Rapid Pest Risk Analysis for *Phytophthora pinifolia*

Disclaimer: This document provides a rapid assessment of the risks posed by the pest to the UK in order to assist decisions on a response to a new or revised pest threat. It does not constitute a detailed Pest Risk Analysis (PRA) but includes advice on whether it would be helpful to develop such a PRA and, if so, whether the PRA area should be the UK or the EU and whether to use the UK or the EPPO PRA scheme.

STAGE 1: INITIATION

1. What is the name of the pest?
Phytophthora pinifolia Durán, Gryzenh & Wingfield. First described as a new species by Durán *et al.* (2008).

Synonyms:
None

Common name of the pest:
The pest does not have a common name, but the disease that it causes is referred to as 'Daño Foliar del Pino' (DFP) which translates as 'pine foliar damage'.

Taxonomic position:
Kingdom - Chromista; Phylum - Oomycota; Class - Oomycetes; Order - Pythiales; Family - Pythiaceae; Genus – *Phytophthora*

Sequence analysis of the ITS region places it into Clade 6 of the phylogeny-based classification of Cooke *et al*. (2000). Its closest relatives include some other Phytophthoras which can also act as tree pathogens such as *P. megasperma* and *P. gonapodyoides*, although these species are all ecologically and morphologically different from *P. pinifolia* despite their phylogenetic affinity.

Special notes on nomenclature or taxonomy:

2. What is the pest's status in the EC Plant Health Directive (Council Directive 2000/29/EC) and in the lists of EPPO?
Phytophthora pinifolia is not listed in the EC Plant Health Directive nor is it currently on the EPPO Alert List. The pest was placed on the EPPO Alert List in 2009 but withdrawn in 2013, as during this period no particular international action was requested by EPPO member countries. In 2013, it was therefore considered that sufficient alert had been given and the pest was deleted from the Alert List.
http://www.eppo.int/QUARANTINE/Alert_List/deleted%20files/fungi/Phytophthora_pinifolia.docx

3. What is the reason for the rapid assessment?
In 2004 and increasingly through to 2006, a new disease of *Pinus radiata* (radiata pine), referred to as 'Daño Foliar del Pino' (DFP) appeared in the coastal Arauco province of Chile and subsequently spread to other areas in central Chile planted with radiata pine. In 2007 a previously unknown *Phytophthora* species was isolated from symptomatic needle tissue of

affected trees and formally named and described as *Phytophthora pinifolia* (Durán *et al.*, 2008).

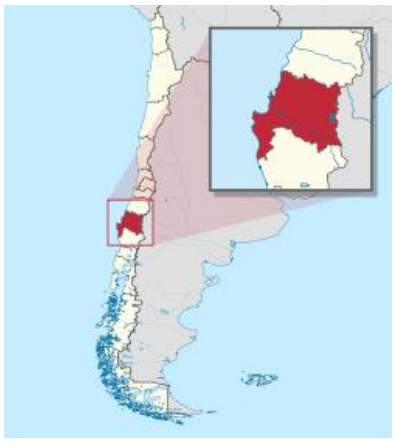
The disease caused by *P. pinifolia* is considered unusual, because at the time of the first report it was the only known *Phytophthora* disease capable of infecting the needles and succulent tissue of any *Pinus* species. *Phytophthora pinifolia* was identified as a pest of concern to the UK during a review of tree health and plant bio-security action plans (LWEC, 2013). Phase I of the UK Plant Health Risk Register in the summer/autumn of 2013 also identified it as a priority pest for risk analysis to help inform the decision on whether any statutory action against the pest is justified.

STAGE 2: RISK ASSESSMENT

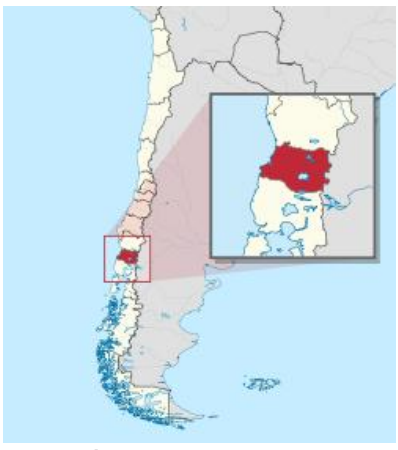
4. What is the pest's present geographical distribution?
The current distribution of *P. pinifolia* is shown in Table 1 and the pest is only known to exist in Chile. Within Chile, DFP-infected trees have only been reported from plantations of *Pinus radiata* in the Bío Bío, Los Ríos and Maule regions in the coastal area (Figure 1) (Ahumanda *et al.*, 2013).

Table 1. Distribution of *Phytophthora pinifolia*

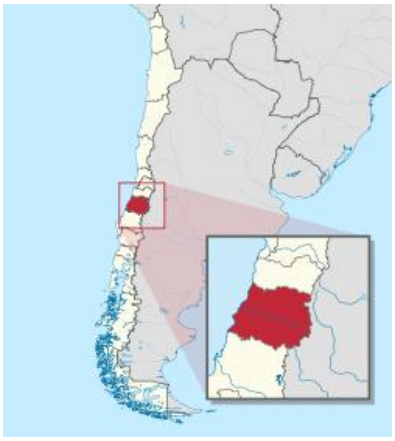
North America	No record
Central America	No record
South America	Chile
Caribbean	No record
Europe	No record
Africa	No record
Asia	No record
Oceania	No record



Bío Bío Region, Chile



Los Ríos Region, Chile



Maule Region, Chile

Figure 1: Regions in Chile where the disease 'Daño Foliar del Pino' (DFP) has been confirmed affecting *Pinus radiata* based on reports in Ahumada *et al*. (2013. Figures taken from Wikipedia http://en.wikipedia.org/wiki/Chile

Annual monitoring indicated that affected areas in Chile increased from 3,300 ha in 2004 to 54,000 ha in 2006. However, between 2007-2011, the incidence of DFP declined to around 2,000 ha each year (Ahumada *et al*., 2013). The reduction is thought to result from a combination of factors: mainly less conducive environmental conditions, management actions including the removal of infected trees and chemical treatments.

Using the DNA 'finger printing' tool Amplified Fragment Length Polymorphism (AFLP) applied to around 90 isolates collected throughout the area of infestation in Chile, this has revealed that *P. pinifolia* comprises a clonal population of two near-identical genotypes, one of which constitutes more than 97% of the isolates sampled (Durán *et al*., 2010). The sudden appearance of DFP, coupled with the almost complete absence of genetic variation in the pathogen, is indicative of a single, recent introduction, and the geographical origins of *P. pinifolia* remain unknown. It has been suggested that it may originate from areas where *Pinus radiata* or related pine species are native but there is no evidence to support this hypothesis at present. The relict native homelands of *P. radiata* comprise California (primarily the Monterey Peninsula) and two Mexican island populations (Lavery and Mead, 2000), and the health status of radiata pine has been under close scrutiny for decades in these areas due to pitch canker (UC IPM 2014). In these circumstances it is unlikely, although not impossible, that *P. pinifolia* could have been overlooked in the native range of radiata pine. An alternative explanation is that *P. pinifolia* is native to Chile but has undergone a host shift from native plants to the extensively planted *P. radiata* (Slippers *et al.* 2005) although there is no evidence so far to suggest that genetic introgression or interspecific hybridisation may have resulted in a new pathogen with a different host range as described by Brasier (2008) for other *Phytophthora* pathogens. The most likely scenario is that *P. pinifolia* has been accidentally introduced into Chile from an unknown location, which also suggests that there is potential for further introductions into other regions, including the UK. It appears to pose a high level of risk to parts of the world where *P. radiata* is grown commercially as a plantation tree.

5. Is the pest established or transient, or suspected to be established/transient in the UK? *(Include summary information on interceptions and outbreaks here).*
There have been no interceptions and there are no records or other evidence to suggest that *P. pinifolia* has ever been transient in the UK or within the EU.

6. What are the pest's natural and experimental host plants; of these, which are of economic and/or environmental importance in the UK?
Only *Pinus radiata* has been recorded as a natural host to date. Even when other conifer species such as *P. pinaster* and *Pseudotsuga menziesii* (Douglas fir) or broadleaf species such as *Nothofagus* are growing in close proximity to affected *P. radiata* they have not been observed to develop symptoms (Durán *et al*. 2008; Ahumada *et al*. 2013). However, testing of other *Pinus* species (all originating from southern USA, Mexico and Central America apart from *P. pinaster*) suggests that several show some level of susceptibility (see Table 2), especially those closely related to *P. radiata*.

Table 2. Potential hosts of *Phytophthora pinifolia* identified through host testing taken from Ahumada *et al*. 2013).

Host		**Family**	**Tissue**	**Symptoms**	**Level of susceptibility**
Scientific name	Common name				
Pinus radiata	Radiata pine	Pinaceae	Needles, shoots	Resinous bands on needles, shoot wilting and lesions	Most susceptible
P. arizonica	Arizona pine	Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Most susceptible
P. durangensis	Durango pine	Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Most susceptible
P. greggii	Greggs pine	Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Moderately susceptible
P. greggii var *australis*		Pinaceae	Sapling shoots	Lesions around inoculation points	Least susceptible
P. greggii var *greggii*		Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Most susceptible
P. maximinoi	Thinleaf pine	Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Most susceptible
P. muricata	Bishop pine	Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Moderately susceptible
P. patula	Spreading-leaved pine	Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Moderately susceptible
P. patula var *longipedunculata*		Pinaceae	Sapling shoots	Lesions around inoculation points	Least susceptible
P. patula var *patula*		Pinaceae	Sapling shoots	Wilting shoots and lesions around inoculation points	Moderately susceptible
P. pinaster	Maritime pine	Pinaceae	Sapling shoots	No symptoms	Resistant
P. taeda	Loblolly pine	Pinaceae	Sapling shoots	No symptoms	Resistant

Only a few of the hosts that are naturally or experimentally susceptible in wound inoculations tests are present in the UK. *Pinus radiata* is the most common but forestry plantings are mainly limited to provenance trials (see http://www.forestry.gov.uk/fr/INFD-8CVE4W); the other species are mainly grown as ornamentals. The BSBI Atlas shows the distribution of *P. radiata* as mainly limited to south west England and the coastal regions of Wales and southern England, but with very sporadic records in the central belt right up to north east Scotland http://www.bsbimaps.org.uk/atlas/map_page.php?spid=2414.0
Overall, known susceptible species are not considered economically and / or environmentally important in the UK.

7. If the pest needs a vector, is it present in the UK?
Phytophthora pinifolia does not have a known vector or associated organisms.

8. What are the pathways on which the pest is likely to move and how likely is the pest to enter the UK?

The most likely pathway for introduction is on live conifer plants, particularly pines. Seedlings and saplings of some *Pinus* species that are of a size and age to move in the plant trade have been shown to be susceptible (Ahumada *et al*. 2013). However, the EU (EC Plant Health Directive, Annex III: Anon. 2000) prohibits the import of plants of *Pinus* species, other than seeds, from non-European countries. On this basis, the pathway is rated as unlikely although the level of uncertainty about host range and the native geographical origin of the pest means that there is considerable uncertainty about this rating.

The likelihood of movement via timber/wood pathways is very unlikely based on evidence drawn from a study by Ahumada *et al*. (2012). They found that the green sawn lumber taken from trees infected by *P. pinifolia*, or green lumber exposed in infected pine plantations, displayed no evidence of the pathogen survival in this material.

Phytophthora pinifolia produces sporangia on infected green needles in the canopy of *P. radiata* trees and these needles later die and fall to the forest floor, so there is potential for the pest to be harboured in soil and for contaminated soil to act as a pathway. However, there is no evidence that *P. pinifolia* produces long-lived chlamydospores and it is sterile in culture and does not produce oospores (Durán *et al*. 2008). The absence of either resting spore stage would limit the ability to persist in soil/infected leaf litter for extended periods. This behaviour, coupled with EC Plant Health Directive (Annex III: Anon, 2000) which prohibits the import of soil from non-European countries, suggests that soil is unlikely to be a significant pathway for entry.

	Very unlikely	Unlikely	Moderately likely	Likely	Very likely
Host plants for planting:		✓			
Timber / wood	✓				
Soil		✓			

9. How likely is the pest to establish outdoors or under protection in the UK?

Establishment under protection is very unlikely because *P. pinifolia* does not affect crops grown under protection.

Phytophthora pinifolia has an optimum temperature for growth of 25°C, with a minimum of 7°C and a maximum of 30°C (Durán *et al*. 2008; Ahumada *et al.* 2013). In the Arauco Province of Chile, where DFP occurs along the coastal region which is known as the Arauco Gulf (mean monthly maximum temperatures of 14-23°C and minimum of 6-11°C: http://www.worldweatheronline.com/) there is frequent mist and rain. New infections occur throughout the year in this region with most occurring during wet winter and spring months (May to September); wet weather in particular appears to favour disease development (Ahumada *et al*. 2013). Similar weather conditions are experienced in the UK, particularly in the western part of the country and already favour other introduced aerial *Phytophthora* species such as *P. ramorum* and *P. kernoviae.* Therefore, environmental conditions throughout western UK are predicted to be favourable to *P. pinifolia* so establishment is likely.

	Very Unlikely	Unlikely	Moderately likely	Likely	Very likely
Outdoors:				✓	
Under protection:	✓				

10. How quickly could the pest spread in the UK?

The infection biology is not fully understood but the *P. pinifolia* appears to spread primarily from sporangia which are produced on infected green needles in the canopy and from shed, dead needles that fall to the forest floor. Although the pathogen spreads aerially, the sporangia do not appear to be caducous, in contrast to other aerial Phytophthoras such as *P. ramorum* and *P. kernoviae*, so zoospores are released into the atmosphere from the sporangia which remain attached to the needles (Ahumada *et al*. 2013). Mist and rain are associated with disease spread and infection and the climate in the UK is likely to be conducive to disease spread, so the potential for natural spread is assessed as moderate. The other major pathway by which *P. pinifolia* is likely to spread (by analogy with other Phytophthora spp.) is on 'plants for planting' of known natural hosts (i.e. *Pinus radiata*). As only limited information is available on the full host range, there is also potential for spread on other species of *Pinus* as well as non-*Pinus* hosts. Overall spread in the plant trade could occur quickly.

	Very slowly	Slowly	Moderately	Quickly	Very quickly
Natural spread:			✓		
In trade:				✓	

11. What is the area endangered by the pest?

Phytophthora pinifolia could potentially become established throughout the range of its known host (*P. radiata*) under suitable climatic regimes. However, *P. radiata* is not a native species to the UK and its distribution is mainly limited to provenance trials (see http://www.forestry.gov.uk/fr/INFD-8CVE4W) and occasional plantings. The BSBI Atlas indicates the species is mainly found in south west England and the west coast of Wales http://www.bsbimaps.org.uk/atlas/map_page.php?spid=2414.0 Other *Pinus* species that showed susceptibility in experimental tests (see Table 2) are also non-natives and when they occur in the UK are grown mainly as ornamentals. Therefore, although climatic conditions are unlikely to limit the potential range of this pest in the UK, the distribution of known host species would mean that only a very limited area could become affected. The caveat to this statement is the uncertainty about the susceptibility of *Pinus* species which are native or widely grown in the UK. Across Great Britain, Scots pine (*Pinus sylvestris*) accounts for 18% of the total conifer area (241, 000 ha), and other major pine species such as lodgepole (*P. contorta*) and Corsican pine (*P. nigra* subsp *laricio*) comprise about 12% (157,000 ha) (Forestry Commission 2013). If any of these species proved to be susceptible to the pest, the endangered area would be highly significant.

12. What is the pest's economic, environmental or social impact within its existing distribution?

In the Southern Hemisphere, symptoms of DFP develop throughout May to September (autumn to late spring) during the rainy season (Ahumada *et al*. 2013). Characteristic symptoms include resinous bands on green needles and exudation of resin at the base of needle bundles leading to needle death (Durán *et al.* 2008). On mature trees this can develop to reddening of the current year's needles during early winter. Dead and dying needles are retained, giving the trees a scorched appearance, and trees can be almost completely defoliated apart from new needle growth. Two or three consecutive years of defoliation can cause mortality, but trees usually recover unless re-infection occurs in the following season. Young trees are more commonly and severely damaged by DFP and symptoms include wilting, necrotic lesions in the cambium which can girdle the branches. Typically, 1 to 2 year-old plantation-grown trees die when infected, while 3 to 6 year-old trees suffer needle damage and defoliation but may survive disease episodes.

Quantification of the economic impact of DFP in Chile is not available, but at the peak of the disease in 2006 it was estimated that 54,000 ha of *P. radiata* were affected although by 2007 the affected area was limited to 2,000 ha. It has remained at this level through to 2011, with roughly 120,000 ha affected from 2004 to 2009 (Ahumada *et al.* 2013). In Chile, 1.5 million ha of *P. radiata* plantation have been established which represents around a third of the total area planted to this species worldwide, so it is of major economic importance to the economy of Chile (Guerrero and Bustamante 2007). On this basis the economic impacts (including the costs of management and treatment) in its existing distribution are assessed as large with medium environmental and social impacts.

Economic:	Very small		Small		Medium		Large	✓	Very large	
Environmental:	Very small		Small		Medium	✓	Large		Very large	
Social:	Very small		Small		Medium	✓	Large		Very large	

13. What is the pest's potential to cause economic, environmental or social impacts in the UK?

Pinus radiata is not a native species to the UK and its distribution is mainly limited to south west England and the west coast of Wales provenance trials (see http://www.bsbimaps.org.uk/atlas/map_page.php?spid=2414.0). Other *Pinus* species that have shown susceptibility in experimental tests (see Table 2) are also non-natives and when they occur in the UK grow mainly as ornamentals. Overall therefore, even if *P. pinifolia* became established in the UK, economic, environmental and social impacts are likely to be small or very small, providing *P. radiata* remains the only host. However, because of the uncertainty about the host range of the pest there is a high level of uncertainty around these assessments.

Economic:	Very small		Small	✓	Medium		Large		Very large	
Environmental:	Very small	✓	Small		Medium		Large		Very large	
Social:	Very small	✓	Small		Medium		Large		Very large	

14. What is the pest's potential as a vector of plant pathogens?

Phytophthora pinifolia is a plant pathogen with no capacity to act as a vector of other pathogens.

STAGE 3: PEST RISK MANAGEMENT

15. What are the risk management options for the UK?

(Consider exclusion, eradication, containment, and non-statutory controls; under protection and/or outdoors).

Action for keeping the pest out of the UK

The origins of the pest are unknown but a known pathway for entry into the UK would be *via* plants for planting from Chile. However, the EU (EC Plant Health Directive, Annex III: Anon. 2000) prohibits the import of plants of *Pinus* species, other than seeds, from non-European countries. In addition, movement via timber/wood pathways is very unlikely based on evidence drawn from a study by Ahumada *et al*. (2012). On this basis, action is in place to exclude the pest from the UK, although there is more uncertainty around the effectiveness of

these actions due to the lack of information about the host range of *P. pinifolia* which is currently assumed to be only conifer species and primarily within the genus *Pinus*.

Options for control if the pest became established
A number of measures are likely to have value:
Management of DFP in Chile has included adopted a range of approaches which are summarised by Ahumada *et al.* (2013). They include selection of *P. radiata* clones tolerant to DFP, selection of sites for planting of *P. radiata* with less conducive conditions for disease development and use of specific fungicides that show activity against *P. pinifolia.*

- Selection of genotypes of *P. radiata* tolerant to DFP is a long-term programme that is already yielding promising results. Initial selections were made by placing young clonal plants under the canopies of established trees with high levels of infection. The clones have been found to show a range of tolerance to DFP and the most tolerant clones are being propagated and planted in high risk areas.
- Systemic fungicides have been shown to have activity against *P. pinifolia*, and spraying with phenylamides, mefenoxam, chlorotalonil and mancozeb up to four times a year significantly reduced symptoms and plant mortality in young plantations. Phosphite based fungicides also gave similar levels of control. To minimise the impacts of DFP in the establishment of plantations, plants are treated in the nursery before planting out.
- Epidemiological modelling using climatic data (dew point and relative humidity) has confirmed a direct relationship between the number of favourable days for infection and the amount of damage observed, allowing the most favourable and least favourable areas for *P. pinifolia* to be identified. In the worst year for DFP in 2006, 141 favourable days for infection were identified retrospectively, with only 51-60 favourable days during 2007 to 2011 (Ahumada *et al.* 2013).

16. Summary and conclusion of rapid assessment.

This rapid assessment shows:

Risk for entry is: **Unlikely** in association with plants for planting (due to prohibitions that are currently in place), with low to very low risks associated with movement of soil and timber.

Risk of establishment is: **High** should *P. pinifolia* be introduced in the UK, particularly in western parts of the British Isles due to climatic compatibility.

Economic, environmental and social impacts are expected to be: **Very small** if only *Pinus radiata i*s affected by the pest. However, if other conifer species and particularly other *Pinus* spp such as *P. sylvestris* showed some level of susceptibility, then the impacts would be much higher.

Endangered area: **All of the UK**, but limited by the sparse distribution of the main known host *Pinus radiata* which is largely limited to south west England and the coastal regions of Wales and southern England.

Risk management:

The EC Plant Health Directive (Annex III: Anon. 2000) prohibits the import of *Pinus* species, other than seeds, from non-European countries so measures are already in place to exclude the pest from the UK. However, the effectiveness of these actions could be undermined if the host range of *P. pinifolia*, currently assumed to be limited to conifer species and primarily those within the genus *Pinus*, encompasses a much

wider range of plant families as is the case with other invasive *Phytophthora* species such as *P. cinnamomi* or *P. ramorum*. Should the pest arrive and establish in the UK there are measures available to minimise impacts (see 15) but most would require evaluation to measure their effectiveness in relation to the UK climate and potential environmental impacts.

17. Is there a need for a more detailed PRA?

Currently, there is insufficient data to support a more detailed PRA. Further work needed to improve the risk analysis is listed below in Table 3.

Yes ☐ No ☑

18. Given the information assembled within the timescale required, is statutory action considered appropriate/justified?

As the pest is currently not established in the UK statutory action can be considered justified.

Table 3: Major Uncertainties and Further Work

Section of PRA	**Further work needed to improve the PRA**
Hosts (host range)	Host range of *P. pinifolia*: • Testing both UK grown *Pinus* species and other conifer species for susceptibility. • Testing non-conifer species including ornamentals such as rhododendron.
Spread (factors affecting spread)	• Determining the rate of spread of the pathogen through epidemiological modelling and taking account of climatic factors. • Potential for persistence in soil and risk of spread in soil.
Impact	• Sporulation potential on UK grown hosts. • Pathogen is currently considered functionally sterile, so improved understanding of breeding system and potential for hybridisation with other Phytophthora species
Management	Control options for the pathogen in plantation and nursery situations.

REFERENCES

Ahumada R, Rotella A, Slippers B and Wingfield MJ. (2012). Potential of *Phytophthora pinifolia* to spread via sawn green lumber: a preliminary investigation. Southern Forests: Journal of Forest Science 74 (4),

Anon. (2000) (as amended). Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community. Official Journal of the European Communities 43, no. L 169, 1-112,

Ahumada R, Rotella A, Slippers B and Wingfield MJ (2013). Pathogenicity and sporulation of *Phytophthora pinifolia* on *Pinus radiata* in Chile. Australasian Plant Pathology 42 (4), 413-420. DOI: 10.1007/s13313-013-0212-4

Ahumada R, Rotella A, Poisson M, Durán A and Wingfield M J (2013). *Phytophthora pinifolia*: the cause of Dano Foliar del Pino on *Pinus radiata* in Chile. In: Phytophthora: a global perspective (ed K. Lamour), pp 159-165.

Brasier CM (2008). The biosecurity threat to the UK and the global environment from the international trade in plants. Plant Pathology 57, 792-808.

Cooke DEL, Drenth A, Duncan JM, Wagels G and Brasier CM. (2000). Molecular phylogeny of *Phytophthora* and related oomycetes. Fungal Genetics and Biology 30, 17-32.

Durán A, Gryzenhout M, Slippers B, Ahumada R, Rotella A, Flores F, Wingfield B D and Wingfield MJ (2008), *Phytophthora pinifolia* sp. nov. associated with a serious needle disease of *Pinus radiata* in Chile. Plant Pathology 57, 715–727.

Durán A, Slippers B, Gryzenhout M, Ahumada R, Drenth A, Wingfield BD and Wingfield MJ. (2009). DNA-based method for rapid identification of the pine pathogen, Phytophthora pinifolia. FEMS Microbiology Letters 298, 99–104.

Durán A, Gryzenhout M, Drenth A, Slippers B, Ahumada R, Wingfield BD and Wingfield MJ. (2010). AFLP analysis reveals a clonal population of Phytophthora pinifolia in Chile. Fungal Biology 114 (9), 746–752.

Forestry Commission (2013). Forestry Statistics 2013. Woodland areas and planting. http://www.forestry.gov.uk/website/forstats2013.nsf/LUContents/4140C187A4F725E6802573610030EFB8

Guerrero PC and Bustamante RO. (2007). Can native tree species regenerate in *Pinus radiata* plantations in Chile? Evidence from field and laboratory experiments. Forest Ecology and Management 253, 97-102.

Lavery PW and Mead DJ (2000). *Pinus radiata*: a narrow endemic from North America takes on the world. In: Ecology and Biogeography of Pinus (ed. DM Richardson), pp 432-450. Cambridge University Press.

LWEC (2013) Securing tree health in a changing environment updated background paper: Background Paper to inform a Research Workshop on Securing Tree Health in a Changing Environment held on 6 May 2011. http://www.forestry.gov.uk/pdf/backgroundpapertreehealth6may2011.pdf/$file/backgroundpapertreehealth6may2011.pdf

Slippers B, Stenlid J and Wingfield MJ (2005). Emerging pathogens: fungal hosts jumps following anthropogenic introduction. Trends in Ecology and Evolution 20, 420-421.

UC IPM (2014). Pests in gardens and landscapes – Pitch canker. http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74107.html Accessed 14th July 2014.

Date of production: 14th July 2014

Version no.: 1.2

Author: Joan Webber[1]

[1]Forest Research, Alice Holt Lodge, Farnham, Surrey, GU10 4LH, UK

Reviewers:

[2]Melanie Tuffen, [2]Richard Baker

[2]The Food and Environment Research Agency, Sand Hutton, York, YO41 1LZ, UK