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Norwegian Scientific Committee for Food Safety

Import of deciduous wood chips from eastern North America – pathway-initiated risk characterizations of relevant plant pests

Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food Safety

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Import of deciduous wood chips from eastern North America – pathway-initiated risk characterizations of relevant plant pests

Leif Sundheim

Daniel Flø

Christer Magnusson

Trond Rafoss

Halvor Solheim

Bjørn Økland

Contributors

Persons working for the Norwegian Scientific Committee for Food Safety (Vitenskapskomiteen for mattrygghet, VKM), either as appointed members of the Committee or as *ad hoc* experts, do this by virtue of their scientific expertise, and not as representatives for their employers. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

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The members of the project group are:

VKM members

Leif Sundheim (Chair), Panel on Plant Health.

Christer Magnusson, Panel on Plant Health.

Trond Rafoss, Panel on Plant Health.

Halvor Solheim, Panel on Plant Health.

Bjørn Økland, Panel on Plant Health.

External expert

Daniel Flø, the Norwegian Forest and Landscape Institute.

Assessed by

The report from the project group has been evaluated and approved by the Panel on Plant Health of VKM.

Panel on Plant Health:

Trond Hofsvang, Christer Magnusson, Trond Rafoss, Arild Sletten, Halvor Solheim, Leif Sundheim (Chair), Anne Marte Tronsmo and Bjørn Økland.

Scientific coordinator from the secretariat

Elin Thingnæs Lid.

Summary

In Europe, the volume of imported wood chips is expected to increase to satisfy demands for energy production. Such import is relevant also in Norway: A former Norwegian wood pellet company presented plans of a yearly import of 1.2 million m^3 of wood chips, for production of 450 000 tonnes pellets. The company started in 2010 with wood chips import from Canada, with two shipments each containing about 40 000 tonnes wood chips. After arrival in Norway the wood chips was stored in unsealed piles outdoors, before transport into a closed factory for pellets production.

VKM Panel on Plant Health finds it important to get a better overview of plant pests, both listed and potential quarantine pests, which might follow the import of wood chips to Norway. As a first step toward a pest risk assessment of the commodity of wood chips, the panel decided in August 2011 to conduct a risk characterization. VKM's Panel on Plant Health appointed a project group consisting of five members of the panel and one external expert to make a draft assessment answering the terms of reference expressed by the panel. The assessment was adopted by the Panel on Plant Health at a meeting 30th April 2013.

In the current document, risk characterizations are given for ten insect pests and four fungal pests that may follow the import of deciduous wood chips from eastern North America (eastern USA and Canada), and that are potentially harmful to Norwegian forests and environment. Bacteria, mites, viruses, nematodes, or other taxa of plant pests were not considered. The selection of insect and fungal species is made primarily for the pathways of wood chips. However, the same insect and fungal species are also relevant for the raw materials for production of wood chips.

The ten insect species selected for risk characterization were: 1) *Agrilus anxius*; 2) *Agrilus planipennis*; 3) *Agrilus bilineatus*; 4) *Chrysobothris femorata*; 5) *Agrilus horni*; 6) *Agrilus granulatus liragus*; 7) *Agrilus granulatus granulatus*; 8) *Hylurgopinus rufipes*; 9) *Agrilus*

politus; 10) *Scolytus schevyrewi*. The four selected fungal pest species were: 1) *Ceratocystis fagacearum*; 2) *Davidiella populorum*; 3) *Phellinus spiculosus*; 4) *Phellinus everhartii*. The ranking of the species given here is according to the likelihood of arriving with relevant pathways of wood chips, the presence of susceptible hosts in Norway, the similarity of climate between Norway and the areas of origin, and the severity of damages they may cause in Norwegian forests. The ranking order indicates which species could undergo full pest risk assessment first. However, the order is uncertain since the behaviour of the species under new conditions is unknown. Also, *Agrilus anxius* has already been risk assessed for Norway.

It is concluded that the whole commodity of wood chips across tree species should be considered, instead of distinguishing only certain tree species hosting each of the insects and fungi in the present report. Due to the methods of harvesting and the high diversity of tree species in the area of origin, it is a significant probability of importing wood of regulated tree species in commodities that officially are declared as limited to legal tree species, and inspection control to detect illegal tree species in wood chips is very difficult.

Keywords

Bronze birch borer (*Agrilus anxius*), Twolined chestnut borer (*Agrilus bilineatus*), Granulate poplar borer (*Agrilus granulatus granulatus*), Bronze poplar borer (*Agrilus granulatus liragus*), Aspen root girdler (*Agrilus horni*), Emerald ash borer (*Agrilus planipennis*), Common willow agrilus (*Agrilus politus*), Flatheaded appletree borer (*Chrysobothris femorata*), Native elm bark beetle (*Hylurgopinus rufipes*), Banded elm bark beetle (*Scolytus schevyrewi*), Canker rot (*Phellinus everhartii*), Spiculosa canker (*Phellinus spiculosus*), Oak wilt (*Ceratocystis fagacearum*), Septoria canker of poplar (*Davidiella populorum*), eco-climatic conditions, area of current distribution, PRA area, import volume, chip size, survival, Pest Risk Analysis (PRA), pest risk assessment, pest risk characterization, establishment, wood chips, deciduous wood, coniferous wood, CLIMEX analysis.

Contents

Background

In Europe, the volume of imported wood chips is expected to increase to satisfy demands for energy production (EPPO 2011b). The European Union (EU) is aiming at a 20 % increase of the bioenergy use within 2020 (Lins 2004). Such import is relevant also in Norway: A former Norwegian wood pellet company presented plans of a yearly import of 1.2 million m^3 of wood chips, for production of 450 000 tonnes pellets. The company started in 2010 with wood chips import from Canada, with two shipments each containing about 40 000 tonnes wood chips. Import from USA, Liberia, Russia and the Baltic States has also been planned. After arrival in Norway the wood chips was stored in unsealed piles outdoors, before transport into a closed factory for pellets production.

Wood chipping and outdoor storage. Photo: iStock Photo.

In Norway, wood chips import is controlled by the Regulation relating to plants and measures against plant pests, also called the Plant health regulation (LMD 2000), adopted December 1st 2000. Import of wood chips made from coniferous trees (*Coniferales*) originating in Canada, China, Japan, Korea, Mexico, Portugal, Taiwan and USA is prohibited. Import of wood chips made of coniferous timber with bark originating in non-European countries and in Portugal is also prohibited. The regulation contains no ban against wood chips from deciduous trees.

According to the Plant health regulation, import of wood chips made from trees of *Quercus* spp., *Populus* spp. and *Castanea* spp. originating from non-European countries, and import of wood chips from *Acer macrophyllum*, *Aesculus californica*, *Lithocarpus densiflorus*, *Quercus* spp. and *Taxus brevifolia* originating from USA should be accompanied by a phytosanitary certificate. The certificate should document that the consignment is considered to be free from quarantine pests listed in Appendices 1 and 2 of the Plant health regulation, that the consignment fulfils relevant requirements in Appendix 4, and that the consignment is in accordance to other import requirements in the Plant health regulation and in other relevant regulations, such as the Regulation on measures against *Phytophthora ramorum* (LMD 2003).

Close-up photo of wood chips. Photo: iStock Photo

The Norwegian Food Safety Authority did some sampling from the two above mentioned shipments of deciduous wood chips imported by the Norwegian company in 2010. Five samples were taken from the first of the two shipments, each sample containing about 5 kg wood chips. The samples were analysed by the Norwegian Forest and Landscape Institute: For possible presence of quarantine pests listed in Appendices 1 and 2 in the plant health regulation; For possible presence of the potential quarantine pests *Agrilus planipennis* (Emerald ash borer) and *A. anxius* (Bronze birch borer); For chip size, bark content, and for the composition of different tree species. In addition, parts of the samples from the first shipment were sent to the Norwegian Institute for Agricultural and Environmental Research (Bioforsk) for a pinewood nematode analysis. Result from the analyses showed that:

- Living quarantine pests listed in the Plant health regulation were not detected.
- The chips contained traces that might be caused by *Agrilus* spp.
- Besides those given by the importer, chips from deciduous tree species (probably *Fraxinus* spp.) were present.
- Chips from coniferous trees (*Picea*) were found.
- Pinewood nematode was not detected.

EPPO has added *A. anxius* to the EPPO A1 list and *A. planipennis* to the A2 list, thus recommending its member countries to regulate the two insects as quarantine pests. In July 2012, the Norwegian Scientific Committee for Food Safety (VKM) published an evaluation of EPPO's risk assessment of *A. anxius* with relevance to Norwegian conditions (VKM 2012). The evaluation was requested by the Norwegian Food Safety Authority, and a similar evaluation concerning *A. planipennis* will be requested in 2013 and conducted in 2013-2014. The Authority needs these evaluations as basis to decide whether these insects should be regulated as quarantine pests in Norway, and if so, which phytosanitary measures should be implemented to prevent entry and establishment in the country.

VKM Panel on Plant Health finds it important to get a better overview of plant pests, both listed and potential quarantine pests, which might follow the import of wood chips to Norway. Therefore, in August 2011 the panel decided to conduct a risk characterization of import of deciduous wood chips or other deciduous raw material for chipping (timber, twigs etc.) from North America (USA and Canada). However, during the process the mandate has been restricted to consider only deciduous wood chips, and not material for chipping.

Risk characterizations or assessments concerning import of wood chips from other parts of the world are also of current interest. However, to limit the size of this document, VKM's Panel on Plant Health decided to do a risk characterization concerning import from North America only. This decision is based on the wood chip import made so far in Norway, and the climate similarity and the many tree species in common between Norway and North America. The geographic area for potentially invasive wood borers was further limited to eastern North America (eastern USA and Canada). It is assumed that chips will be produced on the east coast because there is higher abundance and diversity of deciduous trees in eastern North America compared to western North America, and because it is closer to Norway. So far, chipped deciduous wood arriving in Norway has originated from eastern North America.

The current pest risk characterization includes a prioritised list of the most important pests that can follow the import of deciduous wood chips from eastern North America (eastern USA and Canada). The current report is a first step toward a pest risk assessment of the commodity of wood chips.

The Norwegian Food Safety Authority has responded positively to the initiation of the current report, finding such a survey useful for their further work to prevent introduction and spread of listed and potential quarantine pests representing a threat to Norwegian forest and environment.

VKM's Panel on Plant Health appointed a project group consisting of five members of the panel and one external expert to make a draft assessment answering the terms of reference expressed by the panel. The draft was mainly conducted as contract work by the Norwegian Forest and Landscape Institute. The assessment was adopted by the Panel on Plant Health at a meeting 30th April 2013.

Terms of reference

To do a risk characterization of deciduous wood chips imported from eastern North America (eastern USA and Canada). The risk characterization should be according to ISPM No. 11, section 2.1 (FAO 2011). The risk characterization should give an overview of listed and potential quarantine pests that can enter Norway via this import. For each of these species it should be evaluated whether they have the potential to establish and spread under Norwegian conditions, and whether they have the potential to pose a threat to Norwegian forests and environment.

In the risk characterization it should be taken into consideration that the commodity in question is a mixture of deciduous wood chips, harvested in mixed stands of deciduous trees. A possible presence of conifer trees in the logging areas, and thus the possibility of conifer contamination of the commodity, must also be taken into consideration.

Assessment

In the current document, risk characterizations are given for 14 forest pests that may follow the import of deciduous wood chips from eastern North America (eastern USA and Canada), and that are potentially harmful to Norwegian forests and environment: Ten different species of beetles and four fungal species were characterized. Initially the plan was to consider also other deciduous raw wood material for chipping, and the whole of North America. However, during the process the mandate has been restricted to consider only deciduous wood chips, and not material for chipping. Also, early in the process we narrowed the geographic area for potentially invasive forest pests to eastern North America as defined by Baker (1972). It is assumed that chips will be produced on the east coast because there is higher abundance and diversity of deciduous trees in eastern North America compared to western North America, and because it is closer to Norway. So far, chipped deciduous wood arriving in Norway has originated from eastern North America.

As an introduction, chapter 1 describes the procedure and criteria that were used to screen for these potential pests. In chapters 2-11 risk characterizations are given for the ten different species of beetles, whereas chapters 12-15 are risk characterizations of the four fungal species. The pest risk characterizations are made according to the EPPO Standard PM 5/3(5) Decision-support scheme for quarantine pests (EPPO 2011c) by using the computer programme CAPRA that runs the EPPO decision-support scheme (downloaded from http://capra.eppo.org/index.php). The standard is divided into three stages:

Stage 1 Initiation
Stage 2 Section A: Pest categorization
Stage 2 Section B: Risk assessment
Stage 3 Risk management

The current document evaluates the plant pests by answering “Stage 1 Initiation” and “Stage 2 Section A: Risk characterization” for each of the pests. The current document does not give a full risk assessment or risk analysis, as it does not cover Stage 2 Section B or Stage 3. The EPPO Standard PM 5/3(5) in general is in accordance with ISPM No. 11, and the risk characterizations in the current document are according to ISPM No. 11, section 2.1 (FAO 2011), as prescribed by terms of reference.

The questions in chapters 2 – 15 have numbers corresponding to the EPPO standard. In chapter 16, eco-climatic conditions in North America are compared with the eco-climatic conditions of some locations of the PRA area. Chapter 17 comments on the danger of conifer wood contamination and Pinewood nematode in imported chips. Chapter 18 discusses import volume, chip size, and the probability of the pests surviving the chipping process and transport. Finally, in chapter 19 the ten insect pests and the four fungal pests evaluated in this report are ranked according to the need of a full risk assessment.

1 Criteria to obtain the selected pest list

This chapter describes the criteria that were used in the screening to select potential pests that can follow the import of deciduous wood chips from eastern North America. Only insects (wood borers) and fungi were characterized in the current document, while bacteria, mites, viruses, nematodes, or other taxa of plant pests were not included. Both regulated and unregulated insects and fungi were included; however, the species associated with conifers and not deciduous trees were later excluded. Furthermore, the few regulated insects pests on deciduous trees (*Anoplophora glabripennis*, *A. chinensis*, *Arrhenodes minutus*, and *Saperda candida*) possess relatively large larvae. A small experiment with surrogate larvae of *Anoplophora glabripennis* (plastic and up to 40 mm lengths) indicate that about 94-97.5 % of the larvae may be killed when chipping to down to diameter sizes of 6-10 cm (Wang et al. 2000). Due to a lower likelihood of surviving chipping, these four species were not included in the present screening. However, it cannot be excluded that a significant number of individuals may survive of these species as well in imports of large volumes of wood chips.

Furthermore, more insect species would have been included if we had chosen to consider also the pathways of deciduous wood material for chipping. When it comes to the fungal pests, for many species or species groups the taxonomy both within North America and between North America and Europe is not clear. We chose to include only relevant species with clear taxonomy in the current document. Incidentally, two of the four chosen fungal species are regulated in Norway by the the Plant health regulation (LMD 2000).

The screening procedure of insect pests is given in section 1.1, and for the fungal pests in section 1.2. After this screening, the 14 selected pest species were run through EPPO's CAPRA-program, Pest risk analysis, Section A: Pest categorization, to clarify if they could pose a risk to plant health in Norway. The risk characterizations for each of the 14 species are presented in chapters 2-15. In chapter 19 we make a prioritized list of which of the pests should be further evaluated by a risk assessment.

1.1 Selection of wood borers

The following procedure and criteria were used to select the species of wood borers to include in this survey:

Knowing that invasive wood borers adapt to congeneric hosts, we first listed all deciduous tree genera that are common to eastern North America and Norway and then listed all deciduous tree species occurring in Norway within these genera (See "Potential Norwegian hosts" in Appendix). Then we selected wood borers attacking trees within these genera. Wood borers that are present in Norway were excluded. Only species that are introduced to eastern North America from areas other than Europe or species that are endemic to North America were included.

One of the best indicators of a potential invasive pest is that it is a pest in other countries. We therefore screened literature (Baker 1972; Browne 1968; Craighead 1950; Johnson and Lyon 1976; Mattson et al. 1994; Solomon 1995) and cross-checked databases (bugwood.org 2012; EPPO 2011d; GISD 2012; ISPI 2009; NAFC-ExFor 2012; NAPIS 2012; U.S. Forest Service 2012) for wood-boring beetles that were known pests of deciduous trees in eastern North America. The initial list of wood-boring beetles consisted of 48 species. The list was then reviewed by Dr. Robert A. Haack (USDA Forest Service), Torstein Kvamme (Norwegian Forest and Landscape Institute), and Prof. Daniel Herms (Ohio State University) resulting in a list of 29 species (Appendix). Some of the 48 species on the initial list were considered as irrelevant because of their southern or narrow geographic distribution, others because they are not considered as pests, and some because they are already present in Norway.

Further information on these 29 wood borer species was compiled from the literature, and a further screening process was performed: The ability to kill healthy deciduous trees was emphasized, especially species attacking trees of European descent. The wood borers should be abundant, widely distributed and have a northern distribution, this to ensure an ability to develop under environmental conditions similar to Norway. The wood borers should be polyphagous and have a good capacity for spread and establishment in the new environment. They should also have traits that favour survival through one or several processes such as transport in raw material for production of chipped wood, transport in chipped wood and chipping itself. McCullough et al. (2007) showed that *A. planipennis* could survive chipping with a 10 cm chipping screen. Therefore, extra attention was given to the physical measures of the species, and measurements on egg, larva, pupa and imago were compiled from literature. This screening process resulted in a list of 10 insect pests to be run through the EPPO CAPRA-program (chapters 2-11).

The names of the 10 selected insect species were sent to the Canadian Food Inspection Agency with an enquiry to provide references and/or PDF files of relevant literature for the selected species. Missing literature was then obtained from multiple scientific databases and from Ohio State University.

1.2 Selection of fungal pathogens

The following procedure and criteria were used to screen for fungal species to include in this survey:

A similar procedure as for insects was followed when fungi were screened. The same list of host trees, based on occurrences in Norway and in eastern North America, was used (Appendix). Fungal species potentially surviving in wood chips were chosen among fungi found in both bark and wood in living trees. Relevant groups are fungi causing cankers, wilting, blue staining and rot in living trees. By using literature such as Sinclair and Lyon (2005), Nelson and Hudler (2007), Johnson et al. (2005), and internet pages, a list of 25 fungal species or species groups were found. The list was checked by Dr. Kerry Britton, the USDA Forest Service's National Program Leader for Forest Pathology Research. For many species or species groups the taxonomy both within North America and between North America and Europe is not clear. This is true for species of *Phytophthora* (which are not true fungi), *Armillaria* and *Phellinus* among others. Another example is *Entoleuca mammata*, which is a serious canker disease on poplars in North America. In Norway however, the species is non-pathogenic, and it is found on *Salix* spp. Further studies may reveal that these are two different taxa.

We selected four fungal species for risk characterization. All four species seem to be well defined; *Phellinus everhartii* causes heart rot in many different hardwoods, *P. spiculosus* causes Spiculosa canker on oak trees, *Ceratocystis fagacearum* causes wilt disease on oak trees, and *Davidiella populorum* causes Septoria canker on poplars. The four species were run through the EPPOs CAPRA-program, as for the insects. The risk characterizations are presented in chapters 12-15.

2 Risk characterization of Bronze birch borer (*Agrilus anxius*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:	*Agrilus anxius* Gory, 1814.
Synonyms:	*A. gravis* LeConte, 1860.
	A. torpidus LeConte, 1860.
Common name:	Bronze birch borer.
Common name in Norwegian:	Amerikansk bjørkepraktbille.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

Yes. In 2011, EPPO published three documents on *Agrilus anxius*:

"*Agrilus anxius* EPPO Data sheets on pests recommended for regulation" (EPPO 2011a).

"Pest Risk Analysis for *Agrilus anxius*" (EPPO 2011b).

"Report of a Pest Risk Analysis for *Agrilus anxius*" (EPPO 2003a; EPPO 2003b).

According to the EPPO PRA (EPPO 2011b), *A. anxius* represents an unacceptable risk to those parts of the EPPO region in which tree species of *Betula* are present. EPPO decided to add *A. anxius* to the EPPO A1 list in September 2011, thus recommending its member countries to regulate *A. anxius* as a quarantine pest.

In July 2012, VKM published an assessment of the probability of entry and establishment and impact potential of *A. anxius* in Norway, and an evaluation of the effectiveness of relevant risk reducing measures addressing import of wood chips and other lumber of *Betula* spp. from countries where *A. anxius* is present. VKM addressed these questions by commenting on the relevance of the EPPO PRA (VKM 2012) for Norwegian conditions. The title of this assessment is "The EPPO PRA for *Agrilus anxius*: Assessment for Norwegian conditions" (VKM 2012). In the assessment, VKM gives the following main conclusion concerning entry, spread, establishment, and economic and environmental consequences:

- The probability of entry of *A. anxius* to Norway is considered as low to medium, with a medium level of uncertainty.
- The probability of establishment is considered as very high, with low uncertainty.
- The probability of spread within Norway is considered as very high, with a low level of uncertainty.
- The endangered area is the whole forested area of southern Norway south of Nordland County, and the Pasvik area east in Finnmark County.
- It is expected that the pest will have major economic consequences in the endangered area. On the whole, introduction would result in high mortality of birch throughout the endangered area, and major economic impacts (including major environmental impacts). The overall level of uncertainty is low.

1.05 - 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)? Explain your judgment (edit in the part justification)

"The EPPO PRA for *Agrilus anxius*: Assessment for Norwegian conditions" by VKM (2012) is regarded as entirely valid.

"Pest Risk Analysis for *Agrilus anxius*" (EPPO 2011b) is regarded as highly relevant and partly valid.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

Most North American birch species are attacked by *A. anxius*, except for river birch (*Betula nigra*), which is immune. Primary North American hosts are paper birch (*B. papyrifera*), sweet birch (*B. lenta*), yellow birch (*B. alleghaniensis*), gray birch (*B. populifolia*) and water birch (*B. occidentalis*) (V. Muilenburg, pers. comm.). The Eurasian species silver birch (*B. pubescence*), *B. szechuanica*, white birch (*B. pendula*) and *B. maximowiczianaare* are highly susceptible (Nielsen et al. 2011). Of these *B. pendula* and *B. pubescens* are present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Agrilus anxius is endemic to the boreal and northern hardwood forest of North America and is present throughout the range of its primary hosts (Muilenburg and Herms 2012), but it has expanded its range due to planting of ornamental host trees (V. Muilenburg, pers. comm.). In Canada the distribution is from Newfoundland to British Columbia, but the pest is most common in the southern part of the provinces (Bright 1987; Solomon 1995).

Stage 2 Section A: Pest categorization

1.08 - 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, it is a single taxonomic entity.

1.10 - 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. *Agrilus anxius* larvae produce galleries that disrupt phloem transport, which can kill the infested tree. *Agrilus anxius* can attack and kill stressed native *Betula* species, but causes 100% mortality in European and Asian *Betula* spp. in forests and managed environments (parks and gardens) in North America (Muilenburg and Herms 2012; Nielsen et al. 2011).

1.12- Does the pest occur in the PRA area?

No. *Agrilus anxius* is endemic to North America and has never been recorded outside its native range.

1.14 - 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. Birch is Norway's most abundant tree, constituting 41% of the total number of trees. White birch (*B. pendula*; "Hengebjørk") and Silver birch (*B. pubescens*; "Bjørk") are potential hosts in Norway. In addition, several *Betula* spp. sold as ornamentals are potential hosts: *B. utilis* ("Himalayabjørk") and *B. albosinensis* ("Rødbjørk") amongst others. Dwarf birch (*Betula nana*; "Dvergbjørk"), an alpine shrub, has never been documented as a host.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Agrilus anxius* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. VKM (2012) concluded that the endangered area of Norway is the whole forested area of southern Norway south of Nordland County, and Pasvik in eastern Finnmark County. Given the limited scientific knowledge on the climatic requirements of *A. anxius*, VKM (2012) concluded that an assessment of its potential for establishment in Norway must rely mainly on climatic comparisons with its current area of distribution. Also, see a more general assessment in chapter 16 where we compare the eco-climatic conditions between the PRA area and North America.

1.17 - 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. *Agrilus anxius* is known as a serious pest of forest and shade trees in North America, and experiments have shown that *A. anxius* causes 100% mortality to European and Asian birch species (Nielsen et al. 2011).

In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus anxius* is a known pest of birch in North America. Experiments have shown that *A. anxius* causes 100% mortality to European and Asian birch species.
- Several potential host species of *Betula* spp. are present in the PRA area. Two of them, *B. pendula* and *B. pubescens*, are widely distributed in the PRA area.
- There are eco-climatic similarities between the native range of the pest and Norway.

Also, see VKM’s risk assessment of the pest for Norway (VKM 2012).

3 Risk characterization of Twolined chestnut borer (*Agrilus bilineatus*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Agrilus bilineatus* Weber, 1801.
Synonyms: *Agrilus aurolineatus* Gory, 1841.
Agrilus bivittatus Kirby, 1837.
Agrilus flavolineatus Mannerheim, 1837.
Common name: Twolined chestnut borer.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

Agrilus bilineatus primarily attacks *Quercus* spp. The pest also attacks American chestnut (*Castanea dentate*) and possibly *Fagus* spp. Primary host species in North America are White oak (*Quercus alba*), Scarlet oak (*Quercus coccinea*), Northern pin oak (*Quercus ellipsoidalis*), Bur oak (*Quercus macrocarpa*), Chestnut oak (*Quercus prinus*), Northern red oak (*Quercus rubra*), Post oak (*Quercus stellata*), Black oak (*Quercus velutina*), and Live oak (*Quercus virginiana*) (Haack and Acciavatti 1992; Haack and Benjamin 1982).

Of these, Northern red oak (*Quercus rubra*) occurs in Norway.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Agrilus bilineatus is endemic to North America and widely distributed. It occurs in south-eastern Maritime Provinces of Canada southward throughout the eastern and central United States and westward to the Rocky Mountains and south to Florida and Texas (Bright 1987; Dunbar and Stephens 1976; Haack and Acclavau 1992; Solomon 1995). Haack indicates that the probable range of the Twolined chestnut borer covers the whole range of its oak hosts.

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. *Agrilus bilineatus* is known as a principal pest of *Quercus* spp. in its area of distribution, where it attacks and kills stressed oaks.

1.12 - Does the pest occur in the PRA area?

No. *Agrilus bilineatus* is endemic to North America and has never been recorded outside its native range.

1.14 - 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. Northern red oak (*Quercus rubra*) is present in the PRA area and is a known host of *A. bilineatus* in North America. In addition, three potential hosts are present in the PRA area: English oak (*Q. robur),* Durmast oak (*Q. petraea*), and European beech (*F. sylvatica*). There is no information about *A. anxius* resistance or susceptibility for these potential host tree species.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Agrilus bilineatus* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus bilineatus* is a known pest of oaks in North America.
- There are eco-climatic similarities between the native range of the pest and Norway.
- There is one known host plant species (*Q. rubra*) and several potential host plant species of *A. bilineatus* present in Norway.

4 Risk characterization of Granulate poplar borer (*Agrilus granulatus granulatus*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:	*Agrilus granulatus granulatus* Say, 1823.
Synonyms:	None.
Common name:	Granulate poplar borer.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.
Subspecies of *Agrilus granulatus* (Say, 1823).

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In North America, *Agrilus granulatus granulatus* is common in both native and planted poplars: Lombardy poplar (*Populus nigra*), Eastern cottonwood (*P. deltoides*), and Black cottonwood (*P. trichocarpa*) (Solomon 1995).

Of these, Lombardy poplar (*P. nigra*) is planted in Norway.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Agrilus granulatus granulatus is endemic to North America; From New York south to North Carolina and Louisiana, west to Colorado and Montana, and in the southern regions of Alberta, Canada (Bright 1987; Solomon 1995).

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. *Agrilus granulatus granulatus* attacks and kills trees that are damaged by drought or stressed. Infested trees may succumb suddenly or slowly over several years, depending on other stresses (Solomon 1995).

1.12 - Does the pest occur in the PRA area?

No. *Agrilus granulatus granulatus* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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. Lombardy poplar (*Populus nigra*) is a known host of *A. granulatus granulatus* in North America, and is present in the PRA area. The statuses of the other populous species present in the PRA area are unknown: White poplar (*P. alba*), Balsam poplar (*P. balsamifera*) and European aspen (*P. tremula*). We therefore consider them as potential host plants in the PRA area.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Agrilus granulatus granulatus* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus granulatus granulatus* is a known pest of *Populus* spp. in North America.
- The pest attacks and kills stressed *P. nigra* in North America. This known host plant is present in Norway, in addition to three other *Populus* species that are potential host plants.
- There are eco-climatic similarities between the native range of the pest and Norway.

5 Risk characterization of Bronze poplar borer (*Agrilus granulatus liragus*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Agrilus granulatus liragus* Barter and Brown, 1949.
Synonyms: None.
Common name: Bronze poplar borer.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.
Subspecies of *Agrilus granulatus* Say, 1823.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

Known host plant species in North America are American aspen (*Populus tremuloides*), bigtooth aspen (*P. grandidentata*), Balsam poplar (*P. balsamifera*), Black cottonwood (*P. trichocarpa*), and Eastern cottonwood (*P. deltoides*) (Carlson and Knight 1969; Solomon 1995).

Of these, Balsam poplar (*P. balsamifera*) is present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

In Canada, as far north as Edmonton, from Newfoundland west to British Columbia, in the United States southward to Pennsylvania and westward to northern California and Oregon (Bright 1987; Solomon 1995).

Stage 2 Section A: Pest categorization

1.08 - 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, it is a single taxonomic entity.

1.10 - 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. Attacks on the branches and trunks of trees cause deterioration and frequently death of the hosts (Solomon 1995).

1.12 - Does the pest occur in the PRA area?

No. *Agrilus granulatus liragus* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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. Balsam poplar (*Populus balsamifera*) is a known host of *A. granulatus liragus* in North America, and is present in the PRA area. The statuses of the other *Populus* species present in the PRA area are not known: White poplar (*P. alba*), Lombardy poplar (*P. nigra*) and European aspen (*P. tremula*). We therefore consider them as potential host plants in the PRA area.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No *Agrilus granulatus liragus* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus granulatus liragus* is a known pest of *Populus* spp. in North America.
- There is one known host (*P. balsamifera*) and several potential host plants present in Norway. *Agrilus granulatus liragus* attacks and kills stressed *P. balsamifera* in North America.
- There are eco-climatic similarities between the PRA area and the area of current distribution of the pest in North America.

6 Risk characterization of Aspen root girdler (*Agrilus horni*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Agrilus horni* Kerremans, 1900.
Synonyms: *Agrilus blanchardi* Horn, 1891.
Common name: Aspen root girdler.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In North America, American aspen (*Populus tremuloides*) and Bigtooth aspen (*P. grandidentata*) are hosts (Carlson and Knight 1969; Nord et al. 1965). Rather heavy infestations have also occurred in the Eurasian *P. alba*, *P. tremula* and various aspen hybrids (Nord et al. 1965). Of these, White poplar (*P. alba*) and European aspen (*P. tremula*) are present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

As far north in Canada as Aweme, Manitoba southward through Ontario into the United States, to New York in the east, and to Iowa and South Dakota in the Midwest (Bright 1987; Carlson and Knight 1969).

Stage 2 Section A: Pest categorization

1.08 - 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, it is a single taxonomic entity.

1.10 - Is the organism in its area of current distribution a known pest (or vector of a pest) of plants or plant products?

Yes, *Agrilus horni* is considered to be a pest. Roots and stems of young, apparently healthy aspen suckers are often heavily attacked by *A. horni* (Baker 1972; Nord et al. 1965). Suckers may be killed, but rates of mortality vary depending on the extent of infestation. *A. horni* can be economically damaging in sparsely stocked natural stands.

1.12 - Does the pest occur in the PRA area?

No. *Agrilus horni* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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. White poplar (*Populus alba*) and European aspen (*P. tremula*) suckers are attacked and killed in North America. The status of the other *Populus* species present in Norway are uncertain: Balsam poplar (*P. balsamifera*), Lombardy poplar (*P. nigra*) (Carlson and Knight 1969; Nord et al. 1965).

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Agrilus horni* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus horni* is a known pest of *Populus* spp. in North America.
- *Agrilus horni* attacks and kills suckers of *Populus tremuloides*, *P. grandidentata*, *P. alba* and *P. tremula* in North America. Two of these known host species (*P. alba* and *P. tremula*) and several potential host plants are present in the PRA area.
- There are eco-climatic similarities between the native range of the pest and Norway.

7 Risk characterization of Emerald ash borer (*Agrilus planipennis*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Agrilus planipennis* Fairmaire, 1888.
Synonymes: *Agrilus feretrius* Obenberger, 1936.
Agrilus marcopoli Obenberger, 1930.
Agrilus ulmi Kurosawa, 1956.
Common name: Emerald ash borer.
Common name in Norwegian: Asiatisk askepraktbille.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

A PRA produced by EPPO (EPPO 2003a; EPPO 2003b) is relevant. The overall conclusions of this PRA were: “The endangered part of the PRA area covers most of central and

Mediterranean regions of the EPPO territory. The pest entry with wood packaging material and plants for planting has a high probability. The probability of establishment is high. Its impact within the endangered area would be the direct damage to plantations of forest, city and ornamental trees. *A. planipennis* is absent or of limited distribution in the EPPO region (Russian Far East - ?). Possibilities of the pest control are very limited. Phytosanitary measures could prevent its introduction into the endangered area. *A. planipennis* is proposed for the A1 list."

Today, *Agrilus planipennis* is on EPPO's A2 list, meaning that EPPO recommends its member countries to regulate the pests listed below as quarantine pests.

1.05 - 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)? Explain your judgment (edit in the part justification)

The PRA produced by EPPO (EPPO 2003a; EPPO 2003b) is somewhat outdated and thus only partly valid. Currently EPPO is revising its documents on the pest, and risk management options are being evaluated.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In North America, *A. planipennis* attacks and kills three species of ash: White ash (*Fraxinus americana*), Green ash (*F. pennsylvanica*), and Black ash (*F. nigra*) (Haack et al. 2002; McCullough and Katovic 2008). In Russia, *A. planipennis* attacks and kills Green ash (*F. pennsylvanica*) and the European ash (*F. excelsior*) (Baranchikov 2012; Baranchikov et al. 2009). In China, *A. planipennis* attacks *F. chinensis* var. *chinensis*, *F. chinensis* var. *rhynchophylla* and *F. mandshurica*.

Of these, European ash (*F. excelsior*) is present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Native range in Asia: China, Mongolia, Taiwan, Korea, Japan, and the Russian Far East (Haack et al. 2002).

Agrilus planipennis is introduced to Moscow, Russia, and North America. It is established in 15 mid-western and north-eastern states in USA, and in the provinces of Ontario and Quebec in Canada.

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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.

1.12 - Does the pest occur in the PRA area?

No.

1.14 - 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, the known host plant species European ash (*Fraxinus excelsior*) is present in the PRA area. In addition, *F. pennsylvanica* and other host species of ash (*Fraxinus* spp.) are planted occasionally in the PRA area.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Agrilus planipennis* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus planipennis* is a known pest of *Fraxinus* spp. in North America, Russia and Asia.
- The known host plant *Fraxinus excelsior* is present in Norway. In Russia, *A. planipennis* attacks and kills *F. excelsior*.
- There are eco-climatic similarities between the PRA area and the area of current distribution of the pest in North America and Russia.

8 Risk characterization of Common willow agrilus (*Agrilus politus*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:	*Agrilus politus* Say, 1825.
Synonyms:	*Agrilus canadensis* Obenberger, 1917.
	Agrilus cupreolus LeConte, 1860.
	Agrilus desertus LeConte, 1860.
	Agrilus plumbeus LeConte, 1860.
	Agrilus solitarius Harold, 1869.
Common name:	Common willow agrilus.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Buprestidae* Leach, 1815.
Genus: *Agrilus* Curtis, 1825.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In North America, *Agrilus politus* mainly attacks *Salix* spp. and *Acer* spp. (Bright 1987). Preferred hosts are Arroyo willow (*Salix lasiolepis*), Scouler willow (*S. scouleriana*), Pacific willow (*S. lucida*), and Weeping willow (*S. babylonica*) (Solomon 1995).

Rocky Mountain maple (*Acer glabrum*), Striped maple (*A. pennsylvanicum*), and Dwarf maple (could be any of numerous cultivated *Acer* spp.) are also hosts.

None of the above mentioned host plant species occur naturally in the PRA area. Some of them might be planted in gardens, such as dwarf maple, but this information is uncertain due to taxonomic vagueness in the literature. *Quercus* spp., *Crataegus* spp., *Corylus* spp., and *Alnus* spp. have also been mentioned as possible, but minor hosts (Solomon 1995). Species in all these genera are commonly used as ornamental trees in the southern part of the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Agrilus politus is endemic to North America and is transcontinental across Canada and throughout the United States (Bright 1987; Solomon 1995).

Stage 2 Section A: Pest categorization

1.08 - 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, it is a single taxonomic entity.

1.10 - 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. Attacks give abnormal growth, galls and cracks in the outer bark, resulting in branch dieback and tree mortality.

1.12 - Does the pest occur in the PRA area?

No. *Agrilus politus* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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, several potential host plant species are present in the PRA area: Norway maple (*A. platanoides*) is found in natural forests in the PRA area. Goat willow (*Salix caprea*), Field maple (*Acer campestre*), Norway maple (*A. platanoides*), Sycamore maple (*A. pseudoplatanus*), Red maple (*A. rubrum*) are found in gardens and as ornamental trees in the southern part of the PRA area. In addition, some of the known host plant species mentioned in point 1.06 might be planted in gardens in the PRA area.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Agrilus politus* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Agrilus politus* is a known pest in North America, where it attacks *Salix* spp. and gives abnormal growth, galls and cracks in the outer bark, resulting in branch dieback and tree mortality.
- Several potential host plant species occur in the PRA area.
- There are eco-climatic similarities between the PRA area and the native range of the pest in North America.

9 Risk characterization of Flatheaded appletree borer (*Chrysobothris femorata*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Chrysobothris femorata* Oliver, 1790.
Synonyms: None.
Common name: Flatheaded appletree borer.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Order: Coleoptera.
Family: Buprestidae.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In North America, *Chrysobothris femorata* is a highly polyphagous species. Severe economic losses have been reported from nurseries growing young *Acer rubrum* during periods of intermitted drought (Potter et al. 1988). The pest mainly attacks stressed *Acer* spp, *Malus* spp, and *Populus* spp, but many other trees are also attacked. These are *Pyrus* spp., *Prunus* spp., *Salix* spp., *Fagus* spp., *Castanea* spp., *Quercus* spp., *Ulmus* spp., *Fraxius* spp., *Crataegus* spp., and *Alder* spp.

Of the host plant species mentioned above, Red maple (*Acer rubrum*) occurs in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Chrysobothris femorata occurs throughout most of Canada and the United States (Baker 1972; Drooze 1985).

Stage 2 Section A: Pest categorization

1.08 - 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, it is a single taxonomic entity.

1.10 - 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. *Chrysobothris femorata* is a common and destructive pest of many deciduous trees (Potter et al. 1988). The pest attacks stressed trees or trees otherwise damaged by disease or other insects. Small trees are girdled and killed, and larger trees may be severely weakened and scarred.

1.12 - Does the pest occur in the PRA area?

No. *Chrysobothris femorata* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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. Potential host plant species occurring in the PRA area are Field maple (*Acer campestre*), Norway maple (*A. platanoides*), Sycamore maple (*A. pseudoplatanus*), White poplar (*Populus alba*), Balsam poplar (*P. balsamifera*), Lombardy poplar (*P. nigra*), and European aspen (*P. tremula*). When it comes to *Malus* spp., *M. sylvestris* occurs naturally in the best climatic zones of the PRA area. Several apple varieties are grown commercially in the PRA area. It is not possible to say whether some of these can be attacked by *Chrysobothris femorata.* Species of *Pyrus* spp., *Prunus* spp., *Salix* spp., *Fagus* spp., *Castanea* spp., *Quercus* spp., *Ulmus* spp., *Fraxinus* spp., *Crataegus* spp., and *Alnus* spp. are also potential hosts in the PRA area.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Chrysobothris femorata* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Chrysobothris femorata* is a known, polyphagous pest in North America, where it attacks stressed trees or trees otherwise damaged by disease or other insects. Small trees are girdled and killed, and larger trees may be severely weakened and scarred.
- Several potential host plants are present in the PRA area.
- There are eco-climatic similarities between the PRA area and the area of current distribution of the pest in North America.

10 Risk characterization of Native elm bark beetle (*Hylurgopinus rufipes*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Hylurgopinus rufipes* Eichhoff, 1868.
Synonymes: None.
Common name: Native elm bark beetle.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Order: Coleoptera.
Family: Buprestidae.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

Hylurgopinus rufipes prefers stressed *Ulmus* spp., mainly American elm (*U. americana*) and Siberian Elm (*U. pumila*) (Anderson and Holliday 1999; McLeod et al. 2005). The pest is also reported attacking *Fraxinus* spp. (Baker 1972), but species-specific information is lacking in the literature.

None of the two above mentioned host species occur in the PRA area. Other species of both *Ulmus* spp. and *Fraxinus* spp. are present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Throughout the eastern USA, north of Alabama and Mississippi west to Nebraska and North Dakota. In Canada from New Brunswick to Manitoba.

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. *Hylurgopinus rufipes* populations can grow large during prolonged drought, when the beetles aggressively attack healthy trees. *Hylurgopinus rufipes* is vector of the Dutch elm disease caused by the fungus *Ophiostoma novo-ulmi*.

1.12 - Does the pest occur in the PRA area?

No. See answer to question 1.07.

1.14 - 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. Potential host plant species are present in the PRA area: Wych elm (*Ulmus glabra*) (common in the best climatic zones of Norway) and European ash (*Fraxinus excelsior*), but due to lack of species-specific information in the literature, it is not possible to say whether some of these species are attached by *Chrysobothris femorata* in North America.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Hylurgopinus rufipes* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Hylurgopinus rufipes* is a known pest in North America. It is a polyphagous species that attacks stressed trees, but summer-emergent adults are attracted to healthy elm (Swedenborg et al. 1988).
- Several potential host plant species (of *Ulmus* spp. and *Fraxinus* spp.) are present in the PRA area.
- There are eco-climatic similarities between the PRA area and the area of current distribution of the pest in North America.

11 Risk characterization of Banded elm bark beetle (*Scolytus schevyrewi*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis. EPPO added *Scolytus schevyrewi* to the EPPO alert list in 2005, but deleted the entry in 2008 (EPPO 2013). However, this beetle species is included here because it may represent a vector for Dutch Elm disease (*Ophiostoma novo-ulmi*) in addition to the *Scolytus* species that are currently present in the PRA area (Jacobi et al. 2007; Jacobi et al. 2013; Solheim et al. 2011).

1.01c - Enter the name of the pathway

Deciduous wood chips from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:	*Scolytus schevyrewi* Semenov, 1902.
Synonyms:	None.
Common name:	Banded elm bark beetle.

1.02b - Indicate the type of the pest

Arthropod.

1.02d - Indicate the taxonomic position

Family: *Curculionidae* Latreille, 1802.
Genus: *Scolytus* Geoffroy, 1762.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In Asia, the primary hosts of *Scolytus schevyrewi* are *Ulmaceae*: Siberian elm (*Ulmus pumila*), European white elm (*U. laevis*), Japanese elm (*U. davidiana* var. *japonica*), Bigfruit elm (*U. macrocarpa*), and Smooth-leaved elm (*U. carpinifolia* and *U. propinqua*). The pest is also reported to attack Babylon Willow (*Salix babylonia*)*,* Russian olive (*Eleaganus* spp.), *Caragana korshinskii*, European bird cherry (*Prunus padus*), Apricot (*P. armeniaca* var. *ansu*), Santa Rosa plum (*P. salicina*), Peach (*P. persica*), Yedo flowering cherry (*P. yedoensis*), and *P. pseudocerasus* (NAFC-ExFor 2012).

In USA, Siberian elm (*Ulmus pumila*), American elm, (*U. americana*), and Rock elm (*U. thomasi*) have been reported as hosts (NAFC-ExFor 2012; Negron et al. 2005).

None of these host plant species occur in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Asia: *Scolytus schevyrewi* is indigenous to China, Mongolia, Korea, Turkmenistan, Uzbekistan, Tajikistan, Kazakhstan, Kyrgyzstan and Russia.

North America: *Scolytus schevyrewi* is present in 28 US-states and the province of Alberta, Canada (Lee et al. 2009; NAFC-ExFor 2012).

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. *Scolytus schevyrewi* usually attacks weakened or stressed trees, although during outbreaks it can also attack healthy elms (NAFC-ExFor 2012).

Scolytus schevyrewi may represent a vector for Dutch elm disease (*Ophiostoma novo-ulmi* (Jacobi et al. 2007; Jacobi et al. 2013).

1.12 - Does the pest occur in the PRA area?

No. See answer to question 1.07.

1.14 - 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, several species of *Ulmus* spp. *and Salix* spp. are potential hosts in Norway.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Scolytus schevyrewi* is a free-living organism.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In 2005, *Scolytus schevyrewi* was added to the EPPO Alert list. The pest was removed from the same list in 2008 because EPPO Panel on QPs for Forestry considered that *S. schevyrewi* was not more damaging than existing European *Scolytus*. We do not disagree with this judgement. However, it has been seen that *S. schevyrewi* can possibly act as a vector for Dutch elm disease (*Ophiostoma novo-ulmi*) (Jacobi et al. 2007; Jacobi et al. 2013).

In conclusion, this pest could present a phytosanitary risk to the PRA area by acting as a vector.

1.18 - Summarize the main elements leading to this conclusion.

- *Scolytus schevyrewi* is a known pest in North America, where it attacks *Ulmus* spp.
- Several potential host plant species (of *Ulmus* spp. *and Salix* spp.) are present the PRA area.
- There are eco-climatic similarities between the PRA area and the area of current distribution of the pest in North America.

12 Risk characterization of Canker rot (*Phellinus everhartii*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips imported from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:	*Phellinus everhartii* (Ellis & Galloway) Pilát 1942.
Synonyms:	*Mucronoporus everhartii*.
	Pyropolyporus everhartii.
	Fomes everhartii.
	Scindalma everhartii.
Common name:	Hoof Conk; Canker rot.

1.02b - Indicate the type of the pest

Fungus.

1.02d - Indicate the taxonomic position

Order: Hymenochaetales.
Family: Hymenochaetaceae.
Genus: Phellinus.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

In North America, *Phellinus everhartii* is found mostly on *Quercus*, but occasionally on other hardwood genera like *Betula* spp., *Fagus* spp., *Populus* spp., *Ulmus* spp., *Carya* spp., *Juglans* spp., *Liriodendron* spp., *Oxydenron* spp., and *Prosopsis* spp. (Larsen and Cobb-Poulle 1990). Species-specific information is lacking in the literature.

Species of all above mentioned host plant families are present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Phellinus everhartii is distributed throughout the hardwood forests of eastern North America (Larsen and Cobb-Poulle 1990).

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. This white rot fungus has the ability to attack living trees and cause heart rot. As it is common on oaks, the fungus can cause large economic losses (Michael et al. 2010).

1.12 - Does the pest occur in the PRA area?

No. *Phellinus everhartii* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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. Potential host plant species in the PRA are Sessile oak (*Quercus petraea*), English oak (*Quercus robur*), and Northern red oak (*Quercus rubra*), in addition to several species of *Betula* spp., *Fagus* spp., *Populus* spp., *Ulmus* spp., *Carya* spp., *Juglans* spp., *Liriodendron* spp., *Oxydenron* spp., and *Prosopsis* spp.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Phellinus everhartii* is a free-living organism that disperses by air-borne spores.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Phellinus everhartii* is considered to be a pest in its area of current distribution, which is throughout the hardwood forests of eastern North America.
- At least several host plant species occur in the PRA area.
- There are eco-climatic similarities between the PRA area and the area of current distribution in North America.

13 Risk characterization of Spiculosa canker (*Phellinus spiculosus*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips imported from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:	*Phellinus spiculosus* (W.A. Campb. & R.W. Davidson) Niemelä, 1972.
Synonyms:	*Inonotus spiculosus* Campb & Davidson.
	Poria spiculosus Campb & Davidson.
Common name:	Spiculosa canker.

1.02b - Indicate the type of the pest

Fungus.

1.02d - Indicate the taxonomic position

Family: *Hymenochaetaceae* Imazeki & Toki, 1954.
Genus: *Phellinus* Quél, 1886.

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

The most common hosts in North America are *Quercus* spp., *Q. coccinea*, *Q. nigra*, and *Q. rubra*. *Phellinus spiculosus* is also registered on *Betula alleghaniensis*, *Carya glabra* and *Cornus florida*.

Of these, Northern red oak (*Q. rubra*) is present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Phellinus spiculosus is widespread in eastern hardwood forests in North America, from eastern Texas through the Gulf coast region and north to Pennsylvania.

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. *Phellinus spiculosus* causes serious decay and cull in eastern hardwoods, especially in red oaks. Heartwood decay is the most serious type of damage, but the *P. spiculosus* also kills the cambium and degrade the sapwood as much as one meter above and below the entrance point in the tree. The ability of this fungus to kill the cambium and cause cankers distinguishes it from fungi that are restricted to the heartwood (McCracken 1978).

1.12 - Does the pest occur in the PRA area?

No. *Phellinus spiculosus* is endemic to North America and has never been recorded outside of its native range.

1.14 - 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. The known host plant species Northern red oak (*Quercus rubra*) is present in Norway. In addition other *Quercus* spp. and *Betula* spp. are potential hosts in Norway.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Phellinus spiculosus* is a free-living organism that reproduces from spores. Spores are distributed by air to branch stubs on healthy trees, where infection occurs (McCracken 1978).

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. *Phellinus spiculosus* is widespread in eastern hardwood forests in North America, from eastern Texas through the Gulf coast region and north to Pennsylvania. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Phellinus spiculosus* is considered to be a pest in its area of current distribution in North America. *Phellinus spiculosus* is widespread in eastern hardwood forests, from eastern Texas through the Gulf coast region and north to Pennsylvania.
- At least one known host plant species, *Quercus rubra*, and several potential host plant species occur in the PRA area.
- There are eco-climatic similarities between the PRA are and the area of current distribution of the pest in North America.

14 Risk characterization of Oak wilt (*Ceratocystis fagacearum*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips imported from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name: *Ceratocystis fagacearum* (Bretz) J. Hunt, Lloydia 19: 21 (1956).
Synonyms: *Chalara quercina* B.W. Henry, Phytopathology 34: 635 (1944).
Endoconidiphora fagacearum Bretz, Phytopathology 42: 437 (1952). *Thielaviopsis quercina* (B.W. Henry) A.E. Paulin, T.C. Harr. & McNew, Mycologia 94(1): 70 (2002).
Common name: Oak wilt.
Common name in Norwegian: Eikevisning.

1.02b - Indicate the type of the pest

Fungus.

1.02d - Indicate the taxonomic position

Order: Microascales Luttr. Ex Benny & R.K. Benj. (1980).
Family: Ceratocystidaceae Locq. (1972).
Genus: Ceratocystis Ellis & Halst. (1890).

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

Many oak species are susceptible to *Ceratocystis fagacearum*. Generally, red oaks such as *Quercus coccinea*, *Q. ellipsoidalis*, *Q. falcata*, *Q. palustris*, *Q. rubra*, *Q. shumardii*, and *Q. velutina* are highly susceptible. White oaks such as *Q. alba*, *Q. macrocarpa*, *Q. prinus*, *Q. stellate*, and *Q. virginiana* are less susceptible. However, some white oak species are highly susceptible: *Q. pubescens*, and the European species *Q. robur and Q. petrea* (Juzwik et al. 2012; Tainter and Baker 1996).

Quercus rubra, *Q. robur*, and *Q. petraea* are present in the PRA area.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Ceratocystis fagacearum is only known from eastern and mid-western states and Texas of the USA. The northernmost locations found are in Michigan, Wisconsin, and New York, not far from the Canadian border (Juzwik et al. 2012). However, the pathogen may as well have been introduced with Central or South America, or Mexico as the origin (Juzwik et al. 2012; Juzwik et al. 2008).

Stage 2 Section A: Pest categorization

1.08 - 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, it's a single taxonomic entity.

1.10 - 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. *Ceratocystis fagacearum* is an important pest on oaks threatening various oak species in its distribution area.

1.12 - Does the pest occur in the PRA area?

No. *Ceratocystis fagacearum* is only recorded in USA, but may be an introduced pathogen, with possible origins in Central or South America, or Mexico (Juzwik et al. 2012; Juzwik et al. 2008).

1.14 - 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. *Quercus robur* and *Q. petraea* are common in the southern part of the PRA area, while *Q. rubra* is spread from plantings.

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Ceratocystis fagacearum* is normally spread by root grafting and by insect transmission with nitidulae beetles (and lesser with oak bark borer) (Juzwik et al. 2012). Wood and wood chips are possible pathways for long distance spread.

1.16 - 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. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Ceratocystis fagacearum*is is a well-known pest in its areas of current distribution, which are various oak species in eastern and mid-western part of USA.
- The host plants *Quercus robur* and *Q. petraea* are common in southern parts of the PRA area.
- There are eco-climatic similarities between the PRA are and the area of current distribution of the pest in North America.

15 Risk characterization of Septoria canker of poplar (*Davidiella populorum*)

Stage 1: Initiation

1.01 - Give the reason for performing the PRA

The pest is evaluated in the framework of a pathway-initiated analysis.

1.01c - Enter the name of the pathway

Deciduous wood chips imported from eastern North America (eastern USA and Canada).

1.02a - Name of the pest

Species name:

Davidiella populorum (G.E. Thomps.) Aptroot, CBS Diversity Ser. (Utrecht) 5: 164 (2006).

Synonyms:

Cylindrosporium oculatum Ellis & Everh., J. Mycol. 5(3): 155 (1889).
Mycosphaerella populorum G.E. Thomps., Phytopathology 31: 246 (1941).
Septoria musiva Peck, Ann. Rep. N.Y. St. Mus. nat. Hist. 35: 138 (1883) [1881].

Common name:

Septoria canker of poplar (Septoria leaf spot and canker).

1.02b - Indicate the type of the pest

Fungus.

1.02d - Indicate the taxonomic position

Order: Capnodiales Woron. (1925).
Family: Davidiellaceae C.L. Schoch, Spatafora, Crous & Shoemaker (2007).
Genus: Davidiella Crous & Braun (2003).

1.03 - Clearly define the PRA area

The PRA area is Norway.

1.04 - Does a relevant earlier PRA exist?

No.

1.06 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non-parasitic plants). Indicate the ones which are present in the PRA area.

Davidiella populorum can infect all species of *Populus* spp. native to North America, and a large number of European and Asian species (Ostry and McNabb 1985; Waterman 1951). The pest is most important on exotic and hybrid poplars of parentage with *Populus balsamifera, P. deltoides, P. nigra* and *P. trichocarpa*. Resistance has been reported in *P. alba, P. canescens*, and *P. nigra* var. *italica* (Ostry and McNabb 1985; Waterman 1951).

Some poplar species and hybrids susceptible to *Davidiella populorum* are planted and spread in the PRA area, among others *P. nigra* and *P. balsamifera*.

Populus tremula, the only native species in the PRA area, has not been recorded as resistant or susceptible.

1.07 - Specify the pest distribution for a pest-initiated PRA, or the distribution of the pests identified in 2b for pathway-initiated PRA

Davidiella populorum is widespread in eastern part of North America, both in Canada and USA. Reports from western North America may be false reports caused by confusion with similar species.

Stage 2 Section A: Pest categorization

1.08 - 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, it is a single taxonomic entity. However, in the past confusion with near related species has happened.

1.10 - 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. *Davidiella populorum* can infect leaves of both native and exotic species of *Populus*, but only exotic species and hybrids are severely attacked with cankering and dieback as a result (extensive losses of hybrid plantings).

1.12 - Does the pest occur in the PRA area?

No. *Davidiella populorum* is widespread in North America and is also known from Argentina where it was particularly serious on several imported hybrids imported from Europe and USA (Waterman 1951).

1.14 - 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. Potential host plant species in the PRA are Lombardy poplar (*Populus nigra*), White poplar (*P. alba*) and Balsam poplar (*P. balsamifera*).

1.15a - Is transmission by a vector the only means by which the pest can spread naturally?

No. *Davidiella populorum* is a free-living organism that disperses by air-borne spores.

1.16 - Does the known area of current distribution of the pest include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pest to survive and thrive (consider also protected conditions)?

Yes. Also, see a more general assessment in chapter 16 where we compare eco-climatic conditions in Norway and North America.

1.17 - 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. In conclusion, this pest could present a phytosanitary risk to the PRA area.

1.18 - Summarize the main elements leading to this conclusion.

- *Davidiella populorum* is considered to be a pest in its area of current distribution in North America and Argentina. Many native and exotic *Populus* species are hosts. Many species are only affected with leaf infection, but some species, mainly exotic species and hybrids, may be seriously affected by cankers and dieback.
- It is uncertain whether the only native species in the PRA area, *Populus tremula*, is a host of *Davidiella populorum*. Some poplar species and hybrids susceptible to *D. populorum* are planted and spread in the PRA area, among others *P. nigra* and *P. balsamifera*.
- There are eco-climatic similarities between the PRA area and the area of current distribution of the pest in North America.

16 Eco-climatic conditions in the area of current distribution and in the PRA area

As mentioned under question 1.16 in chapters 2-15, the known areas of current distribution of all the 14 pests characterized in the current document include eco-climatic conditions comparable with those of the PRA area or sufficiently similar for the pests to survive and thrive. Also, the broad geographical distribution of all the 14 selected species may suggest that they are climatically pre-adapted to colonize a wider geographic range as long as suitable host species are present.

Comparison of similarity in climate between locations can be done in many ways. One such method is offered by CLIMEX which take a simple approach by employing an algorithm which summarizes the similarities in monthly mean, minimum and maximum temperatures, rainfall, rainfall pattern, relative humidity and soil moisture at different locations to derive a "composite match index"(CMI) from 0 to 1 (Sutherst and Maywald 1985). The most common way to apply the algorithm is to compare one "home" location of where the pest is present and any number of "away" locations. The index can be calculated for geographic locations by using data from weather stations or for areas by using climatologies calculated for regular grids by interpolation from weather station data. The results can be displayed in a table or a map. The normal procedure will be to compare the climate from a "home" location (where the pest is known to occur) with the climate in "away" location(s) i.e. the pest risk assessment area. Because of the large area from which the commodity may originate from North America, and consequently, the wide range of "home" climates of the pests that potentially may follow the commodity for which the risks are being characterized in this assessment, it was considered more interesting to take an opposite approach to narrow down the comparison of climate exercise. This was done by comparing the climate at one "away" location in Norway (Averøy) with the whole area from which the commodity may originate as the "home" area. However, the areas with climate similar to Averøy constitute only very small parts of North America. In order to get a more detailed overview of climate similarity of forested areas in Norway with areas in North America, four more forest locations in Norway were compared with the North American climate. These other locations in Norway chosen were Bardu in the northern Norway, Otta which is an inland and highland forest valley, Elverum in south-east Norway, and Mandal as the southernmost area of Norway (table 1). The climatology is based on New et al. (2002).

Table 1. Norwegian "away locations" chosen for CLIMEX analysis with North America.

Location	Part of Norway	Climate characteristics
Averøy	Coastal area in Western Norway	Mild and humid coastal climate
Bardu	Northern Norway	Arctic climate, inland but still Gulf stream affected
Otta	Inland and highland valley	Driest area in Norway
Elverum	Inland southeast Norway	Moderate humidity, warm summers
Mandal	Southern Norway, mild and humid	Mild and humid coastal climate

The area of Averøy was selected as one of the potential ports of entry in Norway. The comparison of the climate at Averøy in Norway with the climate in North America show that areas at both the south-eastern and south-western coast of Canada, as well as coastal areas along the Gulf of Alaska have the climate with highest similarity with Averøy in Norway (figure 1).

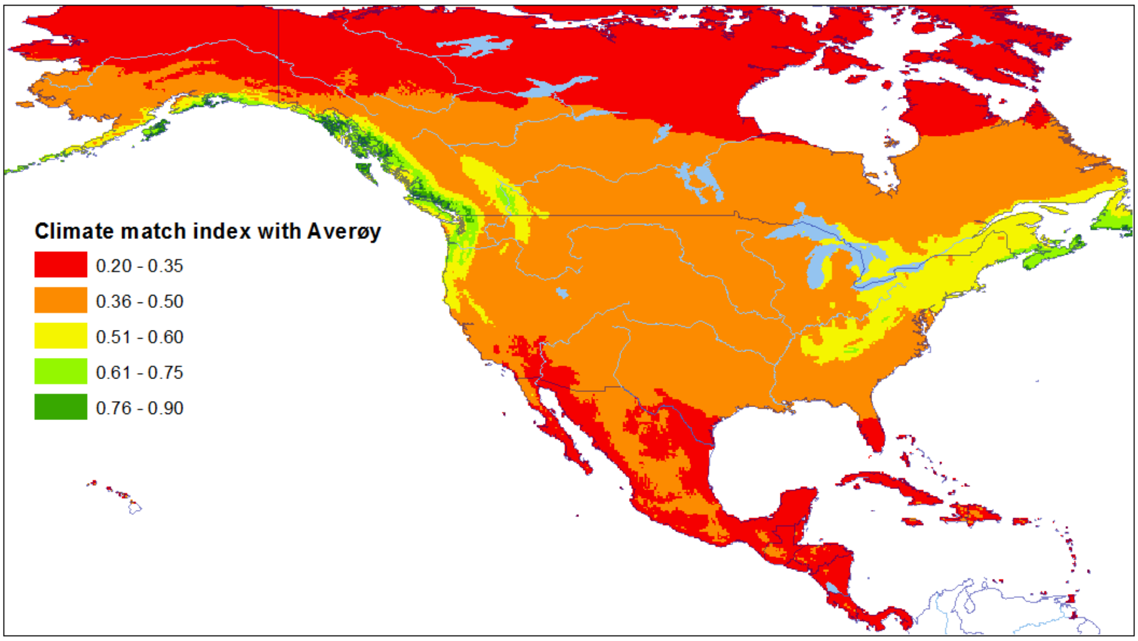

Figure 1. Composite match index (CMI) between Averøya in Norway ("away location") and North America ("home area").

Among the five locations, the southernmost location in Norway, Mandal, has the most similar climate with Averøy, but with slightly hotter summers milder winters and slightly less humidity. Comparison with North America yields slightly greater areas on the east coast of North America with similar climate (figure 2).

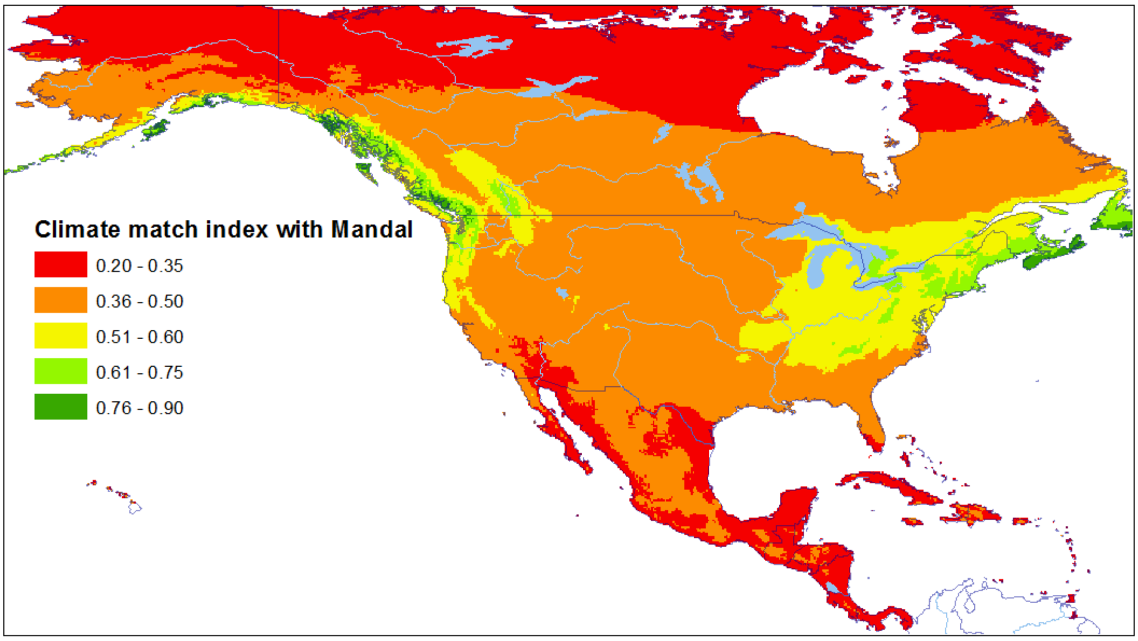

Figure 2. Composite match index (CMI) between Mandal in Norway ("away location") and North America ("home area").

Comparison with the southeastern area location Elverum in Norway yields the greatest areas with similar climate in North America. Large areas around and especially north and east of Lake Superior, British Columbia and Southern Alaska comes out with climate similar to Elverum (figure 3).

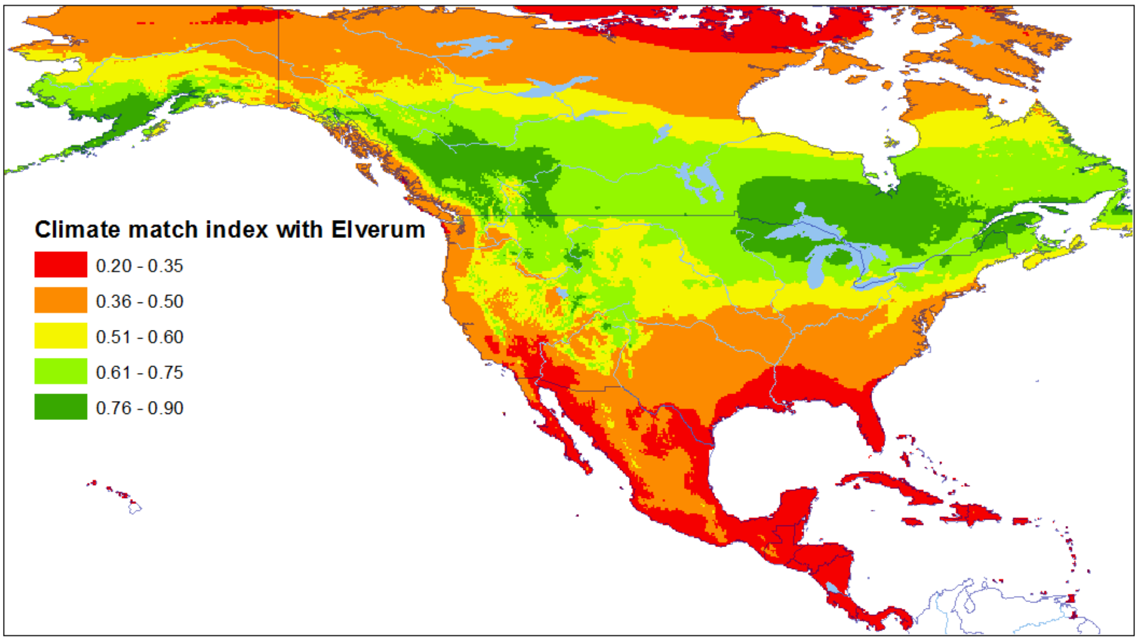

Figure 3. Composite match index (CMI) between Elverum in Norway ("away location") and North America ("home area").

When comparing the climate in Otta with North America, much of the same pattern as for Elverum remains with the exception that the areas around the great lakes does not come out as climatic similar anymore, while the areas with similar climate in Southern Alaska and British Columbia are extended (figure 4).

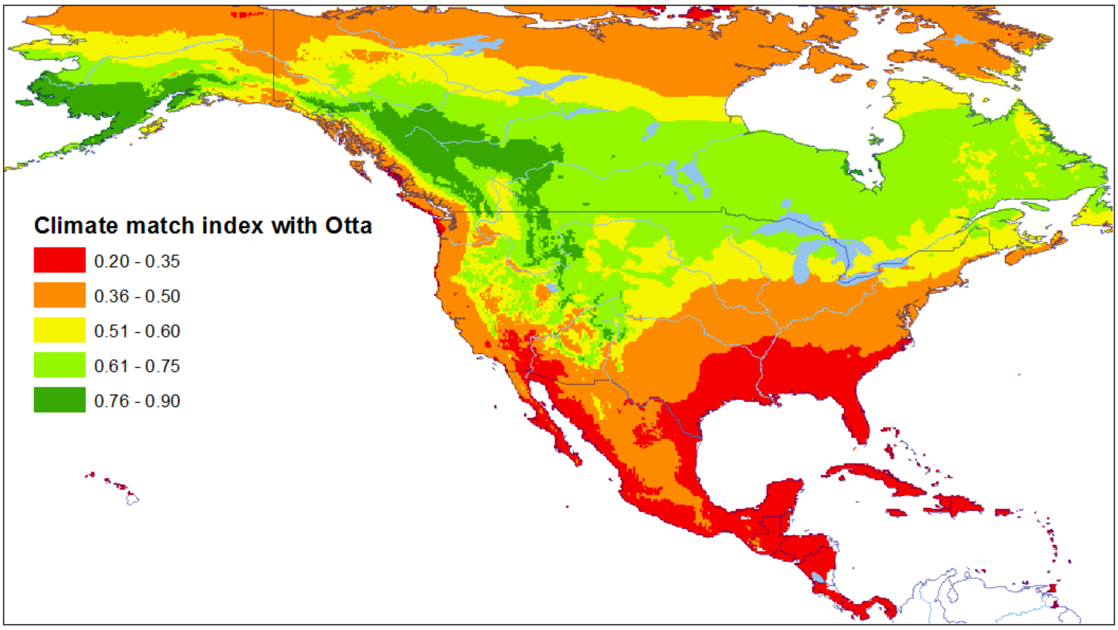

Figure 4. Composite match index (CMI) between Otta in Norway ("away location") and North America ("home area").

Moving northwards in Norway and comparing the climate in the area of Bardu in Troms County with North America has the effect that areas in Newfoundland and Labrador comes out as climatic similar while the areas with climatic similarity in Southern Alaska and British Columbia decrease (figure 5).

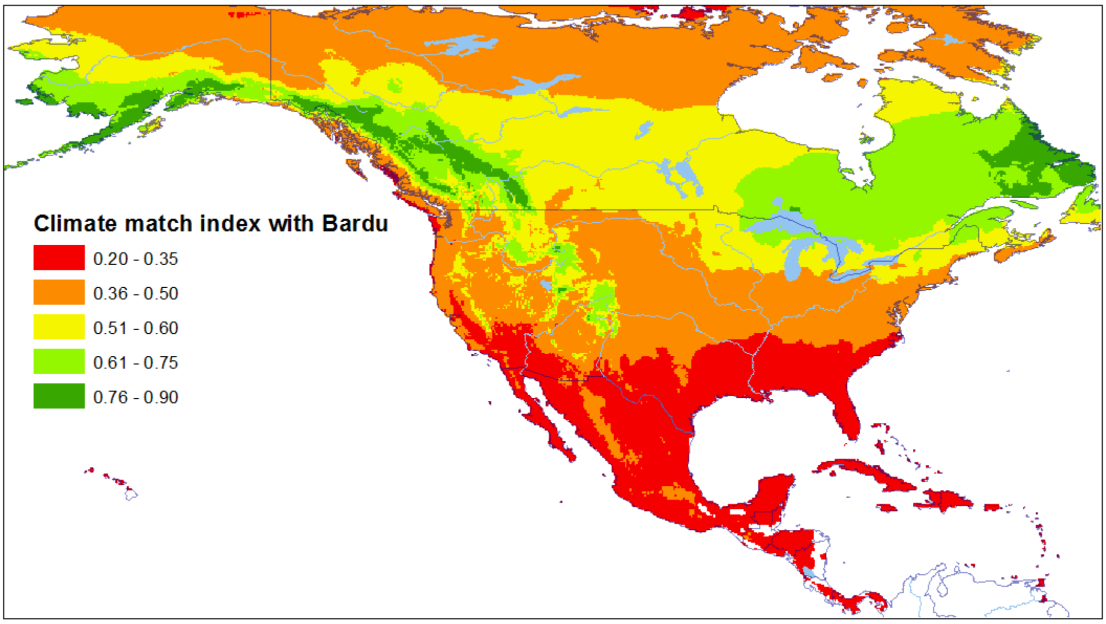

Figure 5. Composite match index (CMI) between Bardu in Norway ("away location") and North America ("home area").

17 Conifer wood contamination in chips

The diversity of tree species in North American forests is significantly higher than in Scandinavian forests (Hultén and Fries 1986; Iverson and Prasad 2001). Logging operations are normally performed by harvester, by which it is difficult to discriminate tree species in species-rich forests. The wood chips produced will normally contain a mixture of tree species, and it may be very difficult to avoid that the chips include regulated tree species. Anatomical analyses of a consignment of deciduous wood chips shipped from North America to Norway in 2010 revealed that coniferous wood was present (Økland et al. 2011).

Import of coniferous wood chips from North America is of major concern due to the wide distribution of the endemic pinewood nematode (*Bursaphelenchus xylophilus*). In wood chip piles the optimum temperature for *B. xylophilus* is between 35-44^{o}C (Dwinell 1986; Dwinell 1987). The generation time at +30^{o}C is 3 days (CABI/EPPO 1997). In chips, *B. xylophilus* tolerates a temperature of 50^{o}C for 13 hours and a temperature of 60^{o}C for 1 hour (Dwinell 1986; Dwinell 1987). *Bursaphelenchus xylophilus* has been reported to increase in population density during trans-Atlantic transport (Dwinell 1987). This information indicates that this nematode will increase rapidly during transit if introduced into deciduous wood chips by contamination by coniferous wood. The introduction of pinewood nematode in wood of coniferales is regulated against in the Plant health regulation (LMD 2000). Monitoring of the pinewood nematode in deciduous wood chips from areas where the nematode is known to occur seems an appropriate precaution. It cannot be excluded that the regulated species of Scolytidae associated with coniferous wood may survive in wood chips with bark cover, but documentation of this kind of survival is lacking. The regulated fungal species are likely to survive in wood chips, such as *Gymnosporangium* spp., *Ophiostoma wageneri* and *Phellinus weirii*.

During large-scale logging operations by harvesters, it is not possible to ensure that trees of certain genera are avoided. If certain tree species were to be avoided, the personnel would have to be well educated. Safe identification may require close examinations of every tree, sometimes based on anatomical characters that are not visible from the ground. When wood chips arrives at the port of entry, identification of tree species requires preparation of microscope slides from single chips, and wood anatomical analyses under a microscope. This is a resource-demanding control method and not feasible for large volumes of wood chips.

18 Import volume, chip size and survival

The import volume of hardwood chips from North America to Europe is large (Appendix 2 in EPPO (2011b), and a further rapid increase is expected due to the targets of the EU energy policy towards 2020 UNECE-FAO (2009). In Norway, large volumes of hardwood chips have been imported from North America in the recent years (Økland et al. 2012a). The ambition of the Norwegian Government is to double the bioenergy production in the period 2008-2020 (Fure 2012). Previous imports of wood chips to Norway have contained a mixture of many hardwood species (Kåre Willumsen, Mattilsynet, pers. comm.), including tree species in genera that are common in Scandinavia, such as *Betula*, *Picea*, *Acer* and *Fraxinus* (Økland 2011). In general, imports of hardwood chips from North America are expected to contain many tree species due to the high diversity of North American forests (Niemela and Mattson 1996). Wood chips are also imported to Europe for production of pulp or fibreboard (EPPO 2011b; Kopinga et al. 2010). In Norway, the import volumes of woodchips for pulp or fibreboard may be smaller than those used for bioenergy purposes; however, imprecise categorizations of the tariff codes and the large variation over time in import volumes makes it difficult to estimate the exact contribution of these categories (Økland et al. 2012b).

Concentration of the pest in the trees logged for chip production depends on the population dynamics of the pest organisms and the logging procedures. The Concentration of pest organisms may be especially high during periods of outbreak (EPPO 2011b). Trees used to produce wood chips are more likely to have a high concentration of pest organisms, because wood chips are typically made of low quality wood (EPPO 2011b). However, the content of pest organisms may be considerable even when apparently healthy forest is logged, because the small and cryptic life stages of insect and fungi are difficult to detect (Økland et al. 2012b). The experiences with hardwood chip import from Canada to Norway in the recent years are that the chip sizes are highly variable and even large wood fragments and branches may be included (VKM 2012). Variable chip sizes were also observed by Roberts and Kuchera (2006) when visiting several wood chip factories in the US. They found several large fragments, and that none of the chip piles consistently contained only chips of 2.5 cm or smaller. Some chips contained adults of *A. planipennis*. Thus, if a maximum size of the chips should be considered safe, it is questionable to what extent the chipping equipment and current procedures will guarantee the maximum size in practice.

Survival of serious pest insects in wood-chipping has been observed (McCullough et al. 2007; Roberts and Kuchera 2006), and for pest fungi it is likely that chipping to a small size will not guarantee absence of a pest. There are few experiments of survival of pests in wood chips, and there are uncertainties about what treatments would be effective against the whole range of possible insects and pathogens that could be imported by wood chips. Surviving specimens of *A. planipennis* were not found in an experiment with eight trunks of ash chipped to a screen size of 2.5 cm (McCullough et al. 2007). However, simulation experiments indicate that such small insects could still be present in chips of 2.5 cm in a volume comparable to a shipload, and chips without survivors would require thicknesses of 6 mm or less (Økland et al. 2012b).

Experiments on survival of pest organisms during storage and ship transport of wood chips are scarce. The main mortality factor during storage and transport is heat development. Heat development is an occasional phenomenon which depends on moisture content, quality of the wood chips, external temperature and size of the pile. In some cases, considerable heat development can occur within the chip pile, or parts of the chip pile (Bergman and Nilsson 1971; Eriksson 2011; Vadla and Wilhelmsen 1982). Comparing to lethal temperatures described in ISPM 15, temperatures in chip piles may in some cases reach lethal levels for biological organisms in the wood chips (FAO 2009). During heat development, higher temperatures are usually associated with the core of the chip pile, while temperatures in the periphery of the pile are much lower and seldom lethal (Bergman and Nilsson 1971; Eriksson 2011; Vadla and Wilhelmsen 1982). Thus, most organisms are expected to survive when heat development does not occur, and under episodes of heat development a fraction of the organisms may survive, especially in the peripheral parts of the pile where the temperatures are lower (Eriksson 2011).

19 Conclusion - Ranking of species involved in the PRA initiation

The initiation of pest risk assessment includes in total ten insect species and four fungal species. Several factors contribute to a lower representation of fungi. E.g. the difficulties of taxonomy and high flexibility of host choice of many fungal species make it difficult to predict the answers of pest assessments when few experiences are reported. However, examples of large forest damages due to fungi introductions indicate that fungi may be highly relevant and more fungi species may be added in the future. Furthermore, the selection of insect and fungal species in the current pest risk initiation is made primarily for the pathways of wood chips. However, the same insect and fungal species are also relevant for the raw materials for production of wood chips. The deciduous wood material for chipping includes wood commodities of non-squared wood, such as logs with bark, debarked logs, sawn wood containing some natural rounded surface, twigs and branches. In addition to the species treated in the present report, the pathways of these raw materials would include more species of insects and fungi, such as *Anoplophora glabripennis* and *A. chinensis* (Wang et al. 2000).

In table 2 and 3 we have ranked the insect and fungal species that we have characterized in the current report. The ranking is according to the likelihood of arriving with relevant pathways of wood chips, the presence of susceptible hosts in Norway, the similarity of climate between Norway and the areas of origin, and the severity of damages they may cause in Norwegian forests. The ranking order indicates which species could undergo full pest risk assessment first. However, the order is uncertain since the behaviour of the species under new conditions is unknown. Also, *Agrilus anxius* has already been risk assessed for Norway.

Ceratocystis fagacearum causes a serious wilting disease, and the pest spreads in the outermost part of the sapwood. Sporulation occurs mainly when the fungus grows out to the inner bark. Sporulating mats, including both the anamorph and teliomorph states of the fungus, are often formed between bark and wood. Chips carrying sporulating mats, or parts of mats, may be the pathway of spread. It is uncertain whether such chips also may include nitidulid beetles, which are the main transporters aboveground. However, local beetles do have the possibility to pick up spores and transfer the disease to wounds of nearby oak trees.

Davidiella populorum causes leaf spots in a wide range of poplar species and hybrids. It can also attack stems and cause cankers on many different poplar species and hybrids. In cankers, pycnidia are formed and the wind-blown spores may infect new trees. Pycnidia may as well be found in chips.

Table 2: Insect species that can follow the import of deciduous wood chips from eastern North America (NA), and which could present a phytosanitary risk to the PRA area Norway. Here they are ranked according to the likelihood of arriving with the pathway, the presence of susceptible hosts in Norway, the similarity of climate between Norway and the areas of origin, and the severity of damages they may cause in Norwegian forests.

Rank	Insect species	Main criteria for ranking
1	*Agrilus anxius*	Widely distributed across the whole range of *Betula* spp. and well documented killing of native and European *Betula* spp. in NA. A wide distribution of susceptible *Betula* spp. in the PRA area.
2	*Agrilus planipennis*	Well documented killing of *Fraxinus* spp. and rapid spread after introduction to NA, with high economic and ecological impact. Kills *Fraxinus* spp. in NA and *F. excelsior* in Russia. *Fraxinus excelsior* is present in the PRA area.
3	*Agrilus bilineatus*	Principal pest of *Quercus* in NA and known to attack and kill *Q. rubra* which is present in the PRA area.
4	*Chrysobothris femorata*	Highly polyphagous pest with an extensive geographical range. Known to attack *Malus domestica* and *Acer rubrum* which is present in the PRA area.
5	*Agrilus horni*	Documented killing *Populus tremula* and *P. alba,* in addition there are two other potential hosts in the PRA area.
6	*Agrilus granulatus liragus*	Documented killing *Populus balsamifera* and a wide geographic range in NA. *Populus balsamifera* and five other potential hosts are present in the PRA area.
7	*Agrilus granulatus granulatus*	Documented killing *Populus nigra,* in addition there are three other potential hosts in the PRA area.
8	*Hylurgopinus rufipes*	Documented killing *Ulmus glabra*. *Ulmus glabra* is present in the PRA area.
9	*Agrilus politus*	Polyphagous with a wide geographic distribution. Several potential hosts in the PRA area.
10	*Scolytus schevyrewi*	Documented killing *Ulmus glabra*. Has an austral distribution in NA which might not be favourable in the PRA area.

Table 3: Four fungal species that can follow the import of deciduous wood chips from eastern North America, and which could present a phytosanitary risk to the PRA area Norway. Here they are ranked according to the likelihood of arriving with the pathway, the presence of susceptible hosts in Norway, the similarity of climate between Norway and the areas of origin, and the severity of damages they may cause in Norwegian forests.

Rank	Fungal species	Main criteria for ranking
1	*Ceratocystis fagacearum*	Is a serious pathogen in the current area of distribution.
2	*Davidiella populorum*	Causes leaf spots and canker on many different poplar species and hybrids in the current area of distribution.
3	*Phellinus spiculosus*	Causes both heart rot and cankers in the current area of distribution and may also grow on dead trunks.
4	*Phellinus everhartii*	Is a well-defined species causing heart rot in the current area of distribution.

The *Phellinus* species cause heart rot. *Phellinus spinulosus* may also cause canker and be found on dead trunks. If attacked trees are included in the chipped material, chips contaminated with both *P. spiculosus* and *P. everhartii* may be introduced to new areas. In contrast to the insect species, the spread of some of the fungal species from a pile of wood chips may not be easy, but if infested chips are in contact with lumber, at least *P. spinulosus* may be transferred and after some years produce fruit bodies.

In addition to certain tree species hosting the insects and fungi in the present report, the whole commodity of wood chips across tree species must be considered. The high diversity of tree species in North America (Mattson et al. 2007) and the methods of harvesting trees for production of wood chips imply a significant probability of importing wood of regulated tree species in commodities that officially are declared as limited to legal tree species (see chapter 17), and inspection control to detect illegal tree species in wood chips is very difficult (Økland et al. 2012b).

Literature

This section describes the literature search conducted for retrieving the scientific documentation available for this opinion:

Literature searches were conducted in CAB Direct (2011), JSTOR (2011), Science Direct (2011), Springer Link (2011), Web of Knowledge (2011) and WorldCat (2011). The searches were conducted in December 2011 using the following combination of words: “species name” OR “common name” alone or in combination with “distribution”, “host” or specific host names. Publications of all ages in English and Scandinavian language were included. If relevant references were discovered (e.g. in article reference lists) and which was not found in the search, these were included. In addition, Ohio State University and the Canadian Food Inspection Agency were contacted for assistance in retrieving additional literature on the species in question. Literature was also retrieved in other ways by the members of the project group, due to their expertise on the subject.

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Appendix

Table: Column 1: All deciduous tree genera common to eastern North America and Norway. Norwegian common names are in brackets. Column 2: All deciduous tree species occurring in Norway within these tree genera. Column 3 and 4: Pest insects (wood borers) and fungal pathogens that attack trees within these genera in North America. Insect species and fungal species that are present in Norway were excluded. Only insect species and fungal species that are introduced to eastern North America from areas other than Europe, or that are endemic to North America, were included.

1. Tree genus	2. Potential Norwegian hosts	3. Pest insects in North America	4. Fungal pathogens in North America
Acer, Maple	*Acer campestre* (Naverlønn) *Acer platanoides* (Spisslønn) *Acer pseudoplatanus* (Platanlønn) *Acer rubrum* (Rødlønn)	*Anoplophora glabripennis* *Anoplophora chinensis* *Xylosandrus germanus* *Chrysobothris femorata* *Xylosandrus mutilatus* *Glycobius speciosus* *Ambrosiodmus lewisi*	*Eutypella parasitica* *Hypoxylon mammatum* *Fusarium solani* *Verticillium dahliae* *Inonotus glomeratus* *Armillaria ostoyae* *Phellinus igniarius* *Ganoderma applanatum* *Fomes fomentarius* *Spongipellis delectans* *Armillaria mellea complexe*
Alder, Alnus	*Alnus glutinosa* (Svartor) *Alnus incana* (Gråor)	*Cryptorhynchus lapathi* (*Linnaeus*) *Xyleborinus alni*	*Phytophthora alni* *Xylaria digitata* *Phellinus igniarius* *Hypoxylon mammatum* *Inonotus obliquus* *Hypoxylon mammatum* *Heterobasidion annosum*
Aesculus	*Aesculus hippocastanum* (Hestekastanje)	*Anoplophora glabripennis*	
Betula, Birch	*Betula nana* (Dvergbjørk) *Betula pendula* (Hengebjørk) *Betula pubescens* (Bjørk)	*Anoplophora glabripennis* *Agrilus anxius* *Xylosandrus germanus* *Cryptorhynchus lapathi* (*Linnaeus*) *Xyleborus affinis* *Trichoferus campestris*	*Armillaria ostoyae* *Phellinus igniarius* *Hypoxylon mammatum* *Phaeolus schweinitzii* *Postia sericeomollis* *Inonotus obliquus* *Ganoderma applanatum* *Fomes fomentarius* *Sphyrapicus varius* *Armillaria mellea complexe* *Amethicium chrysocreas*
Carpinus, Hornbeam	*Carpinus betulus* (Agnbøk)		
Castanea	*Castanea sativa* (Edelkastanje)	*Anoplophora glabripennis* *Xylosandrus mutilatus*	*Cryphonectria parasitica*
Corylus, Hazel	*Corylus avellana* (Hassel)		*Anisogramma anomala*
Fagus, Beech	*Fagus sylvatica* (Bøk)	*Scolytus schevyrewi* *Xylosandrus germanus* *Chrysobothris femorta* *Dirrhagofarsus lewisi*	*Inonotus glomeratus* *Phellinus igniarius* *Inonotus obliquus* *Fomes fomentarius*
Fraxinus, Ash	*Fraxinus excelsior* (Ask)	*Agrilus planipennis* *Scolytus schevyrewi* *Xylosandrus germanus* *Eburia quadrigeminata*	*Verticillium dahliae* *Phellinus igniarius* *Ganoderma applanatum* *Chalara fraxinea*

Prunus, Cherry	*Prunus avium* (Morell) *Prunus cerasus* (Surkirsebær) *Prunus domestica* (Plomme) *Prunus mahaleb* (Mahaleb) *Prunus padus* (Hegg) *Prunus spinosa* (Slåpetorn)	*Cryptorhynchus lapathi* (*Linnaeus*)	
Populus, cottonwood, Poplars and Aspens	*Populus alba* (Sølvpoppel) *Populus balsamifera* (Balsampoppel) *Populus nigra* (Svartpoppel) *Populus tremula* (Osp)	*Enaphalodes rufulus* *Chrysobothris femorta* *Arrhenodes minutus* *Pseudopityophthorus pruinosus* *Pseudopityophthorus minutissimus* *Agrilus coxalis* *Mallodon dasystomus* *Eburia quadrigeminata* *Agrilus auroguttatus* *Agrilus bilineatus*	*Hypoxylon mammatum* *Ceratocystis fimbriata* *Armillaria ostoyae* *Phellinus tremulae* *Phellinus igniarius* *Hypoxylon mammatum* *Inonotus obliquus* *Ganoderma applanatum* *Fomes fomentarius* *Pholiota populnea* *Armillaria mellea complexe* *Mycosphaerella populoru*
Quercus, Oak	*Quercus petraea* (Vintereik) *Quercus robur* (Sommereik) *Quercus rubra* (Raudeik)	*Enaphalodes rufulus* *Chrysobothris femorta* *Arrhenodes minutus* *Pseudopityophthorus pruinosus* *Pseudopityophthorus minutissimus* *Agrilus coxalis* *Mallodon dasystomus* *Eburia quadrigeminata* *Agrilus auroguttatus* *Agrilus bilineatus*	*Inonotus dryadeus* *Phellinus igniarius* *Hypoxylon mammatum* *Phaeolus schweinitzii* *Ganoderma applanatum* *Fomes fomentarius* *Spongipellis delectans* *Phytophthora ramorum* *Ceratocystis fagacearum* *Phellinus spiculosus* *Spongipellis pachydon* *Lasiodiplodia theobromae*
Salix, Willow	*Salix caprea* (Selje)	*Anoplophora glabripennis* *Xylosandrus germanus* *Chrysobothris femorta* *Cryptorhynchus lapathi (Linnaeus)*	*Hypoxylon mammatum*
Sorbus, Rowans, Whitebeams etc	*Sorbus aucuparia* (Rogn) *Sorbus norvegica* (Norsk asal) *Sorbus intermedia* (Svensk asal)	*Saperda candida*	
Tilia, Linden	*Tilia cordata* (Lind) *Tilia platyphyllos* (Storlind) *Tilia* x *vulgaris* (Parklind) *Sorbus hybrida* (Rognasal) *Sorbus aria* (Sølvasal)	*Xylosandrus germanus* *Chrysobothris femorta* *Saperda vestita* *Astylopsis macula*	
Ulmus, Elm	*Ulmus glabra* (Alm)	*Anoplophora glabripennis* *Xylosandrus germanus* *Hylurgopinus rufipes* *Saperda tridentata* *Chrysobothris femorta* *Scolytus schevyrewi*	*Armillaria ostoyae* *Ophiostoma ulmi* *Phellinus igniarius* *Ganoderma applanatum* *Spongipellis delectans* *Stegophora ulme*