

Screening of Emerging risks in Norway (ERIN). Judgments are preliminary and should not be considered as part of a final risk assessment:

***Bursaphelenchus xylophilus* (Steiner & Buhrer 1934) Nickle, 1970**

1. Taxonomic position: Nematoda: Aphelenchoididae: Parasitaphelenchinae;

Popular names: Pinewood Nematode (PWN) (English); Furuvednematode (FVN) (Norwegian).

2a. Status in Norway:

Established <input type="checkbox"/>	Intercepted but not established <input type="checkbox"/>	Not intercepted <input checked="" type="checkbox"/>
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If intercepted or established, provide supplementary information:

2b. If this species is already established in Norway and this assessment is limited to a part of Norway where it may expand, define this part area of Norway:

3. Area of native distribution in the world and information about introductions, expansions and eradications:

The nematode is endemic to North America. It was detected in Japan in 1905 (Mamiya 1984), China in 1982 (Zhao 2008), Taiwan in 1985 (ref.) Korea in 1988 (Shin 2008) and Mexico in 1993 (Dwinell 1993) Portugal in 1999 (Mota et al. 2000) and Madeira Island in 2009 (Fonseca et al 2011). At least 5 outbreaks in Spain close to the Portuguese boarder in 2008, 2010, 2012, 2013 and 2014 which have been eradicated (refs.).

4. Sector in Norway expected to be impacted by the species (related to question 10 below):

Agriculture <input type="checkbox"/>	Forest(ry) <input checked="" type="checkbox"/>	Ornamental/park/garden <input checked="" type="checkbox"/>	Fruit orchard/garden <input type="checkbox"/>
Greenhouse/protected <input type="checkbox"/>	Other sector, or not relevant <input type="checkbox"/> Describe:		

5. Susceptible host(s) and/or type of environment(s) in Norway:

The major hosts are found in the genus *Pinus*. *Pinus sylvestris* is one of the most susceptible species to PWN, making pine forests, as well as open landscapes and urban environments endangered biotopes. In addition hosts for PWN also occur also in the genera *Abies*, *Picea* and *Larix*. The nematode is polyfagous and reproduces on a variety of wood fungi. PWN has a remarkable flexibility in its biology making it capable of exploiting new geographical situations (Evans *et al.* 1996). This plasticity will allow the nematode to establish in the entire forest area of Norway. Winter mortality is not expected to limit PWN from living in the PRA area as the nematode already lives in areas in Canada and northern Japan where winter temperatures are similar or lower than in the commercially important forested areas of Norway (WKM 2008).

6. Description of damage:

The principal damage caused by PWN is the wilting of infested and susceptible trees (Pine Wilt Disease - PWD). The PWN is spread by vector insects in the genus *Monochamus*. The most important vector in Asia is *M. alternatus* (Mamiya 1984). The only vector insect recorded in Europe is *M. galloprovincialis* (Sousa *et al.* 2001). At present *M. galloprovincialis* has a restricted occurrence in the PRA area, while *M. sutor* is the most widespread species. *M. urussovii* has only old scattered records from the southern part of Norway (Bakke & Kvamme 1992; Ehnström & Holmer 2007). The vector status of *M. sutor* for PWN is not known.

When nematode infected beetles feed on the thin bark of branches and shoots, the PWN dispersal stage enter wood through the feeding scars and spread rapidly in the whole tree causing a dysfunctioning of the membranes that connect wood tracheids. This leads to an increasing and

irreversible disruption of the water flow and rapid death of the tree (Futai 2013). Among pine species *P. sylvestris* seems highly susceptible (Evans *et al.* 1996; Malek & Appleby 1984).

Due to low summer temperatures in Norway damage in the current climate will probably be low. Mean July -August temperatures above 20°C is necessary for symptom expression. Below this temperature PWN is present but the disease is not expressed (Rutherford and Webster 1987, Gruffudd *et al* 2016).

However, in connection with operations of eradication and containment considerable areas of forest will be affected to the disadvantage of natural biotopes and ecosystem services (Bergseng *et al.* 2012).

7a. How is the overall probability of entry in Norway, or in a defined part of Norway?

0. not relevant <input type="checkbox"/>	1. very low <input type="checkbox"/>	2. low <input type="checkbox"/>	3. medium <input type="checkbox"/>	4. high <input checked="" type="checkbox"/>	5. very high <input type="checkbox"/>
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Level of uncertainty:	Low <input type="checkbox"/>	Medium <input checked="" type="checkbox"/>	High <input type="checkbox"/>
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7b. How is the overall probability of establishment in Norway, or in a defined part of Norway?

0. not relevant <input type="checkbox"/>	1. very low <input type="checkbox"/>	2. low <input type="checkbox"/>	3. medium <input type="checkbox"/>	4. high <input type="checkbox"/>	5. very high <input checked="" type="checkbox"/>
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Level of uncertainty:	Low <input checked="" type="checkbox"/>	Medium <input type="checkbox"/>	High <input type="checkbox"/>
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Short description of factors for the probability assessment:

PWN will survive transportation (and could even increase in population density). The biological plasticity of the nematode would allow it to enter and establish almost everywhere in Norway.

8. How fast is the pest expected to expand in Norway, or in a defined part of Norway?

< 0.3 km per year <input type="checkbox"/>	0.3 - 10 km per year <input checked="" type="checkbox"/>	10 - 30 km per year <input type="checkbox"/>	> 30 km per year <input checked="" type="checkbox"/>
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The role of asymptomatic carrier trees in the spread of PWD has been recognized for years (Futai 2004; Takeuchi & Futai 2007). In China, and in data from 15 years, short distance spread by vector beetles in the genus *Monochamus* has been estimated to 7,5 km per year, while long distance spread was estimated to 111-339 km. Human population density seemed to have a profound effect on the dispersal of PWN (Robinet *et al* 2009). That PWN can easily spread between continents by anthropogenic mechanisms, especially in trade of infested wood is well recognized. However, there is an high uncertainty related to an unknown vector status within the PRA. Furthermore, the rather cooler climatic conditions within the PRA area, compared to climatic conditions within references, will as well possess a medium uncertainty related to spread and disease development in affected plants.

9. How large percent of potential environment type in Norway, or in a defined part of Norway, is expected to be colonized?

< 5 % <input checked="" type="checkbox"/>	5 - 10 % <input type="checkbox"/>	10 - 20 % <input type="checkbox"/>	20 - 40 % <input type="checkbox"/>	> 40 % <input checked="" type="checkbox"/>
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Due to its biological flexibility in principle, all of the conifer forests of Norway are expected to be colonized of PWN (ie. > 40 %). Damage by tree mortality is very uncertain and would in the current climate probably correspond to <5%.

10. How great a negative effect is the pest likely to have on economy including costs of control measures for the impacted sector in Norway, or in a defined part of Norway? Rate possible effects:

0. not relevant <input type="checkbox"/>	1. minimal <input checked="" type="checkbox"/>	2. minor <input checked="" type="checkbox"/>	3. moderate <input type="checkbox"/>	4. major <input type="checkbox"/>	5. massive <input type="checkbox"/>
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Level of uncertainty:	Low <input checked="" type="checkbox"/>	Medium <input type="checkbox"/>	High <input type="checkbox"/>
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Short description of negative effects on economy:

Information on these aspects were presented in Sundheim *et al.* (2010). In the current climatic conditions the introduction of PWN to the Norway area will not cause increased pine tree mortality, with a low uncertainty. Assuming the IS92a climate change scenario for the period 2000-2049 (RegClim), which predicts a ~2 °C temperature increase by the end of the period, an introduction of PWN to Norway will cause a minor increase in pine tree mortality (300 trees per year on average). The mortality can become larger if the temperature increase more than 2 °C, and will gradually increase with time after 2049 due to spread of PWN. The uncertainty level of these assessments is medium to high. Currently, effects of the presence of PWN Norwegian export of wood and wood products will be of little importance. The uncertainty level of this assessment is low. It will be almost impossible to eradicate PWN once it has been introduced into the PRA area. The uncertainty level of this assessment is low. The net present value of accumulated cost of a single eradication event as described in the preliminary contingency plan for the PRA area is approximately 700 million NOK. The net present value of accumulated cost of the contingency plan following one introduction event will be approximately 2000 million NOK for the initial 50 years. These costs are caused by reduced income from timber production and the expenses of eradication measures. The uncertainty level of these assessments is medium. The negative effects of the control measures on the environment will be major. The uncertainty level of this assessment is low (Sundheim *et al.* 2010).

One item of uncertainty in relation to forest damage is the possibly higher sensitivity in various conifer provenances to increasing temperatures and nematode infection. There is also a concern that Nordic countries after a hypothetical introduction of PWN could serve as a sources for nematode dissemination to continental Europe.

11. How important is the environmental impact likely to be in Norway, or in a defined part of Norway? Rate possible effects:

0. not relevant <input type="checkbox"/>	1. minimal <input type="checkbox"/>	2. minor <input type="checkbox"/>	3. moderate <input type="checkbox"/>	4. major <input type="checkbox"/>	5. massive <input type="checkbox"/>
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Level of uncertainty:	Low <input type="checkbox"/>	Medium <input type="checkbox"/>	High <input type="checkbox"/>
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Short description of environmental impacts:

The net present value of accumulated cost of a single eradication event as described in the preliminary contingency plan for the PRA area is approximately 700 million NOK. The net present value of accumulated cost of the contingency plan following one introduction event will be approximately 2000 million NOK for the initial 50 years. These costs are caused by reduced income from timber production and the expenses of eradication measures. The uncertainty level of these assessments is medium. The negative effects of the control measures on the environment will be major. The uncertainty level of this assessment is low (Sundheim *et al.* 2010).

12. How important is social damage likely to be in in Norway, or in a defined part of Norway? Rate possible effects:

0. not relevant <input type="checkbox"/>	1. minimal <input type="checkbox"/>	2. minor <input type="checkbox"/>	3. moderate <input type="checkbox"/>	4. major <input checked="" type="checkbox"/>	5. massive <input type="checkbox"/>
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Level of uncertainty:	Low <input checked="" type="checkbox"/>	Medium <input type="checkbox"/>	High <input type="checkbox"/>
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Short description of social damage:

Control measures against PWN will dramatically reduce ecosystem services in infested areas, and could severely affect landscape sceneries and urban environments (Bergseng *et al.* 2012; Sundheim *et al.* 2010).

13. Priority in Norway versus EPPO and EU:

In Norway PWN is listed in Forskrift om planter og tiltak mot planteskadegjørere Vedlegg 2. In Europe PWN is placed on the A2 list of EPPO and in Directive 2000/29/EC II A Section 1 in EU.

PWN occurs in Portugal, resulting in Portugal being put under quarantine in relation to other European countries. This means that Norway has a protection level similar to other European countries.

14. Specific questions for Norway:

Wood packing materials WPM of various origin enter Norway at a daily rate of 5 000-10 000 units throughout the year. Gu *et al.* (2006) reported that 1.2% of inspected pallets in Ningbo were infested with PWN. The pallets sampled were mostly of pine wood (Gu pers. comm.). With the assumption of a similar infection rate in pallets arriving in Norway, it can be calculated that maybe 60-120 units arrive each day potentially infested by PWN (predominantly JIII resting stages). Pallet wood is a popular resource for people, so the end-use of this commodity is completely out of control. It is unclear to which extent the control requirements of ISPM15 will be effective in reducing this threat, since Chinese reports have questioned the efficacy of the HT (56/30) treatment and detected PWN in wood packaging material marked with HT (VKM 2008).

The common species of pine sawyer in Norway, *Monochamus sutor*, is so far not known to be a vector of PWN. The other species occurring in Norway *M. galloprovincialis* is already known to vector PWN in Portugal (Sousa *et al.* 2001). The efficacy of both species as vectors of PWN under Norwegian conditions remains an important question to be addressed by future research.

15. Existing assessments:

EPPO 2009. Report of a Pest Risk Analysis for *Bursaphelenchus xylophilus* 09/15450: 17 pp.

Evans, H. F., McNamara, D. G., Braasch, H., Chadoeuf, J. & Magnusson, C. 1996. Pest Risk Analysis (PRA) for the territories of the European Union (as PRA area) on *Bursaphelenchus xylophilus* and its vectors in the genus *Monochamus*. EPPO Bulletin 26: 199-249.

Sundheim, L., Økland, B., Magnusson, C., Solberg, B., Rafoss, T. 2010. Pest risk assessment of the Pine Wood Nematode (PWN) *Bursaphelenchus xylophilus* in Norway – Part 2. Opinion of the Plant Health Panel of the Scientific Committee for Food Safety, 08/906-6_final, ISBN 978-82-8259-002-0 (Electronic edition): 21 pp. VKM, Oslo, Norway.

Swedish Board of Agriculture 2008. Konsekvensanalys av angrepp av tallvedsnematod i svensk skog [Consequences of an outbreak of pine wood nematode in Swedish forests]. Report 2008(19), Jönköping, Sweden. (In Swedish)

VKM 2008. Pest risk assessment of the Pine Wood Nematode (PWN) *Bursaphelenchus xylophilus* in Norway - Part 1. Norwegian Scientific Committee for Food Safety 08/906-4.

16. Requested assessments:

No current assessments.

17. Recommended type of assessment:

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