Forestry Commission

Contingency Plan for the Pine wood nematode (*Bursaphelenchus xylophilus*) and its longhorn beetle (*Monochamus* spp.) vectors

Contingency Plan for *Bursaphelenchus xylophilus* (Pine wood nematode) and its *Monochamus* spp. (longhorn beetle) vectors

INTRODUCTION

1. Serious or significant pests require strategic-level plans developed at a national level describing the overall aim and high -level objectives to be achieved, and the response strategy to either eradicate or contain an outbreak.
2. The Plant Health Risk Group (PHRG) has commissioned, following identification by the Risk Register, pest-specific contingency plans for those pests that pose the greatest risk and require stakeholder consultation. The Forestry Commission has also prioritised its pest-specific contingency plans for updating.

3. The purpose of these pest-specific contingency plans is to ensure a rapid and effective response to an outbreak of the pest or disease described.

4. Contingency planning starts with the anticipation and assessment of potential threats, includes preparation and response, and finishes with recovery.

Anticipate

5. Sources of information and intelligence about the pest, including horizon scanning.

Assess

6. Identifying concerns and preparing plans.
7. Setting outbreak objectives

Prepare

8. Ensuring staff and stakeholders are familiar with the pest.

Response

9. The requirements to either contain or eradicate, including work to determine success.

Recovery

10. When the response strategy has been effective or when the response is not considered feasible, cost-effective or beneficial.

11. The Defra Contingency Plan for Plant Health in England (in draft) gives details of the teams and organisations involved in pest response in England, and their

responsibilities and governance. It also describes how these teams and organisations work together in the event of an outbreak of a plant health pest.

The purpose of pest-specific contingency plans is to ensure a rapid and effective response to an outbreak of the pest or disease described.

INTRODUCTION

This contingency plan was prepared by the Forestry Commission's cross-border Plant Health Service to be used at country and national (UK) levels. It should be used in conjunction with the Specific-Incident Contingency Plan for Plant Health Pest and Disease Outbreaks developed by Forestry Commission England's Forest Services division, which provides details as to the level of response required and by whom, depending on the scenario. Forestry Commission Scotland and the Welsh Government will develop similar documents detailing their management of outbreaks. Where an outbreak becomes of national (UK) concern, the Chief Plant Health Officer will form an outbreak management team to co-ordinate the activities in the different countries.

The following contingency plan falls into three parts:

- official action following a presumptive diagnosis;
- official action following the conformation of an outbreak; and
- background information about the pest.

It is designed to help government agencies anticipate, assess, prepare, prevent, respond and recover from pest outbreaks.

This plan will be updated following new information or changes in policy or contact details (last updated May 2015).

Objectives of this plan

- To raise awareness of the potential threat posed by *B. xylophilus* (PWN) and its vector *Monochamus* spp., and to ensure that stakeholders are aware of the symptoms caused by infestation of the host tree by this pest.
- To provide guidance on the steps to be taken whenever symptoms of attack by PWN and its *Monochamus spp* vectors are observed.
- To ensure that infestations of PWN are managed promptly with the aim of eradicating pioneer populations of the nematode.
- To ensure that all relevant Forestry Commission staff, other government agencies and local authorities are conversant with the contents of this contingency plan so that effective and immediate action can be implemented.

- To ensure that good communications are put in place so that all stakeholders (including the media) are kept fully informed of the scale of infestation both at regional and national levels.

Anticipation & Assessment

1. *Bursaphelenchus xylophilus* (Steiner & Buhrer) (Nematoda: Aphelenchoididae.), commonly known as the Pinewood Nematode, and its longhorn beetle vectors *Monochamus spp.* is a serious and destructive pest of pine.

2. Its native range includes the north and east of North America, south-east Asia.

3. It is present in Europe, mostly in Portugal, with isolated records from Spain. Portugal has spent €80 million from 1999 – 2009 in an attempted eradication programme.

4. It can cause excessive damage, most often as a secondary pest attacking trees that are already stressed.

5. The UK has import controls on wood of pine from demarcated zones within Portugal.

6. It is officially absent from the UK, and the risk of its being introduced in the current climatic conditions is comparatively low, although this might increase with climate change.

Preparation

1. Longhorn beetles of the genus *Monochamus* are not known to occur in the UK. They are, however, frequently intercepted in imported timber, especially wooden packaging, and therefore they have the potential to be accidentally introduced into the UK, using imported wood products as a pathway. The beetles originate not only from continental Europe and Russia, but also from Asia and North America, where PWN is known to be widely distributed.

2. As part of an EU requirement, the UK undertakes an annual monitoring regime for PWN which focuses on woodlands and isolated trees. Sites where pine occurs in the vicinity of premises known to receive imported coniferous timber or wooden packing material, should be given priority when sampling individual trees and in forest locations

Response

Official action following a presumptive diagnosis

This covers both a presumptive diagnosis of *Monochamus sp* vector and PWN, with emphasis mainly on vector diagnosis as the risk of PWN in the absence of the vector is very low.

Determining the response

1. In England, a duty officer (FC England or APHA) will act as a point of contact for incidents, and it is their job to assign a response officer to incidents when they occur. Similar arrangements are expected to be in place in Scotland and Wales. The response officer investigates and reports back to the Defra contingency core group, which is an 'ad hoc' group put together in response to a notification and which is usually chaired by the Chief Plant Health Officer. For outbreaks in Scotland and Wales, respective country teams will fully manage the outbreak as per their own generic contingency plans, but will provide updates to the DEFRA contingency core group for information purposes, and for Defra to report to the EC.

2. The response officer will gather information, including the location, likely origin, host or commodity, level of damage, extent of outbreak and chance of spread. The membership of the contingency core group will depend upon the pest or disease in question, and will comprise plant health officials and specialists from the risk group. Based on the information fed back to the contingency core group, in England they will decide upon the alert status given (black, amber or red), which will determine the level of response. (See appendix 1 for alert status table.) In Scotland and Wales, the core contingency group can advise on alert status and the appropriate response. If required, the Contingency Core Group will request the relevant organisation/s to set up an Incident Management Team to resolve the incident.

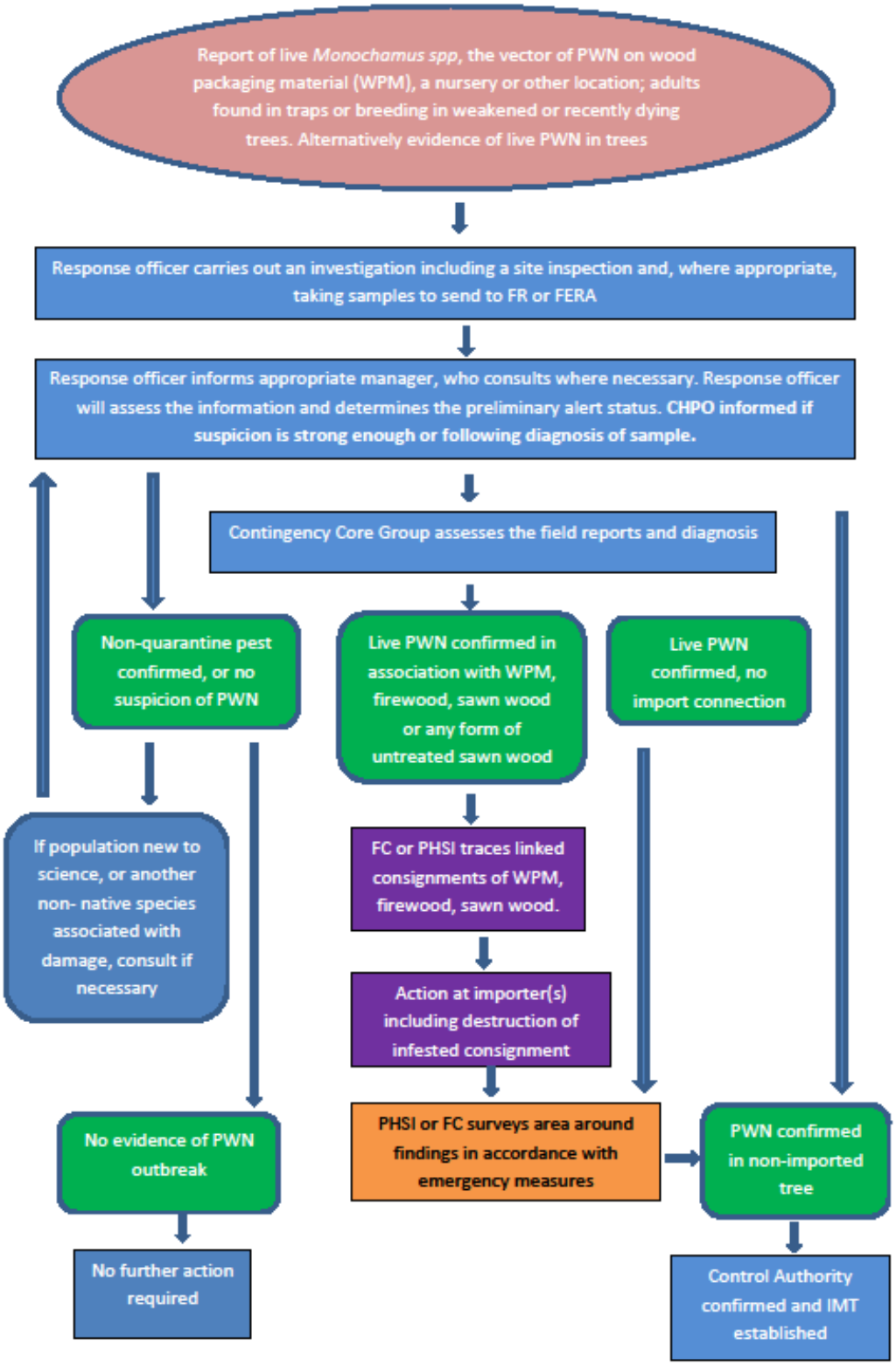

Figure 1: Outline of procedure following a suspected case of PWN.

Holding consignments and movement / planting restrictions

3. Until further investigation, no material shall leave the site, and local operations will be halted until such time as the suspected case is confirmed or rejected.

Preliminary trace forward / trace backward

4. Although the PWN could be introduced on infested plants, there is no known vector to spread the nematode within the UK. *Monochamus* spp. infested with the PWN is required for tree-to-tree transmission of the nematode. Evidence of PWN alone constitutes a low risk, but requires further investigation. Presence of *Monochamus*, whether associated with PWN or not, constitutes a higher risk requiring more rigorous follow-on surveys.

5. Depending upon the pathway of entry, tracing forward and backward to identify suspect material will be conducted to identify other potentially contaminated stock or sites. This will include suppliers, propagators and wholesalers, including any clonally-related or potentially contaminated stocks, where appropriate.

How to survey to determine whether there is an outbreak

6. Member states of the EU are required to carry out annual surveys for the presence of PWN in areas where it is not known to occur, to prevent its spread. The requirements are that:

   a) the surveys shall consist of the collection and laboratory testing of samples of susceptible plants, susceptible wood, bark and vectors;

   b) the number of samples shall be determined in accordance with sound scientific and technical principles; and

   c) samples should be taken in accordance with advice given in “EPPO Bulletin 39, Guidance on sampling to detect the *Bursaphelenchus xylophilus* in trees, wood and insects”.

7. Since the findings of the REPHRAME project using the ETpN simulation model indicates that no wilt arising from PWN infestation is likely in the UK under current climatic conditions, field surveys for PWN cannot rely on symptoms associated with pine wilt. However, trees that are unhealthy or stressed for any reason can act as potential hosts for *Monochamus* spp., and such trees should be targeted for presence of both the vector and PWN. If PWN is found it is likely to be associated with *Monochamus* spp., and follow-on action should concentrate on finding trees utilised by the vector for breeding.

8. Follow-up inspections should gather information on:

    - likely origin of the pest (either or both of PWN and *Monochamus* spp.), particularly focussing on any consignments of woody material capable of carrying the pest both local to the infestation and at any other known destinations of pathway material;
    - geographical location and ownership of the affected site, including any abiotic factors that may influence the outbreak, e.g. public access, presence of watercourses, etc. Include maps if possible;
    - hosts infested at the site (species, variety, development stage, etc.). This will concentrate principally on possible presence of *Monochamus* spp. vectors and, by association, possible presence of PWN;
    - when and how the pest was detected and identified (including photographs of general symptoms and their likely cause (considering that pine wilt arising from PWN infestation is extremely unlikely to be encountered));
    - level of pest incidence and where appropriate, life stages present;
    - presence of unhealthy trees, for any reason, because these might harbour *Monochamus spp* and, as a consequence, PWN;
    - recent import or movement of woody material capable of harbouring PWN and its vectors into and out of the affected site;
    - history of the pest at the site, place of production or in the area; and
    - likely biodiversity impacts of any control, such as felling to control *Monochamus spp* vector spread, and including any duty of care obligations under the NERC (2006) Act.

9. Samples from infested plants should be double-packaged in robust plastic bags and sent immediately to the Tree Health Diagnostic Service at Forest Research for diagnosis. The samples should be accompanied by information on the date when the samples were collected, location (address, postcode, GPS) and contact details of the person collecting the samples. Address is: Entomology Branch, Forest Research, Alice Holt Lodge, Wrecclesham, Farnham, Surrey, GU10 4LH.

Official action following confirmation of a new outbreak

10. Positive identification of PWN depends on DNA analysis. See the EPPO standard on the diagnostics of *Bursaphelenchus xylophilus* for further information on identification.

11. In most cases the Forestry Commission (England and Scotland) is likely to appoint an Incident Controller and an incident management team. In Wales the Welsh Government would take the lead. Forestry Commission England's Forest Services have developed a Specific Contingency Plan for Plant Health Pest and Disease Outbreaks (in draft), which will be enacted in response to a confirmed PWN outbreak. Forestry Commission Scotland and the Welsh Government will have similar documents detailing their management of outbreaks.

Communication

12. Incident controller sets up a management structure to deliver functions of incident management. The scale of the outbreak will determine the size and nature of the management structure

Surveillance

13. A delimiting survey should be set up as soon as possible after the first finding of PWN to determine the geographic limits of the infested area, and to demarcate a regulated area. There are two elements to the delimiting survey:

- an **intensive survey** of all conifer trees within at least 1 km radius of the first tree(s) found to be infested; and
- **line transects** outward to at least 10 km, along which visual inspection and destructive sampling of conifer trees are carried out at regular intervals (e.g. every 50-100m) to estimate the full extent of spread.

14. As *Monochamus* species are attracted to physiologically weakened trees, surveys should focus on weakened standing trees and freshly cut trees, and cutting waste from recent felling seasons (1-2 year old logging sites). All trees that could support breeding by *Monochamus* spp. should be included, regardless of location within a woodland, and isolated trees growing in parks and gardens should also be included in surveys. Sentinels and traps can be used if too few survey sites are available in all directions. Regardless of cause, conifer trees (of all species known to be hosts of PWN) showing canopy thinning and dieback should be felled and the bark removed to look for galleries and immature life stages of the vector *Monochamus* spp. Wood samples should also be removed from these trees for laboratory analysis to identify whether PWN is present. Timing of surveys or deployment of specialised beetle traps should coincide with adult *Monochamus spp* flight periods, as determined by the appropriate phenology model for the species involved.

15. Depending on the species of *Monochamus* present (which would be new to the UK, since this genus is currently absent), breeding will occur in different zones of the tree and depend on bark thickness. For example, *M. galloprovincialis*, the known vector of

PWN in Portugal, only breeds in thin-barked material in the upper trunk and thicker branches and, therefore, surveys for both vector and PWN would need to be concentrated on these parts of the tree. Further details can be found on the REPHRAME website (www.rephrame.eu).

16. If more trees are found to be infested, the surveys should be extended so that the intensive survey covers all conifer trees out to at least 1 km from the new infested trees, and the line transects extend a full 10 km from the new infested trees. This process should be continued to provide a preliminary assessment of the infested area. It should be repeated in subsequent years to monitor possible spread of PWN, and to update the boundaries of the infestation and regulated area.

Demarcated zones

17. The EU directive (2012/535/EU) stipulates that if PWN is found to be present the area should be demarcated where eradication measures are to be applied. A zone with a radius of 500m should be established around infested trees, referred to as the infested zone. A buffer zone of 20km around the infested zone will be established.The infested zone and associated buffer together make up the demarcated area. Within the infested zone, all susceptible trees should be subject to precautionary felling, plus removal and burning of all wood. Intensive surveillance should be carried out within the buffer zone. If surveys within the buffer zone identify new infestations, a new demarcated zone and buffer will need to be established. Where the vector is not present and has not been present for the last three years, the clear-cut zone may be reduced to 100m around infested plants. However, the nature of the habitat will influence this: dense woodland will have less likelihood of long-distance flight by *Monochamus spp.,* whereas longer-distance flight is more likely in more open areas.

Tracing forwards / backwards

18. Although PWN could be introduced on infested plants there is no known vector to spread the nematode within the UK. *Monochamus* spp. infested with PWN are required for tree-to-tree transmission of the nematode.

19. The most likely pathway would be untreated conifer wood, with or without bark, from countries where the pest is known to occur, including Canada, China, Japan, Portugal, Spain, South Korea, Mexico, Taiwan or the USA. Depending upon the pathway of entry, tracing forward and backward to identify suspect material will be conducted to identify other potentially contaminated stock or sites.

Pest management procedures

20. EU directive (2012/535/EU) provides guidelines for eradication and containment of the PWN if an outbreak should occur. The prescribed eradication approach is outlined below. For full details refer to the directive itself.

21. The management programme should initially focus on eradication of PWN. A clear-cut zone should be established with a minimum radius of 500m around susceptible plants in which PWN has been found to be present. All susceptible plants In the clear-cut zone shall be felled, removed and disposed of. The felling and destruction of those plants shall be carried out from the outside of the zone towards the centre. All necessary precautions shall be taken to avoid spreading PWN and its vector during felling.

22. Within the demarcated zone, all dead trees, and trees of poor health or those situated in storm- or fire-affected areas should be felled, based on the suitability of such trees as breeding sites for the vector *Monochamus* spp. All such trees shall be sampled for PWN after felling. The sampling shall be carried out in several parts of each plant, and especially in the thinner bark material in the crown. All samples shall be tested for the presence of PWN. After sampling, susceptible felled trees must be destroyed on site or moved under official control. The EU measures also state that 'a number of healthy-looking plants selected based on the risk of spreading the PWN in the particular case shall be sampled'. However, it is unclear whether this is applicable in the UK, where there will be no wilt expression arising from transmission of PWN by maturation feeding. However, if the nematodes have recently been passed to a healthy tree by maturation feeding and, soon afterwards, the tree is damaged in some way, then nematodes could still be present if the tree is subsequently used by *Monochamus spp* for breeding. This is an unlikely, but possible, scenario.

23. Within the buffer zone, annual surveys shall be conducted of susceptible plants which are dead, in poor health or situated in fire- or storm-affected areas. Those surveys shall also include systematic sampling of healthy-looking susceptible plants. The intensity of the surveys 3000m around each susceptible plant in which PWN has been found shall be at least four times greater than from 3000m thereof to the outer limit of the buffer zone.

24. Trees felled during the flight period of *Monochamus* can be used as trap trees to detect the presence of adult *Monochamus* and associated PWN outside of the infested area. The flight period of the vector occurs between 1st of April to the 31st of October, under current climate conditions. Should UK temperatures rise and approximate those on Madeira, a slightly longer flight period, especially into the autumn, could be expected. Upon finding PWN-infested trees outside of the infested zone, a new demarcated area around these trees will need to be established.

25. Eradication measures should be in place for a minimum of four years. If PWN is still present after this period, actions should revert to containment, but only if eradication is impossible. However, where eradication is impossible, Member States should, in certain cases, be allowed to apply containment measures even before the expiry of the four-year period.

Disposal plan

26. Conditions for movement of susceptible plants and wood within and from demarcated areas are detailed in Annex III of EU directive (2012/535/EU).

In summary, conifer trees within the infested zone that are to be felled to eradicate PWN infestation should be destroyed or treated within the demarcated area by either:

(a) burning in a nearby location within the demarcated area designated for this purpose;
(b) being used in a processing facility as fuel or for other destructive purposes, ensuring freedom from live PWNs and live vectors; and
(c) heat treatment in an authorised treatment facility to achieve a minimum temperature of 56°C for at least 30 minutes throughout the wood and bark, ensuring freedom from live PWNs and live vectors. In the case of a composting heat treatment, the composting shall be carried out in accordance with a treatment specification approved in accordance with the procedure referred to in Article 18(2) of Directive 2000/29/EC. However, there are no currently accepted composting regimes employed in Portugal, where the nematode is present, and this suggests that quality assurance to use such treatments would be extremely difficult.

Wood that is found to be infested should also be disposed of by option a or b as listed above.

Public outreach

27. It is crucial to have public support for the management programme and to help with general surveillance. Engaging the public will require the provision of timely and accurate information, and opportunities to participate in monitoring and control. Information can be made available through newspapers, radio, TV, the internet and social media, and should be targeted locally, especially within the infested and regulated areas, and at a national level. However, given that PWN-affected pines in the UK are unlikely to express wilt-like symptoms, greater value from non-expert surveillance will come from reports of *Monochamus spp.* vectors in woodlands and gardens.

28. It is important to provide information about the location and size of the infested and regulated areas, statutory and voluntary responsibilities, rates of spread, management options, pathways, how the pest might have arrived and could be transported, and the prospects for GB forestry. Managing this level of public engagement will require a central administration office capable of handling large numbers of enquiries and able to provide general and specific information.

Review measures in the case of prolonged official action

29. If continuing official action is required within the delimited area over a prolonged period, a review of the management programme should be undertaken regularly (e.g.

annually) to determine the success and cost-effectiveness of the measures in the longer term. This review will involve consultation with stakeholders and should include:

- evaluation of the effectiveness of current measures;
- evaluation of the economic impact and cost-effectiveness of continuing existing measures;
- consideration of further measures to strengthen containment and eradication actions;
- consideration of statutory obligations and impact on import and export procedures;
- consideration of alternative approaches or the cessation of statutory action; and
- consideration of biodiversity impacts following control.

30. In circumstances where official action is no longer considered appropriate, stakeholders should be consulted and a timetable and mechanism agreed for the removal of official measures and for the dissemination of pest management information as appropriate.

Criteria for declaring / change of policy

31. Policy changes should be considered in light of:

- changes in the geographic distribution of the PWN and its vector;
- new or updated research information on the pest species' range and lifecycle;
- identification of new pathways; and
- impacts on exports due to the UK's being declared an infested region.

Evaluation and review of the contingency plan

32. Plan to be reviewed annually and take account of:

- any new legislative measures, or amendments to measures implemented to reduce the risk of introduction;
- changes in the geographic distribution of the PWN;
- new or updated research information on the range and life-cycle of PWN and its vector; and

- any new pathways identified.

Recovery

1. A site can be deemed as recovered from an outbreak if, after three years of monitoring, there are no indications of PWN and *Monochamus spp.* vector presence.

PEST BACKGROUND INFORMATION

PWN is the causal agent of pine wilt disease. Native to North America, where it is not considered a major pest, the nematode is a major threat to Asian and European pine forests, and has resulted in extensive tree mortality in countries where it has been introduced (FAO 2009). *Monochamus spp.* (sawyer beetles) are the only known vector of the nematode.

Identity of organism and quarantine status

Species name: *Bursaphelenchus xylophilus* (Steiner & Buhrer, 1934) Nickle 1970 Nematoda: Aphelenchoididae.

Synonyms: *Aphelenchoides xylophilus* Steiner & Buhrer, 1934;
Paraphelenchoides xylophilus Steiner and Buhrer 1934 (Haque 1967)
Bursaphelenchus lignicolus Mamiya & Kiyohara, 1972

Common name: Pine wood nematode

UK Plant Health Risk Register rating: Unmitigated 60/125 Mitigated 30/125

EU status: *Bursaphelenchus xylophilus* is on the EPPO A2 list number 158, EU Annex designation II/A1, Commission Decision 2002/887/EC and 2002/449/EC, Commission Implementing Decision 2012/535/EU.

Hosts

Virtually all wood of conifers (with the exception of the genera *Thuja* and *Taxus*) are suitable for the saprophytic (delivered by oviposition (egg-laying)) phase of the nematode cycle.

Distribution of the organism

PWN is native to North America, being found in many of the states of Canada, the USA and Mexico. It has spread to a number of other countries including:

- Japan (where tree deaths were noted in the 19th century, but the nematode as causal agent was only confirmed in the late 1960s);
- China (from 1982);
- Korea (from 1988);
- Taiwan (from 1985);
- Portugal (continental PT 1999 and Madeira 2009); and
- Spain (2008/2009/2012) – three isolated cases.

Monochamus spp. are known vectors of PWN, but are only present in the Northern hemisphere.

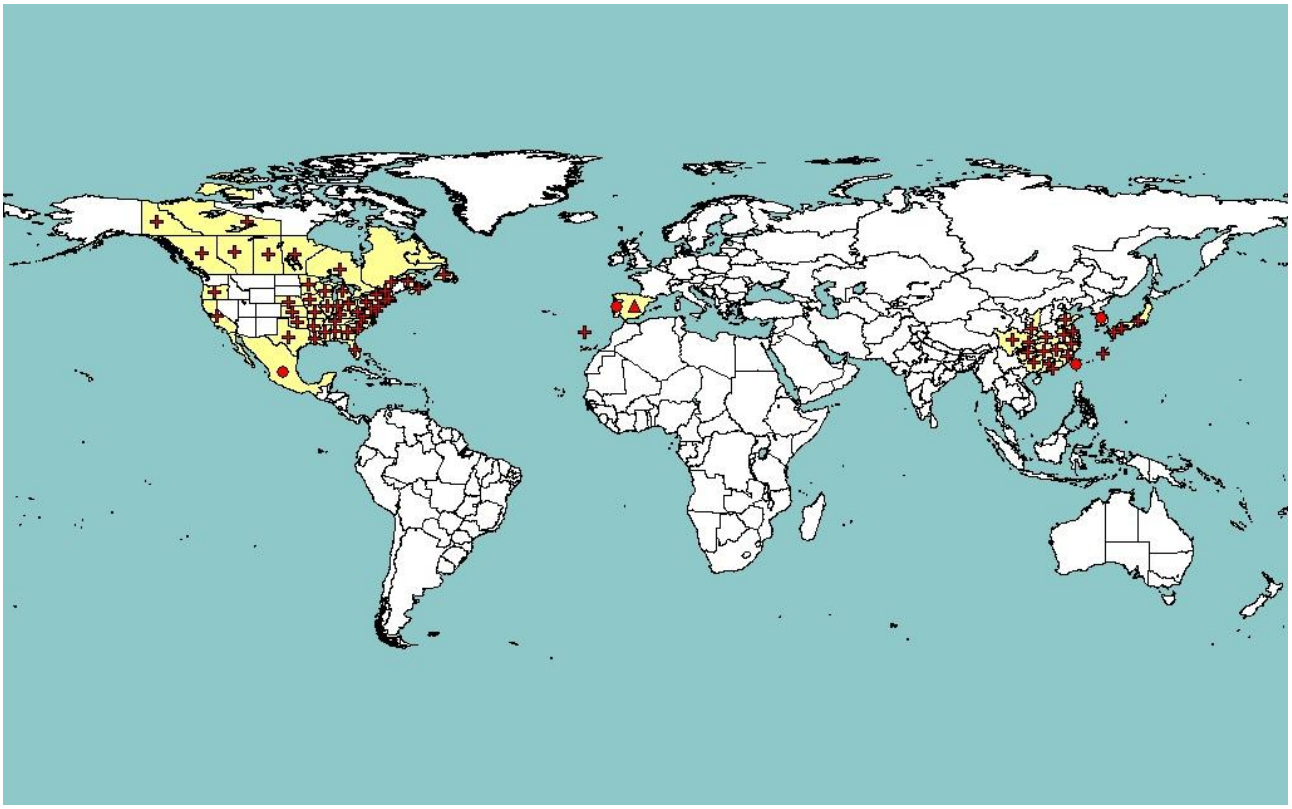

Figure 2: Distribution map of the *B. xylophilus*, circles - present (national record) crosses - present (sub-national record) and triangle - transient (EPPO PQR database)

Damage impact and controls

There has been extensive tree mortality in all countries where wilt expression has been recorded (leading to the description of the syndrome pine wilt disease). For example, in

Japan annual losses peaked at 2.5 million m^3 in the early 1980s, but appear to be fluctuating around an average of about 1.0 million m^3 in 2015.

The recent outbreak in Portugal illustrates the high costs of attempting eradication of a newly discovered organism (approximately €80million from 1999 – 2009 - source EU DG SANCO), but the direct losses from tree mortality must also be added to this amount. The campaign to eradicate the two isolated cases of PWN in Spain has also incurred high management costs, of nearly €3m in 2010 (EU DG SANCO).

In 1979, PWN was associated with death of *Pinus* in Missouri (USA), primarily of *P. sylvestris* growing in amenity plantings and, in North America in general, losses arise almost exclusively among exotic species and in artificial forest ecosystems such as ornamental conifer plantings, wind-breaks and Christmas tree plantations. PWN is widespread in natural coniferous forests, but significant losses are not reported.

Life history

For more detail see the EPPO guidance note: 'Guidance on sampling to detect pine wood nematode, *Bursaphelenchus xylophilus,* in trees, wood and insects (Schröder et al., 2009).'

PWN is transported between host pine trees by wood borers of the genus *Monochamus*. There are two principal pathways of transmission (Schröder et al. 2009, Evans et al. 1996) through oviposition and through maturation feeding by adult *Monochamus* beetles. Adult *Monochamus* beetles fly between trees, feeding on the branches of healthy trees. The nematodes emerge from the beetles and enter the trees through the feeding wounds or during oviposition. When PWN is transmitted during oviposition, the nematodes may remain relatively close to the vector development galleries and aggregate around the pupal chamber just before the final moult to the adult beetle. If nematodes are introduced to a susceptible tree, and environmental conditions are suitable, they can migrate throughout the tree, feeding on parenchyma cells, resulting in cell death and decreased water conductivity due to cavitation of the xylem. For pine wilt to occur, the host species, the vector and the nematode must be present, along with specific climatic conditions: principally high temperatures and low soil moisture content. Recent developments of tree process models within the REPHRAME project have provided reliable simulations of the areas of Europe most likely to be vulnerable to pine wilt expression. Maps can be found on the REPHRAME website (www.rephrame.eu). Current modelling indicates that no wilt is expected for the UK. Since the nematode can survive through the saprophytic transmission cycle by the vector, there might be issues in relation to exports of conifer wood if a country is declared to be infested. Under current legislation, all conifer wood originating in PWN-infested countries may be treated to ensure freedom from the nematode.

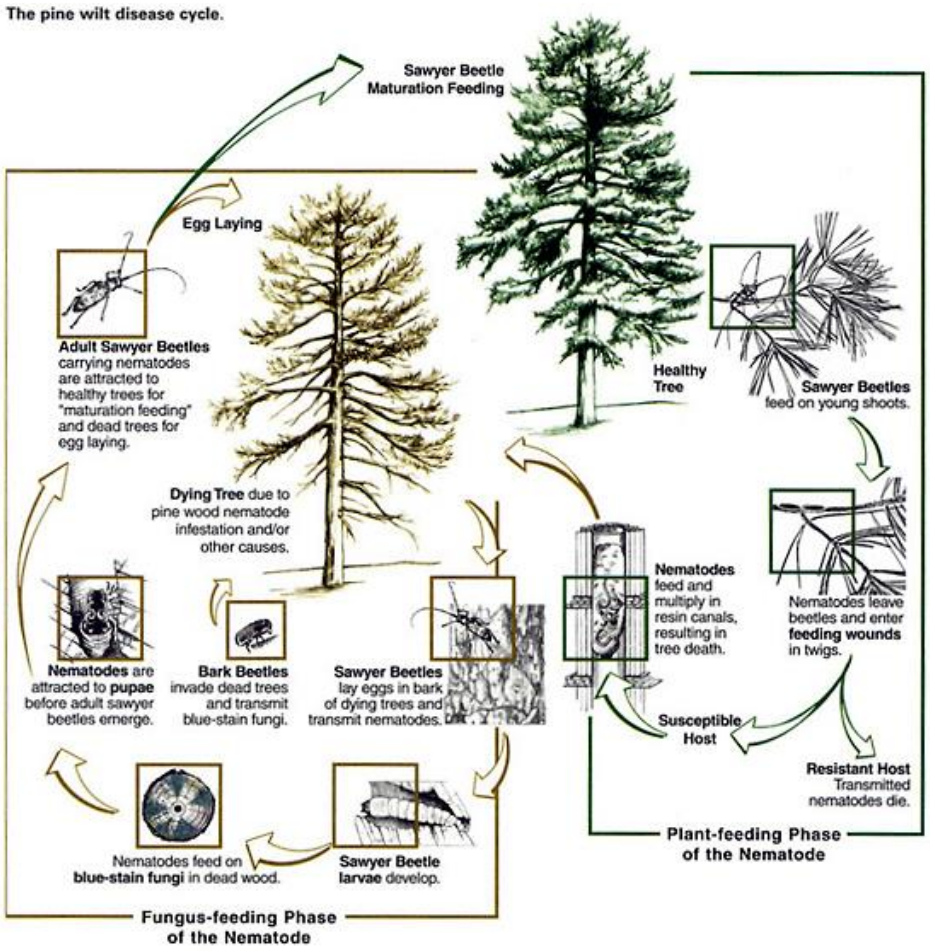

Figure 3: PWN life cycle – it should be noted that it is only the *Monochamus* (longhorn or sawyer beetles) which are capable of spreading PWN. Bark beetles are not vectors.

Main pathways

PWN is spread in nature by its vector *Monochamus* spp. Adult vector beetles are active fliers, with peak flight activity being around 5 days after emergence. The UK Plant Health Risk Register lists 12 potential *Monochamus* vectors of PWN:

M. alternatus , M. carolinensis, *M. galloprovincialis M. marmorator, M. mutator*, , *M. notatus, M. nitens, M. obtusus, , M. sartor, M. scutellatus, M. titillator,* and *M. urussovii.*
A full list of host species and distribution of these *Monochamus* species is given in appendix 2.

Beetles are capable of flying up to 60 kilometres over their life time, although in most cases dispersal is only for a few hundred metres, especially in dense woodland (EPPO / CABI, 1997; www.rephrame.eu). Long-distance dispersal occurs by transporting vector-infested wood, such as wood packaging or infested pine wood. A discovery of PWN was made in furniture being imported to the UK in 2013. Between 1997 and 2015, 18 interceptions of *Monochamus* vectors were made: 10 *M. sartor*, 6 *M. galloprovincialis* and 2. *M. alternatus*

Import controls

PWN is on the EPPO A2 list number 158, EU Annex designation II/A1. To prevent the introduction and spread of the *B. xylophilus*, coniferous plants from infested areas may not be imported into the EU. Conifer wood or isolated bark imported from countries known to have PWN must be accompanied by a phyto-sanitary certificate stating that it has been heat treated to 56°C for at least 30 minutes to eradicate PWN. All wood packaging entering the EU must be ISPM15 treated. Similarly, conifer wood and isolated bark originating from the EU-demarcated area must be heat treated to 56°C for at least 30 minutes in the core, and accompanied by a plant passport verifying this. All wood packaging from the demarcated area must be ISPM15 treated.

Identification

Signs and symptoms are described in the EPPO standard on the diagnostics of *Bursaphelenchus xylophilus* (Schröder *et al*. 2009).

Since it is not expected that PWN would give rise to wilt expression in the UK, there are no reliable visual indicators for the presence of the nematode in infested trees in the UK.

***Monochamus* spp.**

These insects only oviposit on recently felled trees or trees already under stress. The feeding of the young larvae produces feeding tracks on the sapwood under the bark, followed by bore holes in the wood produced by the larger larval stages. Signs of frass from bore holes on bark and larval galleries under the bark, as well as circular exit holes produced by the

emerging adult beetles, should be looked for as indications of the presence of *Monochamus* spp.

Appendices

Appendix 1: Alert status categories.

ALERT	STATUS	COMMAND LEVEL
White	Plant pest/disease with potential for limited geographical spread	Instigation of incident management plan involving operational command at appropriate level and following Standard Operating Procedures or scientific advice where applicable
Black	Significant plant pest/disease with potential for limited geographical spread	Instigation of incident management plan usually involving joint tactical and operational command at appropriate level, and following plant pest/disease specific response plans where applicable
Amber	Serious plant pest/disease with potential for relatively slow but extensive spread leading to host death and/or major economic, food security or environmental impacts	Instigation of incident management plan, usually involving joint strategic and tactical command, and following plant pest/disease-specific response plans where applicable
Red	Serious or Catastrophic plant pest/disease with potential for rapid and extensive geographical spread leading to host death and/or major economic, food security or environmental impacts	Instigation of Incident management plan involving Strategic, Tactical and Operational command, and following plant pest/disease-specific response plans where applicable

Appendix 2: Methodology for annual EU PWN survey

PINE WOOD NEMATODE – SURVEYS AND SAMPLING 2015
FE FOREST DISTRICT SITES

Introduction

Pine wood nematode, *Bursaphelenchus xylophilus*, is a microscopic nematode worm that is native to North America, where it lives mainly on dying or dead trees, and rarely affects healthy living trees. It is carried from tree to tree by longhorn beetles in the genus *Monochamus* (the vectors), commonly known as sawyer beetles. Nematodes move from the adult beetles to the tree either during feeding in the crown or, more usually, during egg laying by female beetles. When trees are susceptible and average temperatures are high (July/August isotherm > 24-26^{o}C), nematodes introduced into the crowns of trees can enter the xylem (water-conducting vessels), breed and, by increases in numbers and production of a toxin, eventually kill the tree. Tree death can be rapid and give rise to characteristic wilting in which needles redden within a few weeks of nematode introduction.

PWN has established in a number of new locations worldwide, and has resulted in extensive tree mortality in these new locations. It is now a serious pest in Japan, China, Korea, and Taiwan and, in 1999, was also found in Portugal, where the outbreak has spread significantly. As a result of the extensive spread of the pest in Portugal, one of the strategies now being adopted by the EU is to require Member States to carry out surveys to determine whether the nematode is present in their territories, and also to assess whether either the nematode or its vector is being carried to the EU on imported wood.

Longhorn beetles of the genus Monochamus are not known to occur in the UK. They are, however, frequently intercepted from imported timber, especially wooden packaging, and therefore they have the potential to be accidentally introduced into the UK using imported wood products as a pathway. The beetles originate not only from Continental Europe and Russia, but also from Asia and North America, where PWN is known to be widely distributed.

The protocol in this document describes the UK monitoring regime, and is based on an agreed EU procedure. Sampling sites should be selected carefully. **Sites where pine occurs in the vicinity of premises known to receive imported coniferous timber or wooden packing material, should be given priority when sampling individual trees and in forest locations.**

Sampling protocols

Forest/Woodland Locations

- If possible, site selection should be based on the proximity to a 'high-risk' location. That is anywhere infected material might have entered the UK from a country where PWN is known to occur, e.g. ports, wood-processing facilities, solid wood packaging material (SWPM) disposal sites, or final destination points of imported SWPM, such as industrial estates. Where possible, choose sampling sites within 5km of a high-risk site or >5kms distant if it's the first woodland encountered
- For woodland sites, select and sample **at least 5 trees per site**. Samples should be taken preferentially from trees showing signs of poor health, especially wilting, or recently dead trees.
- The exact number of samples will depend on the number of recently dead (within the last 6-12 months) or dying trees present. It is important to take a representative sample from the site; if there are many dead trees, it would be wise to take samples from more trees.
- Samples from up to five trees can be combined into one bag, and need only be accompanied by a single survey form.

Samples should be taken from standing live trees if it is not possible to find trees (or parts of trees) with signs or symptoms. For all trees, irrespective of symptoms, take approximately 30g per drill site sample per tree at a height of 1.3m, and in three different directions around the trunk (i.e. a total sample size of 80g – 100g /tree) using a drill (see method below). Sample at least five trees per site. Where normal felling or thinning operations are taking place, take advantage of felled trees and cut discs as described below.

Sampling Methods:

Nematodes are easily killed by heat, so whichever method is used, try to ensure that heat generated by friction is kept to a minimum.

Disc Method - the best method for assessing nematodes.

1. Cut wood discs from three positions along the length of a fallen or felled tree at lower, mid and upper positions on the trunk.
2. Remove the bark from the discs and assess for presence of fungal infection (blue or grey staining) or insect galleries or grub holes.
3. Cut the disc into smaller pieces, (unless the diameter is very small, in which case the whole disc can be sent in for testing). Take a total of at least 100g per disc. Be sure to include any parts affected by stain or grub holes, but avoid including knots or high-resin areas.

Sawdust samples.

It is also possible to use the sawdust from a chainsaw to produce material suitable for extraction of nematodes. Tests have shown that the heat generated by chain sawing does not kill the nematodes. To do this, cut into several parts of the tree or branches, and amalgamate the samples for processing. Take at least 100g per tree.

Drilled samples.

Use a drill, running at a slow speed, with an auger bit with a diameter of at least 8mm, but ideally 20mm. Gather the shavings to make up a sample of approximately 30g per drill site, and at least a sample of 80–100g per tree. Clean the borer bit between samples (i.e. between every five trees to be combined) with alcohol (methylated spirits is readily available and effective).

Isolated Trees

Where isolated trees are being sampled, take at least 80–100g of sample per tree using the drill method. You must indicate on the accompanying form that the sample is from an isolated tree.

All samples should be placed in a plastic bag, sealed and labelled (Nb. samples from up to five trees per site can be combined into one bag, and need only be accompanied by a single survey form). Please keep your sample form clean and dry by placin it in the separate plastic bag provided to protect it from the wood material

Survey Form

A survey form **must** be completed for **each site.** All data fields must be completed. If a 'nil' or 'n/a' entry is appropriate, please annotate the relevant data field accordingly.

Enquiries

For further information on the sampling methodology or the survey in general, contact your Plant Health Regional Manager.

Appendix 3: Sample survey form for annual EU PWN survey

Forestry Commission

FORESTRY COMMISSION Ref No. 076/

PINEWOOD NEMATODE (PWN) SURVEY MATERIAL - TREES

NOTE: All samples should be sent directly to Entomology Branch, Forest Research, Alice Holt, Wrecclesham, Surrey GU10 4LH with a completed form for each amalgamated sample

1. The accompanying samples(s) is/are forwarded for investigation.

From: Name

Address

Tel No

2. Source of sample(s)

Location (include forest name and compartment number if appropriate)

a. **Grid Reference**

b. **Is there a high-risk site nearby?** YES/NO

c. **Proximity to 'high-risk' site**

d. **Indicate nature of 'risk'** sea/airport industrial site landfill site other

3. Details of sample(s) submitted for investigation

a. **Tree Genus/species** ☐

b. **Tree condition** ☐ Symptomless ☐ Wilting ☐ give reason for wilting if known

☐ Recently*dead ☐ Recently*felled *(* within the last 12months)*

c. **Disease symptoms** ☐ Staining ☐ Decay ☐ Fruiting ☐ Other

d. **Signs of insect attack** ☐ Grub holes** in wood ☐ Exit holes** through bark

*(** larger than 3mm in diameter)*

e. **Pest stages present** Adult Live: YES/NO Pupa Live: YES/NO Larva Live: YES/NO

If suspected longhorn beetle larvae or adults are found, please send them in with this form. Use a crush-proof container.

4. Additional remarks†

☐

Signed:

Date:

Appendix 4. *Monochamus* species from coniferous trees, known to be vectors of *Bursaphelenchus xylophilus,* or considered to be potential vectors

Monochamus species	Geographical distribution	Main hosts	Vector status
North America			
M. carolinensis Olivier	USA (eastern half), Canada (east & US border), Mexico(north central)	*Pinus*	+
M. clamator LeConte	USA (west coast), Canada (British Columbia)	*Pinus contorta*	-
M. marmorator Kirby	USA, Canada	*Abies*, *Picea*	+
M. mutator LeConte (syn. *M. maculosus* Haldeman)	USA, Canada	*Pinus*	+
M. notatus (Drury)	USA, Canada	*Pinus strobus*	-
M. obtusus Casey	USA (west coast), Canada (British Columbia)	*Pinus*, *Abies*, *Pseudotsuga*	+
M. rubigeneus Bates	USA (south), Mexico, Guatemala, Honduras	*Pinus*	-
M. scutellatus Say subsp. *scutellatus*	Eastern North America (including parts of Mexico)	*Pinus*, *Picea*, *Abies*, *Larix*	+
M. scutellatus subsp. *oregonensis* LeConte	USA (west coast), Canada (British Columbia)	*Picea*	-
M. titillator (Fabricius)	USA (centre, east & south-east), Canada (Ontario)	*Pinus*, *Abies*, *Picea*	+

Monochamus species	Geographical distribution	Main hosts	Vector status
Palaearctic region (overlapping *B. xylophilus*)			
M. alternatus Hope	Japan, Korea Republic, Taiwan, Hong Kong, Lao, China (Anhui, Guangdong, Hunan, Jiangsu, Shandong, Zhejiang, i.e. east & centre)	*Pinus*, *Cedrus*, *Abies*, *Picea*, *Larix*	+
M. nitens Bates	Japan	*Pinus*	+
M. saltuarius Eschscholz	Japan, China (Heilongjiang; NE) Siberia, Lithuania, central & eastern Alps, central & eastern Europe and south to Italy	*Picea*	+
M. tesserula White	Japan, China	*Pinus*	-
M. urussovii (Fischer) (syn. *M. rosenmuelleri* Cederhielm)	Japan, China (Liaoning, Heilongjiang, Neimenggu; i.e. NE) Siberia, Russia (Caucasus), Finland, Poland	*Abies*, *Larix*, *Picea*, *Pinus*	

Monochamus species	Geographical distribution	Main hosts	Vector status
Palaearctic region (not overlapping *B. xylophilus*)			
M. galloprovincialis (Olivier)	Portugal, North Africa, Italy, France, Greece, Germany, Poland, Sweden, Finland, Russia (European), Siberia	*Pinus*	-
M. sartor	Central	*Picea, Pinus*	-

Fabricius	Europe (eastern France to western Ukraine)		
M. sutor (Linnaeus)	China (Heilongjiang, Liaoning; NE), Siberia, Russia (European), Georgia, the Nordic countries, central & eastern Europe, the Pyrenees, Alps	*Pinus, Picea, Larix*	-

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