: difficulty of control can result from such factors as lack of effective plant protection products against this pest, occurrence of the pest in natural habitats or amenity land, simultaneous presence of more than one stage in the life cycle, absence of resistant cultivars). **(easily = 1; with difficulty = 9)**	**9**	**Control is very difficult due to the scattered occurrence of Juglandaceae and the absence of knowledge about resistant cultivars. Fungicides are not effective or not authorised (e.g. Benomyl) in Germany, and even if they were, application would be limited.**
2.17 How likely are control measures to disrupt existing biological or integrated systems for control of other pests? **(not likely = 1; very likely = 9)**		**not relevant**
2.18 How likely are control measures to have other undesirable side-effects (for example on human health or the environment)? **(not likely = 1; very likely = 9)**		**not relevant**
2.19 Is the pest likely to develop resistance to plant protection products? **(not likely = 1; very likely = 9)**		**not relevant**

3. Final evaluation

Evaluation of available information and major uncertainties

For most questions, reliable and well documented information was available. Nevertheless, some important information is still lacking. The most important question still open is how susceptible European proveniences of Juglans species would be to *Sirococcus clavigignenti-juglandacearum*. For *Juglans* species other than *J. cinerea*, damage by the pathogen has occurred in North America but is very low or has only been proven in laboratory experiments. However, it can not be excluded that the susceptibility of European proveniences of *Juglans* species to the pathogen could be very high. This has e.g. occurred with the European proveniences of *Quercus robur* and *Q. petraea*: In experiments, European proveniences were a lot more susceptible to the fungus *Ceratocystis fagacearum* than the American proveniences (Pinon, 1997, Schröder et al., 2002). Up to now, it is not sure if *Juglans nigra* from heavily infested areas could act significantly as a pathway for the fungus. Twig cankers on *J. nigra* and *J. ailantifolia*

var. *cordiformis* in plantations have been found. However, the disease has either not been recognized or has not been a major problem in plantations of these species established within the native range of butternut (Michael Ostry, North Central Research Station, Minnesota, USA, pers. comm.). Economic (including environmental) impacts of an introduction of the fungus into the PRA area are therefore difficult to estimate.

There are no exact data on the volume of seed, propagative material and wood of butternut and black walnut imported from North America to Germany or Europe, though volumes are estimated to be very low. The German foreign trade statitistics do not record the importation of *Juglans* wood separately (Klaus Schwarz, Gesamtverband Holzhandel e.V., Germany, pers. comm.).

Additionally, from a scientific point of view, it would be interesting to know, if debris of infected butternuts or other susceptible trees in nursery beds presents a risk to infect the next crop (newly planted Juglandaceae/susceptible plants). Nevertheless, there is no reason why inoculum produced on the previous crop could not result in infection of the above ground portions of seedlings if the infected plant debris is not incorporated into the soil. There are no studies to test whether the pathogen can survive on plant debris and infect below ground portion of seedlings (Michael Ostry, North Central Research Station, Minnesota, USA, pers. comm.).

Estimate of pest risk

From the nine questions marked with an asterisk (more important than the others) five are rated high (scores 7, 8 or 9), two are rated low (scores 2 and 3), one is not relevant, and one is indicated to have a high uncertainty for at least one pathway. From the 42 questions of the scheme that have been given a score, 23 are rated high, most of them were scored 9 for at least one pathway. This indicates already an increased risk posed by the fungus. On the other hand, trade with material that could be infected is estimated to be very low. The most important pathway is seed. Probability of introduction of the pest is therefore estimated to be low (at least for plants and wood as pathways) to medium (possibly for seeds). Up to now, the pathogen is not known to occur in the EPPO-region.

Probable level of economic impact: low to medium for Germany, medium to high for France, Hungary, Balkans, Italy, Turkey and possibly other European countries, if European proveniences of *Juglans* species (esp. *Juglans regia*) are (highly) susceptible. Reliable control measures are not available at the moment. In any case, a precautionary approach should be taken into account.

***Sirococcus clavigignenti-juglandacearum* is much more aggressive than those two fungi causing the chestnut blight and the Dutch elm disease, *Cryphonectria parasitica* and *Ophiostoma ulmi/Ophiostoma novo-ulmi* respectively (Patterson, 1993). It is internally seed borne, i.e. it can be transmitted directly from seed to seedling, spread by infected seeds and seedlings on nursery stock is possible and has already taken place in Québec, Canada (Innes, 1997). Therefore, it is stated, that national and international quarantine regulations against the spread of the disease are necessary, and that the pathogen presents a potential threat to walnut plantations throughout the world (e.g. Orchard, 1984, Fleguel, 1996; Nair, 1999, Ostry and Woeste, 2004). The seed transferability of the pathogen represents the main phytosanitary risk and has to be specially considered when measures against the introduction of the fungus are taken.**

It is recommended that *Sirococcus clavigignenti-juglandacearum* should be considered a quarantine pest, and phytosanitary measures should be taken against it.

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