

***Import Risk Analysis:***

***Wollemia nobilis* (Wollemi Pine) Araucariaceae  
Nursery Stock from Australia**

**Consultation**

**Review of Submissions**

**14 March 2008**



*This page is intentionally blank*

Ministry of Agriculture and Forestry  
Te Manatu Ahuwhenua, Ngaherehere  
Pastoral House  
25 The Terrace  
P O Box 2526  
Wellington  
New Zealand

Telephone: +64 4 894 0100  
Facsimile: +64 4 894 0733  
Internet: <http://www.maf.govt.nz>

MAF Biosecurity New Zealand

*Import risk analysis: Wollemia nobilis* (Wollemi Pine) Araucariaceae  
Nursery Stock from Australia

Consultation  
Review of Submissions

14 March 2008

Approved for general release

Christine Reed  
Manager, Risk Analysis Group  
MAF Biosecurity New Zealand

*This page is intentionally blank*

# TABLE OF CONTENTS

- 1. Executive Summary ..... 1
- 2. Introduction..... 2
- 3. Review of Submissions..... 4
  - 3.1 HortResearch Ltd ..... 4
  - 3.2 Biosecurity Australia (BA)..... 5
- Appendix 1: Submissions received ..... 20
  - App 1.1 HortResearch Ltd ..... 20
  - App 1.2 Biosecurity Australia..... 21



# 1. EXECUTIVE SUMMARY

The risk analysis examined the nature and possible effect on people, the New Zealand environment, and the New Zealand economy of any organisms that may be associated with *Wollemia nobilis* (Wollemi pine) nursery stock imported from Australia.

Wollemi pine is the world's newest known conifer, having been discovered in an isolated area in Australia only 10 years prior to this analysis. Information on associations with hazard organisms is limited by both the lack of research and the lack of opportunity for contamination. To ensure as far as possible that this risk analysis will be relevant into the future, available information on organisms associated with all members of the *Wollemia* family of plants (Araucariaceae) have been considered together with organisms known to associate with *Wollemia nobilis*.

The recommended management options contained in the risk analysis take account of existing industry practices and systems established in Australia and New Zealand to manage biosecurity risks associated with nursery stock material in international trade. Therefore while around 25 separate biosecurity measures are recommended for Wollemi pine nursery stock imported from Australia, the bulk of these can be easily incorporated into existing industry practices and should be seen as enhancements to the current biosecurity system.

The risk analysis was released for public consultation on 1 July 2007. Two submissions were received, with the most extensive comments coming from Biosecurity Australia. Copies of all submissions are included in Appendix 1 of this document.

Submissions focused primarily on the process of the development of the risk analysis and concerns related to the risks of soil and large plants. As a result of the issues raised in the submissions a number of organisms have been removed from the potential hazard list.

## 2. INTRODUCTION

Risk analyses are conducted in accordance with MAF's policy on *Conducting Import Risk Analyses and Applying them in the Development of IHSs*, and Biosecurity New Zealand's risk analysis procedures. These documents can be found on the MAF website at <http://www.biosecurity.govt.nz/pests-diseases/risk-policy.htm> and <http://www.biosecurity.govt.nz/files/pests-diseases/surveillance-review/risk-analysis-procedures.pdf> respectively.

Risk analyses are carried out by MAF / Biosecurity New Zealand under section 22 of the Biosecurity Act 1993, which lays out the requirements in regard to issuing Import Health Standards (IHSs) to manage effectively the risks associated with the importation of risk goods.

Preliminary risk analyses are written by the Risk Analysis Group and submitted to internal and external technical review before a draft risk analysis document is released for public consultation. The Risk Analysis Group of MAF Biosecurity New Zealand then reviews the submissions made by interested parties and produces a review of submissions document. The final risk analysis and the review of submissions together inform the development of any resulting IHS by MAF Biosecurity New Zealand for issuing under section 22 of the Biosecurity Act by the Director General of MAF on the recommendation of the relevant Chief Technical Officer (CTO).

Section 22(5) of the Biosecurity Act 1993 requires CTOs to have regard to the likelihood that organisms might be in the goods and the effects that these organisms are likely to have in New Zealand. Another requirement under section 22 is New Zealand's international obligations and of particular significance in this regard is the *Agreement on Sanitary & Phytosanitary Measures* (the "SPS Agreement") of the World Trade Organisation. MAF's Policy Statement on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures is available on the MAF website: <http://www.biosecurity.govt.nz/sps/resources/policies/raspol.htm>

A key obligation under the SPS agreement is that sanitary and phytosanitary measures must be based on scientific principles and maintained only while there is sufficient scientific evidence for their application. In practice, this means that unless MAF is using internationally agreed standards, all sanitary measures should be justified by a scientific analysis of the risks posed by the imported commodity. Therefore, risk analyses are by nature scientific documents, and they conform to an internationally recognised process that has been developed to ensure scientific objectivity and consistency.

MAF Biosecurity New Zealand released the document *Draft Import Risk Analysis: Wollemia nobilis (Wollemi Pine) Araucariaceae Nursery Stock from Australia* for public consultation on 1 July 2007. Every step was taken on the transparency of the risk analysis to ensure that it provided a reasoned and logical discussion, supported by references to scientific literature. The closing date for public submissions on the risk analysis was 31 August 2007.

Two submissions were received. Table 1 lists the submitters and the organisations represented.

This document is MAF Biosecurity New Zealand’s review of the submissions that were made by interested parties following the release of the draft risk analysis for public consultation. Public consultation on risk analyses is primarily on matters of scientific fact that affect the assessment of risk or the likely efficacy of the recommended measures. For this reason, the review of submissions will answer issues of science surrounding likelihood<sup>1</sup>, not possibility<sup>2</sup>, of events occurring. Speculative comments and economic factors other than the effects directly related to a potential hazard are beyond the scope of the risk analysis and these will not be addressed in this review of submissions.

**Table 1. Submitters and organisations represented**

| <b>Date</b> | <b>Submitter</b> | <b>Organisation Represented/Location</b>          |
|-------------|------------------|---|
| 29/08/07    | Louise van Meurs | Australian Government: Biosecurity Australia (BA) |
| 14/09/07    | Paul Austin      | HortResearch Ltd (New Zealand)                    |

<sup>1</sup> Likelihood: The quality or fact of being likely or probable; probability; an instance of this.

<sup>2</sup> Possible: Logically conceivable; that which, whether or not it actually exists, is not excluded from existence by being logically contradictory or against reason.

## 3. REVIEW OF SUBMISSIONS

### 3.1 HORTRESEARCH LTD

The submission from HortResearch Ltd is included in Appendix 1. The discussion below summarises the main points raised and gives MAF's responses to them.

**3.1.1 The submitter from HortResearch Ltd noted that surprise has been expressed by pathology staff, in relation to the “whole plant” import pathway anticipated by the risk assessment. Their main concern centres around the importing of relatively large trees with soil on them. It strikes them that this is “not a good idea. For instance, the view of one of our pathologists, with experience working with soil pathogens, is that it would take a lot more than inspection of roots to determine if pathogens were present on the roots, or in the soil, even for as little 1 kg of soil.**

**The view is that importing of soil with these trees will almost guarantee bringing in unwanted fungal and bacterial organisms. Symptoms would not necessarily be obvious in potted trees, yet numerous organisms could be harboured in the soil or feeder roots. *Phytophthora* is an obvious candidate for concern - *P. cinnamomi* is a known pathogen of Wollemi pine. Although we already have *P. cinnamomi* in NZ, we possibly have only one strain, and almost certainly only one mating type. Import of another strain or mating type could be devastating to our native forests and to some horticultural industries. There are also numerous other *Phytophthora* species which may not necessarily show symptoms on Wollemi pine, yet could be harboured in roots or soil. Detection of these would be very difficult.**

**Many other pathogenic soil organisms could also be unwittingly imported in soil or roots, introducing new strains or even new species. Detection of many soil fungi is difficult, and eradication from soil is almost impossible without fumigation (which would also kill the tree). Fungicide treatment of soil is not particularly helpful.**

**The essence of the comments is simply that “it’s not a good idea to import trees with roots and soil, when there are practical and much safer alternatives”. We understand the obvious alternatives to importing whole trees (e.g. cuttings or tissue culture, or even seed) are all available for this species, and would all carry substantially lower risks of importing unwanted organisms.**

***MAF response:*** Soil is a prohibited import unless sterilised. The risk analysis does not recommend the import of trees with soil. The risk analysis also recommends that plants with stem diameters larger than 12 centimetres are not imported, and that plants with stem diameters larger than 5 centimetres have further restrictions added.

The risk analysis also examines the question of root contamination by plant pathogens, and recommends two separate root inspections to manage these potential biosecurity

risks. The second root inspection is recommended after a season in a quarantine facility in New Zealand under conditions that are likely to encourage the expression of disease symptoms from any root infections.

The risk analysis supports your opinion that importing tissue-cultured material carries a substantially lower biosecurity risk to New Zealand than does importing whole plants.

**3.1.2 The submitters from HortResearch Ltd are also concerned that this particular risk assessment should not be seen as establishing a precedent for importing large whole plants of other species.**

*MAF response:* Decisions concerning the import of other plant species will be made on a case-by-case basis, and will reflect the biosecurity risks posed by these other species.

## **3.2 BIOSECURITY AUSTRALIA (BA)**

The Biosecurity Australia submission is included in Appendix 2. MAF appreciates the efforts taken by Biosecurity Australia to review this risk analysis and wishes to take this opportunity to thank them for their generous time and expertise. The discussion below summarises the main points raised and gives MAF's responses to them.

Biosecurity Australia's comments on draft import risk analysis for Wollemi pine of 22 June 2007 are based on the risk analysis processes as set out in the International Standards for Phytosanitary Measures (ISPMs), particularly ISPM No. 2 – *Guidelines for Pest Risk Analysis* and ISPM No. 11 – *Pest Risk Analysis for Quarantine Pests including Analysis of Environmental Risk Analysis Pests and Living Modified Organisms*.

**3.2.1 Due to considerable variation in susceptibility to pests found among plant genera within a family and sometimes within species of a genus, it is not appropriate to consider pests (pathogens and arthropod pests) of all plant species within a family when assessing quarantine risks associated with a particular plant species (e.g. *Wollemia nobilis*). Indeed, pathogens of native plants tend to be host specific, and they may have co-evolved with their host (McKenzie, 1998). The same appears to be true with the rust fungi, and usually spread to hosts within the same genus as the native host (McKenzie, 1998). For example, *Aecidium fragiforme* occurs on *Agathis palmerstonii* in Queensland, *Agathis alba*, *Agathis dammara* and *Agathis* spp. in Malaysia and Indonesia, *Agathis labillardieri* in New Guinea, and *Agathis vitiensis* in Fiji (Ridley *et al.*, 2000).**

*MAF response:* Taxonomic relationships between pests and hosts are often difficult to define given that the taxonomic concepts themselves are artificial and may change over time. Pest species defined by host preferences are often redefined under genetic analysis into a number of species or grouped with other closely related species on different hosts.

*Wollemia nobilis* represents a particular challenge from a plant pathological perspective as there is very little known about this species or genus. Assuming that only the pests currently recorded on *Wollemia nobilis* represent all of the pests that are likely to be associated with this species as its distribution increases, would be negligent in terms of the management of biosecurity risks to New Zealand. Indeed it would be a possible consequence of a limited analysis may be that the import of *Wollemia nobilis* germplasm into New Zealand could be interrupted if new pests were detected during trade and the pathway closed for re-assessment. It is MAF Biosecurity New Zealand's standard practice to monitor pathways such as these by identifying organisms intercepted on the imported plants and reviewing new pest records as they become available in the literature.

The problem then becomes one of determining what types of risks should be considered and how. MAF considered that there was no justification for assuming that *Wollemia nobilis* could reasonably be associated with all types of plant pests. The approach taken in this risk analysis therefore was considered the most appropriate one available. By limiting the assessment of risks to pests recorded on *Wollemia nobilis* to date and the types of pests known to be associated with the Araucariaceae family in Australia, MAF has attempted to ensure that trade will not be interrupted and unnecessary measures would be avoided. In effect MAF has decided that a risk analysis of the plant family Araucariaceae should be used as the basis for developing phytosanitary measures for *Wollemia nobilis*, which we believe is entirely consistent with the principles of IPPC including ISPM No. 11, and the WTO SPS Agreement.

**3.2.2 In this import risk analysis MAF has considered available information on pathogens and arthropod pests associated with all species within Araucariaceae family in Australia and New Zealand. This is a major concern for Australia. According to ISPM 11, the categorisation of a pest as a quarantine pest must include assessment of the pathway association. The pest cannot be considered as a quarantine pest, requiring mitigating measures, if it is not associated with the pathway (Wollemi pine). Indeed, quarantine pests determined through the process of pest categorisation should meet the following IPPC criteria for a quarantine pest:**

- the pest is absent, or has limited distribution and is being officially controlled in the pest risk analysis (PRA) area; and
- the pest is of potential economic importance to the PRA area.

**Pest categorisation (resulting in a list of quarantine pests based on the IPPC definition); and risk assessment (resulting in a list of quarantine pests where the risk has been estimated to be unacceptable) are important measures in the ISPM 11.**

**MAF response:** The import risk analysis for *Wollemia nobilis* from Australia has not categorised any pests into quarantine or non-quarantine status. New Zealand's risk analysis procedures differ slightly from ISPM No. 11 in that the categorisation stage considers whether a pest could potentially be a hazard. The final decision on the quarantine status of a pest on a particular pathway and commodity is made on the issuance of any resulting import health standards. We consider this difference in process between the domestic and international standards is not substantive.

**3.2.3 It is stated in Chapter 2, section 2.2.2 of the Biosecurity New Zealand process and methodology for undertaking import risk analysis that “when considering whether an identified organism or disease should be included in the hazard list for a particular risk analysis, the following questions should be considered: 1) is the organism associated with the commodity or conveyance; 2) is the organism or disease absent from New Zealand but likely to be present in the exporting country .....”. It should be noted that the commodity or conveyance in this case is *Wollemia nobilis* (Wollemi pine) nursery stock and only pests associated with the commodity should be considered for the pest risk assessment.**

*MAF response:* As discussed in 3.2.1 above, MAF considered that using pests recorded on Araucariaceae in Australia to indicate the types of pests that may potentially be found on *Wollemia nobilis* in future years, MAF has attempted to ensure that trade will not be interrupted and unnecessary measures will be avoided.

**3.2.4 Section 2.2.4 of the report states “since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required level of protection .....” What is the New Zealand’s required level of protection? This was not provided or discussed in the PRA document.**

*MAF response:* For a general discussion on New Zealand’s approach to risk management and level of concern regarding biosecurity, please refer to the following publications:

- Tiakina Aotearoa Protect New Zealand (2003), which is available at <http://www.biosecurity.govt.nz/files/bio-strategy/biostrategy.pdf>
- Balance in Trade (2003), <http://www.biosecurity.govt.nz/sps/resources/new-zealand/balance-in-trade.pdf>

**3.2.5 Table 3.4 (page 25) of the PRA document provides information of hazard groups used for the pest risk assessment of *Wollemia nobilis*. However, none of the significant examples of pests cited is known to be associated with the pathway (see Appendix 1).**

*MAF response:* This issue has been discussed in 3.2.1 and 3.2.3 above.

**3.2.6 It is noted with surprise that organisms such as mycorrhizal fungi which are fundamentally beneficial fungi were included in the hazard grouping. Such fungi live in and around the roots of 95% of the earth's plant species, serving as a secondary root system, extracting mineral elements and water from soil for their host plant, and live off the plant's sugars. BA does not believe that mycorrhizal fungi meet the definition of a pest that is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (ISPM, 2006).**

*MAF response:* Firstly please note that the import risk analysis has not categorised or otherwise labelled mycorrhizal fungi as pests, but only as a potential hazard. The justification for considering mycorrhizal fungi as a potential hazard is clearly explained in the text of the analysis and will not be repeated here.

When MAF considers the biosecurity risks to New Zealand of organisms associated with imported goods, MAF is required under domestic legislation (Biosecurity Act 1997) to consider risks to not only the economy but also the environment and human health. While mycorrhizal fungi were considered a potential biosecurity hazard, much of the risk was attributed to uncertainty. It was decided that no specific measures would be required for mycorrhizal fungi on *Wollemia nobilis* nursery stock from Australia.

- 3.2.7 The risk assessment of Wollemi pine imports to New Zealand was based on representative arthropod pest and fungi species; however, no member of these representative species selected for the generic assessment has been recorded as associated with the commodity in question, namely *Wollemia nobilis* nursery stock. The outcome of the risk assessment therefore does not reflect the actual risks posed by Wollemi pine imports to New Zealand. Furthermore, the question of whether or not pests (eg. surface feeding insects, wood boring insects, etc.) are pests of *Wollemia nobilis* should be resolved. To the best of our knowledge, there is no available scientific information showing that these pests are associated with the pathway in question. Biosecurity Australia does not believe that these pests are likely to be associated with the pathway.**

*MAF response:* This issue has been discussed in 3.2.1 and 3.2.3 above. While it could be said that the majority of these particular pests may not be associated with *Wollemia nobilis* nursery stock exported from Australia, the intention of the risk analysis was to assume that these types of pests could be. This should not be considered an unreasonable assumption, as other members of this family are susceptible to these types of pests and diseases.

- 3.2.8 It is clear from the available scientific literature that some of the pests listed in the PRA document as likely to be associated with *W. nobilis* are host specific and only attack species of a particular genus. Examples are: 1) *Conifericoccus agathids* feeds on young succulent leaves and stems of *Agathis* spp in Australia (Ridley *et. al.*, 2000); 2) *Oxythrips agathidsis* defoliator of *Agathis* spp. in Queensland; 3) Seed-eating moth *Agathiphaga* also found on *Agathis* spp. in Queensland (Earle, 2006).**

*MAF response:* This issue has been discussed in 3.2.1, 3.2.3 and 3.2.7 above.

- 3.2.9 The IRA report acknowledges that none of the insects and pathogens listed in the PRA has been found associated with the pathway. It is therefore surprising to note that NZMAF has based its management measures on pests, which are not in the pathway. Representative pests should be pests that are known to be associated with the commodity.**

*MAF response:* This issue has been discussed in 3.2.1, 3.2.3 and 3.2.7 above.

- 3.2.10 Management measures have been proposed for group of pests, such as, surface feeding invertebrates, wood boring insects and foliage diseases. It is not clear from the PRA which specific quarantine pests are of concern to New Zealand and are to be managed by these mitigation measures.**

*MAF response:* This issue has been discussed in 3.2.1, 3.2.3 and 3.2.7 above.

**3.2.11 It should be noted that the taxonomic level for organisms considered in PRA is usually the species. The use of a higher or lower taxonomic level should be supported by a scientifically sound rationale (ISPM, 2007). Additional epidemiological information is therefore required on *Acromyrmex* sp., *Alternaria* sp., *Armillaria* sp. and *Pythium* sp. given in the report as pests associated with Araucariaceae.**

*MAF response:* The only records available for the association of *Acromyrmex* sp., *Alternaria* sp., *Armillaria* sp. and *Pythium* sp. with members of the Araucariaceae do not provide any information on the species that was found or the specific epidemiology of the recorded association.

**3.2.12 The PRA report provided *Alternaria* sp., *Pythium* sp. and *Athelia rolfsii* as examples of diseases that are associated with plants in Araucariaceae, known to be present in Australia and not present in New Zealand. A search of the literature showed that *Alternaria* sp., *Pythium* sp. and *A. rolfsii* are present in New Zealand (Pennycook, 1989; Flux *et al.*, 1993; McKenzie and Dingley, 1996). Also the report cited Farr *et al* (1989) as a reference for the association of *A. rolfsii* with the host. However, Farr *et al* do not list *Wollemia nobilis* or Araucariaceae as a host of *A. rolfsii*.**

*MAF response:* It was not our intention to state that these genera (*Alternaria* sp. and *Pythium* sp.) are absent from New Zealand, but rather that species of these genera are absent from New Zealand. The risk analysis will have the appropriate wording included to make this more explicit. Please also note that Farr *et al.* (1989) lists *Sclerotinia rolfsii* as being recorded on *Araucaria heterophylla*. *Sclerotinia rolfsii* is a synonym for *Athelia rolfsii*. The risk analysis also recognises that *Athelia rolfsii* has been recorded in New Zealand.

**3.2.13 The following arthropod pests are reported to be present in New Zealand and should not be considered in the IRA with the purpose of establishing generic mitigation measures for quarantine pests identified in the IRA: 1) *Coptodryas eucalyptica*, 2) *Pachycotes* sp and 3) *Xylosandrus pseudosolidus* (see Attachment 1).**

*MAF response:* With regards to *Pachycotes* sp., as in 3.2.12 above it was not our intention to state that these genus was absent from New Zealand, but rather that species of these genus are absent from New Zealand. The risk analysis will have the appropriate wording included to make this more explicit.

MAF has now reviewed the status of *Coptodryas eucalyptica* and *Xylosandrus pseudosolidus* in New Zealand and agrees that *Coptodryas eucalyptica* is now established albeit with a limited distribution. As there is no official control programme for *Coptodryas eucalyptica* this pest will be removed from the hazard list in Appendix 1 of the risk analysis. While there is a single record of *Xylosandrus pseudosolidus* from New Zealand, the authors considered that there is no evidence of a breeding population in New Zealand. As such *Xylosandrus pseudosolidus* will not be considered present in New Zealand and will remain on the hazard list.

**3.2.14** As stated in the IRA report “unlike fungal pathogens, mycorrhizal fungi form symbiotic relationships with their hosts, gaining food and nutrients from the plant in return for specific nutrients from the fungi”. There is no information provided in the report to show the identity and the injury caused to plants or plant products by the mycorrhizal fungi associated with *Wollemia nobilis* from Australia. According to ISPM 2 (Framework for pest risk assessment, 2007), “the taxonomic identity of the organism should be specified because any biological and other information used should be relevant to the organism in question. If the organism has not yet been fully named or described, then, to be a pest, it should at least have been shown to be identifiable, consistently to produce injury to plants or plant products (eg. symptoms, reduced growth rate, yield loss or any other damage) and to be transmissible or able to disperse”. This information is missing in the IRA document.

*MAF response:* This issue has been covered in 3.2.1 and 3.2.6 above.

**3.2.15** No categorised pest list for *Wollemia nobilis* was provided. According to ISPM 2 (2007), for pathway-initiated analysis, categorised pest list should be sufficiently documented. The hazard list provided in Appendix 1 of the IRA document can not be considered as a pathway associated pest list, as none of the pests were found to be associated with the commodity under question.

*MAF response:* This issue has been covered in 3.2.2 above.

**3.2.16** Although the identity of the specific *Botryosphaeria* spp. considered in the PRA are not provided, it is acceptable to use the biological and epidemiological characteristics of the well researched *B. ribis* to describe the possible biological nature of the risks posed by the two *Botryosphaeria* spp. isolated from *W. nobilis* from Australia. One of the *Botryosphaeria* isolates from *W. nobilis* was found to be closely related to *B. ribis*, but with some unique similarities with *B. parva*. Both *B. ribis* and *B. parva* are known to occur in Australia and New Zealand (Slippers *et al*, 2005). The other *Botryosphaeria* isolate from *W. nobilis* grouped with *B. australis*, but also varied slightly from this taxon in the gene regions analysed. *B. australis* occurs in Australia (Slippers *et al*, 2005). It is also noted that a recent study has revealed that a species of *Botryosphaeria* is highly pathogenic to *W. nobilis* (Slippers *et al*, 2005). *Botryosphaeria* spp. have a wide host range and could potentially be transmitted in *W. nobilis* nursery stock pathway and appropriate mitigation measures are warranted to control entry of this species into New Zealand.

*MAF response:* Thank you.

**3.2.17** The assumption put forward in the IRA report that the strains or isolates of *Phytophthora cinnamomi* from Australia would represent greater level of risk to New Zealand than the strains or isolates from New Zealand is not supported by scientifically sound rationale. It should be noted that the taxonomic level for organisms considered in PRA is usually the species, and the use of a higher or lower taxonomic level should be supported by a scientifically sound rationale (ISPM 2, 2007). In cases where levels below the species level are being analysed, the

rationale for this distinction should include evidence of reported significant variation in factors such as virulence, pesticide resistance, environmental adaptability and host range (ISPM 2, 2007). None of these rationales is provided in the IRA document.

*MAF response:* The IRA document provides a detailed discussion on the evidence supporting the differences in virulence levels between strains of *Phytophthora cinnamomi* found in Australia.

As stated in the risk analysis however, there is a significant degree of uncertainty related to the strains of *Phytophthora cinnamomi* in New Zealand and the role of the environment on the expression of virulence. The risk analysis recommends that research be undertaken in New Zealand and Australia to clarify these issues.

**3.2.18** Currently, *P. cinnamomi* is widely distributed in New Zealand and there is no comprehensive information on the isozyme genotypes/strains present in New Zealand. The reported level of severity of disease caused by the pathogen in Australia may be due to environmental factors, such as higher soil temperatures, which are conducive for growth and disease expression. Optimal growth temperatures are in the range of 20-32.5°C, maximum 30-36°C (OEPP/EPPO, 2004). The pathogen does not survive well or spread under conditions of low soil moisture (Weste, 1983). Also, Australia, particularly Queensland is not likely to generate cold-tolerant strains of the pathogen. In Kauri forests in the far north island of New Zealand, soil temperatures and moisture content were considered important factors in affecting seedling mortality by *P. cinnamomi* (Johnston *et al.*, 2004). *P. cinnamomi* populations in Australia consist of three isozyme genotypes with low genetic variation, one A1 type and two A2 types (Old *et al.*, 1988). These genotypes represent three clonal lineages of *P. cinnamomi*. There is no indication of the sexual interactions for *P. cinnamomi* in Australia (Old *et al.*, 1888; Dobrowolski *et al.*, 2003). No sexual recombinant genotypes have been recovered suggesting that the two mating types are incompatible due to differences in their ploidy or karyotype (Dobrowolski, 1999).

*MAF response:* The information provided above has been discussed in the risk analysis. As mentioned in 3.2.17, the risk analysis acknowledges that there is a significant degree of uncertainty related to the strains of *Phytophthora cinnamomi* in New Zealand and the role of the environment on the expression of virulence. The risk analysis recommends that research be undertaken in New Zealand and Australia to clarify these issues. It should also be noted that the risk analysis does not recommend any significant measures for *Phytophthora cinnamomi* but rather expects that action should be taken only if this organism is found on any imported nursery stock.

**3.2.19 Management Options:** As indicated above Biosecurity Australia has concerns regarding the methodology used in the assessment of pests likely to be associated with Wollemi pines, however, BA acknowledges that there are possible quarantine risks likely to be associated with the Wollemi pine nursery stock from Australia. The measures proposed by New Zealand to mitigate these risks include: 1) Pre-export nursery management; 2) Pre-export and shipment inspection; and 3) Post entry quarantine and inspection in New Zealand. It is noted that Wollemi pine plants *in vitro* imported into New Zealand from

**Australia will not require phytosanitary measures. Wollemi pine industry in Australia welcomes this recommendation and hopes to produce plants *in vitro* for future export to New Zealand and other countries. Biosecurity Australia believes that the proposed management options including post entry quarantine protocols and rationale for the proposed changes are appropriate and sufficient to ensure Wollemi pine nursery stock introduction into New Zealand is free from pests of quarantine significance.**

*MAF response:* Thank you.

### 3.2.20 Appendix–1: Biosecurity Australia’s comments on pests identified by MAF being associated with Araucariaceae in Australia

| Scientific name of the pests   | Status in                            |   | Remarks  |
|--|--------------------------------------|---|--|
|  | Australia                            | New Zealand                                 |  |
| <b>ARTHROPODS</b>  |                                      |   |  |
| <b>Coleoptera (beetles, weevils)</b>                                 |                                      |   |  |
| <i>Aesiotes notabilis</i> Pascoe [Coleoptera: Curculionidae]         | Present (Mecke <i>et al.</i> 2005)   |   | This wood-boring species has been recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005). Mainly associated with standing <i>Araucaria</i> spp., <i>Agathis</i> spp. and <i>Pinus</i> spp. and larvae feed on the phloem (Schneider, 1999). This species take advantage of the host’s decreased natural resistance caused by injury, diseases, fire and other stress factors (Schneider, 1999). |
| <i>Aragomacer leai</i> Kuschel [Coleoptera: Nemonychidae]            | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005).  |
| <i>Aragomacer uniformis</i> Kuschel [Coleoptera: Nemonychidae]       | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005).  |
| <i>Basiliogeus prasinus</i> Kuschel [Coleoptera: Nemonychidae]       | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria bidwillii</i> in Australia (Mecke <i>et al.</i> 2005).  |
| <i>Basiliogeus striatopunctatus</i> (Lea) [Coleoptera: Nemonychidae] | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).   |
| <i>Bunyaeus eutactae</i> Kuschel [Coleoptera: Nemonychidae]          | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005)..   |
| <i>Bunyaeus monteithi</i> Kuschel [Coleoptera: Nemonychidae]         | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria bidwillii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005).   |
| <i>Coptocorynus araucaridae</i> Marshall [Coleoptera: Curculionidae] | Present (Mecke <i>et al.</i> 2005)   |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).   |
| <i>Coptocorynus</i> sp [Coleoptera: Curculionidae]                   |                                      |   | Schneider (1999) reference is on insects of PNG not Australia. Reported as a wood-boring weevil of hoop pine (Schneider, 1999).  |
| <i>Coptodryas eucalyptica</i> (Schedl) [Coleoptera: Curculionidae]   | Present (Mecke <i>et al.</i> 2005)   | Present (Brockerhoff <i>et al.</i> , 2003). | <b>This species is present in NZ.</b>  |
| <i>Dihammus australis</i> (Boisduval) [Coleoptera: Cerambycidae]     | Present (APPD, 2007)                 |   | Recorded on <i>Araucaria</i> species (Schneider, 1999)   |
| <i>Dihammus tincturatus</i> Pascoe [Coleoptera: Cerambycidae]        | <b>ABSENT</b>                        |   | <b>Not present in Australia.</b> Schneider (1999) and Hawkeswood (1990) refer to species in PNG.   |
| <i>Diotimana undulata</i> Pascoe [Coleoptera: Cerambycidae]          | Present (APPD, 2007)                 |   | Recorded on <i>Araucaria</i> species (Schneider, 1999)   |
| <i>Dysthaeta anomala</i> Pascoe [Coleoptera: Cerambycidae]           | Present (Mecke <i>et al.</i> , 2005) |   | Recorded on <i>Araucaria</i> spp. and <i>Agathis</i> spp. in Australia (Mecke <i>et al.</i> , 2005; APPD, 2007)).  |
| <i>Euplatypus parallelus</i> Fabricius [Coleoptera: Curculionidae]   | Present (Mecke <i>et al.</i> , 2005) |   | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).  |
| <i>Eurhamphus fasciculatus</i> Shuckard [Coleoptera: Curculionidae]  | Present (Mecke <i>et al.</i> , 2005) |   | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i>   |

|  |                                      |                                    |   |
|--|--------------------------------------|------------------------------------|---|
| <i>Eutactobius puellus</i> Kuschel [Coleoptera: Nemonychidae]              | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i>  |
| <i>Euthyrhinus meditabundus</i> (Fabricius) [Coleoptera: Curculionidae]    | Present (Hawkeswood, 1991)           |                                    | This species has been recorded from 29 species from 18 plant families but attack is usually restricted to dead or dying material (Hawkeswood, 1991).                                      |
| <i>Euwallacea barbatus</i> (Hagedorn) [Coleoptera: Curculionidae]          | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).  |
| <i>Euwallacea destruens</i> (Blandford) [Coleoptera: Curculionidae]        | Present (Wood & Bright 1992)         |                                    | Recorded on <i>Agathis</i> species and <i>Araucaria cunninghamii</i> (CABI, 2007).  |
| <i>Hyleops glabratus</i> Schedl [Coleoptera: Curculionidae]                | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005; APPD, 2007).  |
| <i>Hyludrectonus corticinus</i> Wood [Coleoptera: Curculionidae]           | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria bidwillii</i> , <i>Araucaria cunninghamii</i> , <i>Araucaria heterophylla</i> and <i>Araucaria hunsteinii</i> in Australia and PNG (Mecke <i>et al.</i> , 2005). |
| <i>Hyludrectonus pinarius</i> Schedl [Coleoptera: Curculionidae]           | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria bidwillii</i> and <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Hyludrectonus</i> sp [Coleoptera: Curculionidae]                        |                                      |                                    | <b>Reference cited (Sequeira &amp; Farrell, 2001) does not show that this species is present in Australia.</b>  |
| <i>Ilacuris laticollis</i> Pascoe [Coleoptera: Curculionidae]              | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> and <i>Araucaria hunsteinii</i> from Australia and PNG (Mecke <i>et al.</i> 2005).  |
| <i>Mallus costatus</i> Marshall [Coleoptera: Curculionidae]                | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).  |
| <i>Mitrastethus australiae</i> Lea [Coleoptera: Curculionidae]             | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> and <i>Araucaria hunsteinii</i> in Australia and PNG (Mecke <i>et al.</i> , 2005).  |
| <i>Notamacer eximius</i> Kuschel [Coleoptera: Nemonychidae]                | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Notamacer reginae</i> Kuschel [Coleoptera: Nemonychidae]                | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Notamacer zimmermani</i> Kuschel [Coleoptera: Nemonychidae]             | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Orthorhinus cylindrirostris</i> (Fabricius) [Coleoptera: Curculionidae] | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Pachycotes minor</i> Wood [Coleoptera: Curculionidae]                   | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Pachycotes</i> sp [Coleoptera: Curculionidae]                           | Present (Sequeira & Farrell, 2001)   | Present (Sequeira & Farrell, 2001) | <b>This species is present in NZ.</b>   |
| <i>Palophagus australiensis</i> Kuschel [Coleoptera: Megalopodidae]        | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Palophagus bunyae</i> Kuschel [Coleoptera; Megalopodidae]               | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria bidwillii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Platypus froggatti</i> Sampson [Coleoptera: Curculionidae]              | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |

|  |                                       |  |   |
|--|---------------------------------------|--|---|
| <i>Platypus omnivorus</i> (Lea) [Coleoptera: Curculionidae]                      | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005; APPD, 2007).  |
| <i>Platypus queenslandi</i> Schedl [Coleoptera: Curculionidae]                   | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Platypus semigranosus</i> Sampson [Coleoptera: Curculionidae]                 | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).   |
| <i>Platypus subgranosus</i> Schedl [Coleoptera: Curculionidae]                   | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).   |
| <i>Prosppheres aurantiopictus</i> Laporte & Gory, 1838 [Coleoptera: Buprestidae] | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).   |
| <i>Strongylurus decoratus</i> [Coleoptera: Cerambycidae]                         | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005; APPD, 2007).  |
| <i>Strongylurus</i> sp [Coleoptera: Cerambycidae]                                | Present (Schneider, 1999)             |  | Recorded on <i>Araucaria cunninghamii</i> in Australia. A peculiar pest of Northern QLD that develops in branches of Hoop pines (Schneider, 1999).                        |
| <i>Treptoplatypus australis</i> Chapuis [Coleoptera: Curculionidae]              | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Tyrtaeosus microthorax</i> Pascoe [Coleoptera: Curculionidae]                 | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Xenocnema</i> sp [Coleoptera: Curculionidae]                                  | Present (Sequeira & Farrell, 2001)    |  | Recorded on <i>Araucaria</i> spp. and <i>Agathis</i> spp. (Sequeira & Farrell, 2001; Mecke <i>et al.</i> , 2005).   |
| <i>Xyleborus affinis</i> Eichhoff [Coleoptera: Curculionidae]                    | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria angustifolia</i> and <i>Araucaria cunninghamii</i> and (Mecke <i>et al.</i> 2005).   |
| <i>Xyleborus emarginatus</i> Eichhoff [Coleoptera: Curculionidae]                | Present (Wood & Bright, 1992)         |  | Recorded on Araucariaceae it has been recorded on <i>Agathis</i> species (CABI, 2007).  |
| <i>Xyleborus perforans</i> Wollaston [Coleoptera: Curculionidae]                 | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Agathis macrophylla</i> , <i>Araucaria cunninghamii</i> and <i>Araucaria hunsteinii</i> (Mecke <i>et al.</i> , 2005).                                      |
| <i>Xyleborus similis</i> Ferrari [Coleoptera: Curculionidae]                     | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> and <i>Agathis</i> spp. (Mecke <i>et al.</i> 2005; CABI, 2007)).  |
| <i>Xylosandrus pseudosolidus</i> Schedl [Coleoptera: Curculionidae]              | Present (Mecke <i>et al.</i> , 2005)  | Present (Brockhoff <i>et al.</i> , 2003) | <b>This species is present in NZ</b> therefore, does not meet the definition of a quarantine pest unless it is under 'official control'                                   |
| <b>Hemiptera (aphids, leafhoppers, scales, whiteflies)</b>                       |                                       |  |   |
| <i>Amblypelta cocophaga</i> China [Hemiptera: Coreidae]                          | <b>Absent</b>                         |  | <b>Not present in Australia. It is on North Australia's Quarantine Strategy target list of plant pests. Not listed in Schnieder (1999) as referenced in the document.</b> |
| <i>Chrysomphalus dictyospermi</i> (Morgan) [Hemiptera: Diaspididae]              | Present (CSIRO, 2007)                 |  | Reported on <i>Araucaria angustifolia</i> (CABI, 2007).   |
| <i>Conifericoccus agathidis</i> Brimblecombe [Hemiptera: Margarodidae]           | Present (Ridley <i>et al.</i> , 2000) |  | Reported on <i>Agathis</i> spp. in Australia; feeds on young succulent leaves and stems of <i>Agathis</i> spp. (Ridley <i>et al.</i> 2000).                               |
| <i>Illinoia morrisoni</i> (Swain) [Hemiptera: Aphididae]                         | <b>Absent</b>                         |  | <b>Not present in Australia. Not listed in Schnieder (1999) as stated by the author.</b>  |
| <i>Neophyllaphis araucariae</i> Takahashi [Hemiptera: Aphididae]                 | Present (Hales & Lardner, 1988)       |  | This species is recorded from <i>Araucaria</i> spp. (Hales & Lardner, 1988).  |

|  |   |   |   |
|--|---|---|---|
| <i>Nipaecoccus</i> sp (Hemiptera: Pseudococcidae]                          | Present (APPD, 2007)                                |   | This species is reported to have been recorded from <i>Araucaria</i> spp. (Ridley <i>et al.</i> , 2000). Reference cited does not show that this species is present in Australia (Ridley <i>et al.</i> , 2000). |
| <b>Hymenoptera (ants)</b>  |   |   |   |
| <i>Acromyrmex</i> sp [Hymenoptera: Formicidae]                             | <b>Absent</b>                                       |   | <b>The reference cited (Diehl <i>et al.</i>, 2002) does not show that <i>Acromyrmex</i> sp. is present in Australia</b>   |
| <b>Lepidoptera (moths, butterflies)</b>                                    |   |   |   |
| <i>Agathiphaga queenslandensis</i> Dumbleton [Lepidoptera: Agathiphagidae] | Present (CSIRO, 2007)                               |   | Caterpillars of <i>Agathiphaga</i> feed only on <i>Agathis</i> (Upton, 1997). <b>Whitmore &amp; Page, 1997 ref not in IRA document reference list.</b>  |
| <b>Thysanoptera (thrips)</b>   |   |   |   |
| <i>Oxythrips agathidis</i> Morison [Thysanoptera: Thripidae]               | Present (CSIRO, 2007; APPD, 2007)                   |   | This species is reported to have been recorded from <i>Agathis robusta</i> in Queensland (APPD, 2007). <b>Whitmore &amp; Page, 1997 ref not in IRA document reference list.</b>                                 |
| <b>PATHOGENS</b>   |   |   |   |
| <i>Aecidium fragiforme</i> Ces.  | Present (APPD, 2007; Ramsden <i>et al.</i> , 2002)  |   | Rust fungus recorded on <i>Agathis dammara</i> , <i>A. macrophylla</i> , <i>A. vitiensis</i> and <i>A. palmerstonii</i> (Ramsden <i>et al.</i> 2002; Riley <i>et al.</i> , 2000).                               |
| <i>Alternaria</i> sp   | Present (APPD, 2007)                                | Present (Pennycook, 1989)                     | <b>Farr <i>et al.</i> (1989) reference cited does not show that this particular species is associated with the host.</b>  |
| <i>Armillaria</i> sp   | Present (APPD, 2007)                                | Present (Pennycook, 1989)                     | <b>Present in New Zealand.</b>  |
| <i>Athelia rolfsii</i> (Curzi) Tu & Kimbr.                                 | Present (APPD, 2007)                                | Present (McKenzie & Dingley, 1996)            | <b>Host association not recorded in Farr <i>et al.</i> (1989) as stated in the PRA document.</b>  |
| <i>Botryosphaeria rhodina</i> (Berk. & M.A. Curtis) Arx                    | Present (APPD, 2007)                                | Present (Landcare Research, 2007)             | Recorded on <i>Araucaria heterophylla</i> and <i>Araucaria cunninghamii</i> (Ramsden <i>et al.</i> 2002; CABI, 2007).   |
| <i>Botryosphaeria</i> sp.  | Present (Slippers <i>et al.</i> , 2005; APPD, 2007) | Present (Pennycook, 1989)                     |   |
| <i>Fomitopsis pinicola</i> (Shaw) P. Karst.                                | Present (Gilbertson & Ryvardeen, 1986)              | Recorded on <i>Agathis</i> spp. (CABI, 2007). |   |
| <i>Fusicoccum mangiferum</i> (Syd. & P. Syd.) Johnson <i>et al.</i>        | Present (APPD, 2007)                                |   | <b>Host association is not recorded in Slippers <i>et al.</i> (2005).</b>   |
| <i>Ganoderma lucidum</i> (Curtis) (Curt. ex Fr.) Karst.                    | Present (APPD, 2007)                                |   | Recorded on <i>Agathis vitiensis</i> (Ramsden <i>et al.</i> 2002).  |
| <i>Leptosphaeria</i> sp  | Present (APPD, 2007)                                | Present (Pennycook, 1989)                     | Some species of the genus occur on <i>Araucaria</i> (Farr <i>et al.</i> , 1989).  |
| <i>Macrophoma araucariae</i> Delacr  | <b>Not present in Mainland Australia</b>            |   | Recorded on <i>Araucaria heterophylla</i> from Norfolk Island (Ramsden <i>et al.</i> , 2002).   |
| <i>Meliola</i> sp  | <b>Not present in Mainland Australia</b>            |   | Recorded on <i>Araucaria heterophylla</i> from Norfolk Island (Ramsden <i>et al.</i> , 2002).   |
| <i>Pestalotia gubae</i> sp. nov  | Present (Yuan, 1996)                                |   | Recorded from <i>Agathis robusta</i> (CABI, 2007).Report from Northern Territory (Yuan, 1996).  |

|  |                                      |                                     |   |
|--|--------------------------------------|-------------------------------------|---|
| <i>Phellinus noxius</i> (Corner) G. Cunningham               | Present (Ramsden <i>et al.</i> 2002) |                                     | Recorded on <i>Agathis</i> spp. and <i>Araucaria</i> spp. (Ramsden <i>et al.</i> 2002).   |
| <i>Phytophthora boehmeriae</i> Sawada                        | Present (D'Souza <i>et al.</i> 1997) | Present (Landcare Research, 2007)   | Recorded on <i>Araucaria heterophylla</i> (Ramsden <i>et al.</i> 2002).   |
| <i>Phytophthora cinnamomi</i> Rands                          | Present (APPD, 2007)                 | Present (Flux <i>et al.</i> , 1993) | It has been reported to cause significant disease symptoms and mortality of juvenile <i>Wollemia nobilis</i> plants (Bullock <i>et al.</i> , 2000).   |
| <i>Phytophthora</i> sp.                                      | Present (APPD, 2007)                 | Present (Pennycook, 1989)           | Some species of the genus are known to cause mortality in <i>Wollemia</i> pine ((Bullock <i>et al.</i> , 2000).   |
| <i>Pythium</i> sp.   | Present (APPD, 2007)                 | Present (Flux <i>et al.</i> , 1993) | <i>Pythium</i> spp. including <i>P. ultimum</i> has been recorded on <i>Araucaria heterophylla</i> in Norfolk Island and cause damping-off of <i>Agathis australis</i> in New Zealand (Ecroyd, 1981; Ramsden <i>et al.</i> , 2002). |
| <i>Servazziella longispora</i> (Servazzi) J. Reid & C. Booth | Present (Farr <i>et al.</i> , 1989)  | Present (Farr <i>et al.</i> , 1989) | Recorded on <i>Araucaria heterophylla</i> (Ramsden <i>et al.</i> 2002; Farr <i>et al.</i> , 1989).  |

**MAF response:** Thank you for undertaking such a comprehensive review of the hazard list provided in Appendix 1 of the draft import risk analysis. MAF's responses to the following specific comments in the table are provided as follows:

***Dihammus tinctoratus* - Not present in Australia. Schnieder (1999) and Hawkeswood (1990) refer to species in PNG**

It was unclear from the references whether the report was from PNG only or included northern areas of Australia. In this instance MAF is willing to accept Biosecurity Australia's authority on the absence of *Dihammus tinctoratus* in Australia.

***Hylurdretonus* sp - Reference cited (Sequeira & Farrell, 2001) does not show that this species is present in Australia**

Sequeira & Farrell (2001) refer in their first table to *Hylurdretonus* being present in Australia.

***Amblypelta cocophaga* - Not present in Australia. It is on North Australia's Quarantine Strategy target list of plant pests. Not listed in Schnieder (1999) as referenced in the document**

It was unclear from the references whether the report was from PNG only or included northern areas of Australia. In this instance MAF is willing to accept Biosecurity Australia's authority on the absence of *Amblypelta cocophaga* in Australia.

***Illinoia morrisoni* - Not present in Australia. Not listed in Schnieder (1999) as stated by the author**

It was unclear from the references whether the report was from PNG only or included northern areas of Australia. In this instance MAF is willing to accept Biosecurity Australia's authority on the absence of *Illinoia morrisoni* in Australia.

***Acromyrmex* sp. - The reference cited (Diehl *et al.*, 2002) does not show that *Acromyrmex* sp. is present in Australia**

We agree that this reference does not show that *Acromyrmex* sp. are present in Australia and as such will remove this reference and organism from the potential hazard list.

**Whitmore & Page, 1997 reference not in IRA document reference list.**

Thank you for pointing this out. This reference has now been included in the reference list.

***Fusicoccum mangiferum* - Host association is not recorded in Slippers *et al.* (2005).**

The phylogenetic lineages of the *Botryosphaeriaceae* are confusing at best, which seems to have led to what may be an incorrect association record. As this genus is an

anamorph of the *Botryosphaeria* it will be removed from the host association list in the risk analysis.

***Macrophoma araucariae* and *Meliola* sp - Not present in Mainland Australia**

*Macrophoma araucariae* and *Meliola* sp are listed by Ramsden, M; Mac Donald, J; Wylie, F R (2002) (Forest pests in the South Pacific region: A review of major causal agents of tree disorders. *Department of Primary Industries, Agency for Food and Fibre Sciences, Forestry Research, Queensland, Australia*. 1 – 33) as being present on Norfolk Island, an Australian territory. The scope of this risk analysis includes all territories of Australia.

***Phytophthora boehmeriae* - Present in New Zealand (Landcare Research, 2007)**

The Landcare Research record states that *Phytophthora boehmeriae* is present in the South Pacific region (e.g. Australia). There is no record of this species of *Phytophthora* being present in New Zealand.

***Servazziella longispora* - Present in New Zealand (Farr *et al.*, 1989)**

There is no record of this fungus in any of New Zealand's authoritative fungal databases. It would therefore seem that the Farr *et al.* (1989) reference was in error.

# APPENDIX 1: SUBMISSIONS RECEIVED

## APP 1.1 HORTRESEARCH LTD

Hi Martin,

Thank you for offering us an extended period for comment on the Risk Assessment for Wollemi Pine. Unfortunately, pressure of other work commitments has meant that staff with relevant technical skills have not been able to dedicate the time to perform a thorough review of the document. This means that our comments are really only an informal assessment.

At a general level, however, surprise has been expressed by pathology staff, in relation to the “whole plant” import pathway anticipated by the risk assessment. Their main concern centres around the importing of relatively large trees with soil on them. It strikes them that this is “not a good idea”.

For instance, the view of one of our pathologists, with experience working with soil pathogens, is that it would take a lot more than inspection of roots to determine if pathogens were present on the roots, or in the soil, even for as little 1 kg of soil.

The view is that importing of soil with these trees will almost guarantee bringing in unwanted fungal and bacterial organisms. Symptoms would not necessarily be obvious in potted trees, yet numerous organisms could be harboured in the soil or feeder roots. Phytophthora is an obvious candidate for concern - *P. cinnamomi* is a known pathogen of Wollemi pine.

Although we already have *P. cinnamomi* in NZ, we possibly have only one strain, and almost certainly only one mating type. Import of another strain or mating type could be devastating to our native forests and to some horticultural industries. There are also numerous other Phytophthora species which may not necessarily show symptoms on Wollemi pine, yet could be harboured in roots or soil. Detection of these would be very difficult.

Many other pathogenic soil organisms could also be unwittingly imported in soil or roots, introducing new strains or even new species. Detection of many soil fungi is difficult, and eradication from soil is almost impossible without fumigation (which would also kill the tree).

Fungicide treatment of soil is not particularly helpful.

The essence of the comments is simply that “it’s not a good idea to import trees with roots and soil, when there are practical and much safer alternatives”. We understand the obvious alternatives to importing whole trees (e.g. cuttings or tissue culture, or even seed) are all available for this species, and would all carry substantially lower risks of importing unwanted organisms.

We are also concerned that this particular risk assessment should not be seen as establishing a precedent for importing large whole plants of other species.

I hope this is helpful. Again, apologies that we have not been able to perform a thorough review of the document.

## Biosecurity Australia's comments on New Zealand draft import risk analysis of Wollemi Pine nursery stock from Australia



**August, 2007**

## **TABLE OF CONTENTS**

|   |           |
|---|-----------|
| <b>SUMMARY</b>  | <b>3</b>  |
| <b>1 Introduction</b>   | <b>4</b>  |
| <b>2 Comments on the import risk analysis for Wollemi pine nursery stock from Australia</b> | <b>4</b>  |
| <b>2.1 GENERAL COMMENTS</b>   | <b>4</b>  |
| <b>2.2 SPECIFIC COMMENTS</b>  | <b>4</b>  |
| <b>3 Management Options</b>   | <b>8</b>  |
| <b>4 References</b>   | <b>15</b> |

## **SUMMARY**

Biosecurity Australia (BA) provides this technical information to Ministry of Agriculture and Forestry (MAF) in response to New Zealand's draft import risk analysis for the importation of *Wollemia nobilis* nursery stock from Australia.

MAF identified several pests being associated with Wollemi pine nursery stock from Australia. Biosecurity Australia's comments on the draft import risk analysis are based on the risk analysis processes as set out in the International Standards for Phytosanitary Measures (ISPM), particularly ISPM No. 2 – *Guidelines for Pest Risk Analysis* and ISPM No. 11 – *Pest Risk Analysis for Quarantine Pests, including Analysis of Environmental Risks and Living Modified Organisms*.

Biosecurity Australia's assessment indicates that:

- *Dihammus tincturatus* [Coleoptera: Cerambycidae], *Amblypelta cocophaga* [Hemiptera: Coreidae] and *Illinoia morrisoni* [Hemiptera: Aphididae] are not recorded in Australia and therefore, these pests should be removed from the draft import risk analysis.
- The methodology used in the assessment of pests likely to be associated with Wollemi pine is not consistent with ISPM 11. For example, Appendix 1 of the import risk analysis document (Hazard list – Organisms associated with Araucariaceae in Australia) does not address the ISPM 11. The pests of quarantine significance identified in the PRA were not determined through the process of pest categorisation as required by ISPM 11. Indeed, the pests do not meet the criteria for a quarantine pest.
- Most of the pests analysed in the import risk analysis are not known to be associated with Wollemia pine. According to ISPM 11, the categorisation of a pest as a quarantine significance must include assessment of the pathway association.
- The import risk analysis report has several inconsistencies (e.g. incorrect references cited throughout the document or references do not show the correct geographical distribution of the pest).

Presence and absence, and pathway analyses of all organisms identified in the PRA as associated with Araucariaceae in Australia are provided in Attachment 1, and inconsistencies in the hazard list are discussed in this report.

Biosecurity Australia acknowledges that there are possible quarantine risks likely to be associated with the Wollemi pine nursery stock from Australia. The phytosanitary measures proposed by New Zealand to mitigate these risks include: 1) Pre-export nursery management; 2) Pre-export and shipment inspection; and 3) Post entry quarantine and inspection in New Zealand. BA welcomes the recommendation that Wollemi pine plants *in vitro* imported into New Zealand will not require phytosanitary measures.

Biosecurity Australia believes that the proposed management options including post entry quarantine protocols and rationale for the proposed changes are appropriate and sufficient to ensure Wollemi pine nursery stock introduction into New Zealand is free from pests of quarantine significance. The recommended phytosanitary measures are supported.

## **1 Introduction**

The Government of Australia welcomes the opportunity to provide comments on the draft import risk analysis to MAF. Australia appreciates that New Zealand is taking into consideration comments from trading partners prior to the finalisation of the import risk analysis.

Presence and absence, and pathway analyses of all organisms identified in the PRA as associated with Araucariaceae in Australia are provided in Attachment 1 and inconsistencies in the hazard list are discussed in this report.

## **2 Comments on the import risk analysis for Wollemi pine nursery stock from Australia**

Biosecurity Australia's comments on draft import risk analysis for Wollemi pine of 22 June 2007 are based on the risk analysis processes as set out in the International Standards for Phytosanitary Measures (ISPMs), particularly ISPM No. 2 – *Guidelines for Pest Risk Analysis* and ISPM No. 11 – *Pest Risk Analysis for Quarantine Pests including Analysis of Environmental Risk Analysis Pests and Living Modified Organisms*.

### **2.1 General Comments**

The Araucariaceae is a conifer family containing three genera: 1) *Agathis* genus with 20 species distributed from the Philippines through Queensland to New Zealand and from Malaysia to Fiji; 2) *Araucaria* with 16 species distributed from south America through Australia, New Caledonia, New Zealand to Norfolk Island (Sporne, 1974); and 3) *Wollemia* with one species is limited to a few small populations in New South Wales, Australia (da Silva, 1997). Presence and absence and pathway analyses of all organisms identified in the import risk analysis as associated with Araucariaceae in Australia are listed in Attachment 1 of this report. Inconsistencies in the hazard list are discussed below.

### **2.2 Specific Comments**

- a) Due to considerable variation in susceptibility to pests found among plant genera within a family and sometimes within species of a genus, it is not appropriate to consider pests (pathogens and arthropod pests) of all plant species within a family when assessing quarantine risks associated with a particular plant species (eg *Wollemia nobilis*). Indeed, pathogens of native plants tend to be host specific, and they may have co-evolved with their host (McKenzie, 1998). The same appears to be true with the rust fungi, and usually spread to hosts within the same genus as the native host (McKenzie, 1998). For example, *Aecidium fragiforme* occurs on *Agathis palmerstonii* in Queensland, *Agathis alba*, *Agathis dammara* and *Agathis* spp. in Malaysia and Indonesia, *Agathis labillardieri* in New Guinea, and *Agathis vitiensis* in Fiji (Ridley *et al.*, 2000).
- b) In this import risk analysis MAF has considered available information on pathogens and arthropod pests associated with all species within Araucariaceae family in Australia and New Zealand. This is a major concern for Australia. According to ISPM 11, the categorisation of a pest as a quarantine pest must include assessment of the pathway association. The pest can not be considered as a quarantine pest, requiring mitigating measures, if it is not associated with the pathway (Wollemi pine).

- c) Indeed, quarantine pests determined through the process of pest categorisation should meet the following IPPC criteria for a quarantine pest:
- the pest is absent, or has limited distribution and is being officially controlled in the pest risk analysis (PRA) area; and
  - the pest is of potential economic importance to the PRA area.

Pest categorisation (resulting in a list of quarantine pests based on the IPPC definition); and risk assessment (resulting in a list of quarantine pests where the risk has been estimated to be unacceptable) are important measures in the ISPM 11

- e) It is stated in Chapter 2, section 2.2.2 of the Biosecurity New Zealand process and methodology for undertaking import risk analysis that “when considering whether an identified organism or disease should be included in the hazard list for a particular risk analysis, the following questions should be considered: 1) is the organism associated with the commodity or conveyance; 2) is the organism or disease absent from New Zealand but likely to be present in the exporting country .....”. It should be noted that the commodity or conveyance in this case is *Wollemia nobilis* (Wollemi pine) nursery stock and only pests associated with the commodity should be considered for the pest risk assessment.
- f) Section 2.2.4 of the report states “since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required level of protection .....” What is the New Zealand’s required level of protection? This was not provided or discussed in the PRA document.
- g) Table 3.4 (page 25) of the PRA document provides information of hazard groups used for the pest risk assessment of *Wollemia nobilis*. However, none of the significant examples of pests cited is known to be associated with the pathway (see Appendix 1).
- h) It is noted with surprise that organisms such as mycorrhizal fungi which are fundamentally beneficial fungi were included in the hazard grouping. Such fungi live in and around the roots of 95% of the earth's plant species, serving as a secondary root system, extracting mineral elements and water from soil for their host plant, and live off the plant's sugars. BA does not believe that mycorrhizal fungi meet the definition of a pest that is any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products (ISPM, 2006).
- i) The risk assessment of Wollemi pine imports to New Zealand was based on representative arthropod pest and fungi species; however, no member of these representative species selected for the generic assessment has been recorded as associated with the commodity in question, namely *Wollemia nobilis* nursery stock. The outcome of the risk assessment therefore does not reflect the actual risks posed by Wollemi pine imports to New Zealand.

Furthermore, the question of whether or not pests (eg. surface feeding insects, wood boring insects, etc.) are pests of *Wollemia nobilis* should be resolved. To the best of our knowledge, there is no available scientific information showing that these pests are associated with the pathway in question. Biosecurity Australia does not believe that these pests are likely to be associated with the pathway.

- j) It is clear from the available scientific literature that some of the pests listed in the PRA document as likely to be associated with *W. nobilis* are host specific and only attack species of a particular genus. Examples are: 1) *Conifericoccus agathids* feeds on young succulent leaves and stems of *Agathis* spp in Australia (Ridley *et al.*, 2000); 2) *Oxythrips agathidsis* defoliator of *Agathis* spp. in Queensland; 3) Seed-eating moth *Agathiphaga* also found on *Agathis* spp. in Queensland (Earle, 2006).
- k) The IRA report acknowledges that none of the insects and pathogens listed in the PRA has been found associated with the pathway. It is therefore surprising to note that NZMAF has based its management measures on pests, which are not in the pathway. Representative pests should be pests that are known to be associated with the commodity.
- l) Management measures have been proposed for group of pests, such as, surface feeding invertebrates, wood boring insects and foliage diseases. It is not clear from the PRA which specific quarantine pests are of concern to New Zealand and are to be managed by these mitigation measures.
- m) It should be noted that the taxonomic level for organisms considered in PRA is usually the species. The use of a higher or lower taxonomic level should be supported by a scientifically sound rationale (ISPM, 2007). Additional epidemiological information is therefore required on *Acromyrmex* sp., *Alternaria* sp., *Armillaria* sp. and *Pythium* sp. given in the report as pests associated with Araucariaceae.
- n) The PRA report provided *Alternaria* sp., *Pythium* sp. and *Athelia rolfsii* as examples of diseases that are associated with plants in Araucariaceae, known to be present in Australia and not present in New Zealand. A search of the literature showed that *Alternaria* sp., *Pythium* sp. and *A. rolfsii* are present in New Zealand (Pennycook, 1989; Flux *et al.*, 1993; McKenzie and Dingley, 1996). Also the report cited Farr *et al* (1989) as a reference for the association of *A. rolfsii* with the host. However, Farr *et al* do not list *Wollemia nobilis* or Araucariaceae as a host of *A. rolfsii*.
- o) The following arthropod pests are reported to be present in New Zealand and should not be considered in the IRA with the purpose of establishing generic mitigation measures for quarantine pests identified in the IRA: 1) *Coptodryas eucalyptica*, 2) *Pachycotes* sp and 3) *Xylosandrus pseudosolidus* (see Attachment 1).
- p) As stated in the IRA report “unlike fungal pathogens, mycorrhizal fungi form symbiotic relationships with their hosts, gaining food and nutrients from the plant in return for specific nutrients from the fungi”. There is no information provided in the report to show the identity and the injury caused to plants or plant products by the mycorrhizal fungi associated with *Wollemia nobilis* from Australia. According to ISPM 2 (Framework for pest risk assessment, 2007), “the taxonomic identity of the organism should be specified because any biological and other information used should be relevant to the organism in question. If the organism has not yet been fully named or described, then, to be a pest, it should at least have been shown to be identifiable, consistently to produce injury to plants or plant products (eg. symptoms, reduced growth rate, yield loss or any other damage) and to be transmissible or able to disperse”. This information is missing in the IRA document.
- q) No categorised pest list for *Wollemia nobilis* was provided. According to ISPM 2 (2007), for pathway-initiated analysis, categorised pest list should be sufficiently

documented. The hazard list provided in Appendix 1 of the IRA document can not be considered as a pathway associated pest list, as none of the pests were found to be associated with the commodity under question.

- r) Although the identity of the specific *Botryosphaeria* spp. considered in the PRA are not provided, it is acceptable to use the biological and epidemiological characteristics of the well researched *B. ribis* to describe the possible biological nature of the risks posed by the two *Botryosphaeria* spp. isolated from *W. nobilis* from Australia. One of the *Botryosphaeria* isolates from *W. nobilis* was found to be closely related to *B. ribis*, but with some unique similarities with *B. parva*. Both *B. ribis* and *B. parva* are known to occur in Australia and New Zealand (Slippers *et al*, 2005). The other *Botryosphaeria* isolate from *W. nobilis* grouped with *B. australis*, but also varied slightly from this taxon in the gene regions analysed. *B. australis* occurs in Australia (Slippers *et al*, 2005). It is also noted that a recent study has revealed that a species of *Botryosphaeria* is highly pathogenic to *W. nobilis* (Slippers *et al*, 2005). *Botryosphaeria* spp. have a wide host range and could potentially be transmitted in *W. nobilis* nursery stock pathway and appropriate mitigation measures are warranted to control entry of this species into New Zealand.
- s) The assumption put forward in the IRA report that the strains or isolates of *Phytophthora cinnamomi* from Australia would represent greater level of risk to New Zealand than the strains or isolates from New Zealand is not supported by scientifically sound rationale. It should be noted that the taxonomic level for organisms considered in PRA is usually the species, and the use of a higher or lower taxonomic level should be sported by a scientifically sound rationale (ISPM 2, 2007). In cases where levels below the species level are being analysed, the rationale for this distinction should include evidence of reported significant variation in factors such as virulence, pesticide resistance, environmental adaptability and host range (ISPM 2, 2007). None of these rationales is provided in the IRA document.

Currently, *P. cinnamomi* is widely distributed in New Zealand and there is no comprehensive information on the isozyme genotypes/strains present in New Zealand. The reported level of severity of disease caused by the pathogen in Australia may be due to environmental factors, such as higher soil temperatures, which are conducive for growth and disease expression. Optimal growth temperatures are in the range of 20-32.5°C, maximum 30-36°C (OEPP/EPPO, 2004). The pathogen does not survive well or spread under conditions of low soil moisture (Weste, 1983). Also, Australia, particularly Queensland is not likely to generate cold-tolerant strains of the pathogen. In Kauri forests in the far north island of New Zealand, soil temperatures and moisture content were considered important factors in affecting seedling mortality by *P. cinnamomi* (Johnston *et al.*, 2004).

*P. cinnamomi* populations in Australia consist of three isozyme genotypes with low genetic variation, one A1 type and two A2 types (Old *et al.*, 1988). These genotypes represent three clonal lineages of *P. cinnamomi*. There is no indication of the sexual interactions for *P. cinnamomi* in Australia (Old *et al.*, 1888; Dobrowolski *et al.*, 2003).

No sexual recombinant genotypes have been recovered suggesting that the two mating types are incompatible due to differences in their ploidy or karyotype (Dobrowolski, 1999).

### **3 Management Options**

As indicated above Biosecurity Australia has concerns regarding the methodology used in the assessment of pests likely to be associated with Wollemi pines, however, BA acknowledges that there are possible quarantine risks likely to be associated with the Wollemi pine nursery stock from Australia. The measures proposed by New Zealand to mitigate these risks include: 1) Pre-export nursery management; 2) Pre-export and shipment inspection; and 3) Post entry quarantine and inspection in New Zealand. It is noted that Wollemi pine plants *in vitro* imported into New Zealand from Australia will not require phytosanitary measures. Wollemi pine industry in Australia welcomes this recommendation and hopes to produce plants *in vitro* for future export to New Zealand and other countries.

Biosecurity Australia believes that the proposed management options including post entry quarantine protocols and rationale for the proposed changes are appropriate and sufficient to ensure Wollemi pine nursery stock introduction into New Zealand is free from pests of quarantine significance.

Appendix–1: Biosecurity Australia's comments on pests identified by MAF being associated with Araucariaceae in Australia

| Scientific name of the pests  | Status in                          |   | Remarks  |
|---|------------------------------------|---|--|
|   | Australia                          | New Zealand                                 |  |
| <b>ARTHROPODS</b>   |                                    |   |  |
| <b>Coleoptera ((beetles, weevils)</b>                                 |                                    |   |  |
| <i>Aesiotes notabilis</i> Pascoe [Coleoptera: Curculionidae]          | Present (Mecke <i>et al.</i> 2005) |   | This wood-boring species has been recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005). Mainly associated with standing <i>Araucaria</i> spp., <i>Agathis</i> spp. and <i>Pinus</i> spp. and larvae feed on the phloem (Schneider, 1999). This species take advantage of the host's decreased natural resistance caused by injury, diseases, fire and other stress factors (Schneider, 1999). |
| <i>Aragomacer leai</i> Kuschel [Coleoptera: Nemonyrchidae]            | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005).  |
| <i>Aragomacer uniformis</i> Kuschel [Coleoptera: Nemonyrchidae]       | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005).  |
| <i>Basiliogeus prasinus</i> Kuschel [Coleoptera: Nemonyrchidae]       | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria bidwillii</i> in Australia (Mecke <i>et al.</i> 2005).  |
| <i>Basiliogeus striatopunctatus</i> (Lea) [Coleoptera: Nemonyrchidae] | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).   |
| <i>Bunyaeus eutactae</i> Kuschel [Coleoptera: Nemonyrchidae]          | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005)..   |
| <i>Bunyaeus monteithi</i> Kuschel [Coleoptera: Nemonyrchidae]         | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria bidwillii</i> in Australia. Adults and larvae feed on pollen of Araucariaceae (Mecke <i>et al.</i> 2005).   |
| <i>Coptocorynus araucaridae</i> Marshall [Coleoptera: Curculionidae]  | Present (Mecke <i>et al.</i> 2005) |   | This species is reported to have been recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).   |
| <i>Coptocorynus</i> sp [Coleoptera: Curculionidae]                    |                                    |   | Schneider (1999) reference is on insects of PNG not Australia. Reported as a wood-boring weevil of hoop pine (Schneider, 1999).  |
| <i>Coptodryas eucalyptica</i> (Schedl) [Coleoptera: Curculionidae]    | Present (Mecke <i>et al.</i> 2005) | Present (Brockerhoff <i>et al.</i> , 2003). | <b>This species is present in NZ.</b>  |

**Biosecurity Australia's comments on New Zealand PRA on Wollemi pine nursery stock**

|  |                                      |  |   |
|--|--------------------------------------|--|---|
| <i>Dihammus australis</i> (Boisduval) [Coleoptera: Cerambycidae]       | Present (APPD, 2007)                 |  | Recorded on <i>Araucaria</i> species (Schnieder, 1999)  |
| <i>Dihammus tincturatus</i> Pascoe [Coleoptera: Cerambycidae]          | <b>ABSENT</b>                        |  | <b>Not present in Australia.</b> Schnieder (1999) and Hawkeswood (1990) refer to species in PNG.  |
| <i>Diotimana undulata</i> Pascoe [Coleoptera: Cerambycidae]            | Present (APPD, 2007)                 |  | Recorded on <i>Araucaria</i> species (Schnieder, 1999)  |
| <i>Dysthaeta anomala</i> Pascoe [Coleoptera: Cerambycidae]             | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria</i> spp. and <i>Agathis</i> spp. in Australia (Mecke <i>et al.</i> , 2005; APPD, 2007).  |
| <i>Euplatypus parallelus</i> Fabricius [Coleoptera: Curculionidae]     | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).   |
| <i>Eurhamphus fasciculatus</i> Shuckard [Coleoptera: Curculionidae]    | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i>  |
| <i>Eutactobius puellus</i> Kuschel [Coleoptera: Nemonychidae]          | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i>  |
| <i>Euthyrinus meditabundus</i> (Fabricius) [Coleoptera: Curculionidae] | Present (Hawkeswood, 1991)           |  | This species has been recorded from 29 species from 18 plant families but attack is usually restricted to dead or dying material (Hawkeswood, 1991).                                      |
| <i>Euwallacea barbatus</i> (Hagedorn) [Coleoptera: Curculionidae]      | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).  |
| <i>Euwallacea destruens</i> (Blandford) [Coleoptera: Curculionidae]    | Present (Wood & Bright 1992)         |  | Recorded on <i>Agathis</i> species and <i>Araucaria cunninghamii</i> (CABI, 2007).  |
| <i>Hyleops glabratus</i> Schedl [Coleoptera: Curculionidae]            | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005; APPD, 2007).  |
| <i>Hyludrectonus corticinus</i> Wood [Coleoptera: Curculionidae]       | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria bidwillii</i> , <i>Araucaria cunninghamii</i> , <i>Araucaria heterophylla</i> and <i>Araucaria hunsteinii</i> in Australia and PNG (Mecke <i>et al.</i> , 2005). |
| <i>Hyludrectonus pinarius</i> Schedl [Coleoptera: Curculionidae]       | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria bidwillii</i> and <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Hyludrectonus</i> sp [Coleoptera: Curculionidae]                    |                                      |  | <b>Reference cited (Sequeira &amp; Farrell, 2001) does not show that this species is present in Australia.</b>  |
| <i>Ilacuris laticollis</i> Pascoe [Coleoptera: Curculionidae]          | Present (Mecke <i>et al.</i> , 2005) |  | Recorded from <i>Araucaria cunninghamii</i> and <i>Araucaria hunsteinii</i> from Australia and PNG (Mecke <i>et al.</i> 2005).  |
| <i>Mallus costatus</i> Marshall [Coleoptera: Curculionidae]            | Present (Mecke <i>et al.</i> , 2005) |  | Recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> 2005).  |
| <i>Mitrastethus australiae</i> Lea [Coleoptera: Curculionidae]         | Present (Mecke <i>et al.</i> , 2005) |  | Recorded from <i>Araucaria cunninghamii</i> and <i>Araucaria hunsteinii</i> in Australia and PNG (Mecke <i>et al.</i> , 2005).  |
| <i>Notamacer eximius</i> Kuschel [Coleoptera: Nemonychidae]            | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Notamacer reginae</i> Kuschel [Coleoptera: Nemonychidae]            | Present (Mecke <i>et al.</i> , 2005) |  | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).  |

**Biosecurity Australia's comments on New Zealand PRA on Wollemi pine nursery stock**

|   |                                      |                                    |  |
|---|--------------------------------------|------------------------------------|--|
| <i>Notamacer zimmermani</i> Kuschel [Coleoptera: Nemonyndidae]                  | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Orthorhinus cylindrirostris</i> (Fabricius) [Coleoptera: Curculionidae]      | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Pachycotes minor</i> Wood [Coleoptera: Curculionidae]                        | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Pachycotes</i> sp [Coleoptera: Curculionidae]                                | Present (Sequeira & Farrell, 2001)   | Present (Sequeira & Farrell, 2001) | <b>This species is present in NZ.</b>  |
| <i>Palophagus australiensis</i> Kuschel [Coleoptera; Megalopodidae]             | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Palophagus bunyae</i> Kuschel [Coleoptera; Megalopodidae]                    | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria bidwillii</i> in Australia (Mecke <i>et al.</i> , 2005).  |
| <i>Platypus froggatti</i> Sampson [Coleoptera: Curculionidae]                   | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded from <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Platypus omnivorus</i> (Lea) [Coleoptera: Curculionidae]                     | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005; APPD, 2007).   |
| <i>Platypus queenslandi</i> Schedl [Coleoptera: Curculionidae]                  | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Platypus semigranosus</i> Sampson [Coleoptera: Curculionidae]                | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).  |
| <i>Platypus subgranosus</i> Schedl [Coleoptera: Curculionidae]                  | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).  |
| <i>Prospheres aurantiopictus</i> Laporte & Gory, 1838 [Coleoptera: Buprestidae] | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> (Mecke <i>et al.</i> , 2005).  |
| <i>Strongylurus decoratus</i> [Coleoptera: Cerambycidae]                        | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005; APPD, 2007).   |
| <i>Strongylurus</i> sp [Coleoptera: Cerambycidae]                               | Present (Schneider, 1999)            |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia. A peculiar pest of Northern QLD that develops in branches of Hoop pines (Schneider, 1999). |
| <i>Treptoplatypus australis</i> Chapuis [Coleoptera: Curculionidae]             | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Tyrtaeosus microthorax</i> Pascoe [Coleoptera: Curculionidae]                | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria cunninghamii</i> in Australia (Mecke <i>et al.</i> , 2005).   |
| <i>Xenocnema</i> sp [Coleoptera: Curculionidae]                                 | Present (Sequeira & Farrell, 2001)   |                                    | Recorded on <i>Araucaria</i> spp. and <i>Agathis</i> spp. (Sequeira & Farrell, 2001; Mecke <i>et al.</i> , 2005).                                  |
| <i>Xyleborus affinis</i> Eichhoff [Coleoptera: Curculionidae]                   | Present (Mecke <i>et al.</i> , 2005) |                                    | Recorded on <i>Araucaria angustifolia</i> and <i>Araucaria cunninghamii</i> and (Mecke <i>et al.</i> 2005).  |
| <i>Xyleborus emarginatus</i> Eichhoff [Coleoptera: Curculionidae]               | Present (Wood & Bright, 1992)        |                                    | Recorded on Araucariaceae it has been recorded on <i>Agathis</i> species (CABI, 2007).   |

**Biosecurity Australia's comments on New Zealand PRA on Wollemi pine nursery stock**

|  |                                       |  |   |
|--|---------------------------------------|--|---|
| <i>Xyleborus perforans</i> Wollaston [Coleoptera: Curculionidae]           | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Agathis macrophylla</i> , <i>Araucaria cunninghamii</i> and <i>Araucaria hunsteinii</i> (Mecke <i>et al.</i> , 2005).  |
| <i>Xyleborus similis</i> Ferrari [Coleoptera: Curculionidae]               | Present (Mecke <i>et al.</i> , 2005)  |  | Recorded on <i>Araucaria cunninghamii</i> and <i>Agathis</i> spp. (Mecke <i>et al.</i> 2005; CABI, 2007)).  |
| <i>Xylosandrus pseudosolidus</i> Schedl [Coleoptera: Curculionidae]        | Present (Mecke <i>et al.</i> , 2005)  | Present (Brockerhoff <i>et al.</i> , 2003) | <b>This species is present in NZ</b> therefore, does not meet the definition of a quarantine pest unless it is under 'official control'   |
| <b>Hemiptera (aphids, leafhoppers, scales, whiteflies)</b>                 |                                       |  |   |
| <i>Amblypelta cocophaga</i> China [Hemiptera: Coreidae]                    | <b>Absent</b>                         |  | <b>Not present in Australia. It is on North Australia's Quarantine Strategy target list of plant pests. Not listed in Schnieder (1999) as referenced in the document.</b>                                       |
| <i>Chrysomphalus dictyospermi</i> (Morgan) [Hemiptera: Diaspididae]        | Present (CSIRO, 2007)                 |  | Reported on <i>Araucaria angustifolia</i> (CABI, 2007).   |
| <i>Conifericoccus agathidis</i> Brimblecombe [Hemiptera: Margarodidae]     | Present (Ridley <i>et al.</i> , 2000) |  | Reported on <i>Agathis</i> spp. in Australia; feeds on young succulent leaves and stems of <i>Agathis</i> spp. (Ridley <i>et al.</i> 2000).   |
| <i>Illinoia morrisoni</i> (Swain) [Hemiptera: Aphididae]                   | <b>Absent</b>                         |  | <b>Not present in Australia. Not listed in Schnieder (1999) as stated by the author.</b>  |
| <i>Neophyllaphis araucariae</i> Takahashi [Hemiptera: Aphididae]           | Present (Hales & Lardner, 1988)       |  | This species is recorded from <i>Araucaria</i> spp. (Hales & Lardner, 1988).  |
| <i>Nipaecoccus</i> sp (Hemiptera: Pseudococcidae)                          | Present (APPD, 2007)                  |  | This species is reported to have been recorded from <i>Araucaria</i> spp. (Ridley <i>et al.</i> , 2000). Reference cited does not show that this species is present in Australia (Ridley <i>et al.</i> , 2000). |
| <b>Hymenoptera (ants)</b>  |                                       |  |   |
| <i>Acromyrmex</i> sp [Hymenoptera: Formicidae]                             | <b>Absent</b>                         |  | <b>The reference cited (Diehl <i>et al.</i>, 2002) does not show that <i>Acromyrmex</i> sp. is present in Australia</b>   |
| <b>Lepidoptera (moths, butterflies)</b>                                    |                                       |  |   |
| <i>Agathiphaga queenslandensis</i> Dumbleton [Lepidoptera: Agathiphagidae] | Present (CSIRO, 2007)                 |  | Caterpillars of <i>Agathiphaga</i> feed only on <i>Agathis</i> (Upton, 1997). <b>Whitmore &amp; Page, 1997 ref not in IRA document reference list.</b>  |
| <b>Thysanoptera (thrips)</b>   |                                       |  |   |
| <i>Oxythrips agathidis</i> Morison [Thysanoptera: Thripidae]               | Present (CSIRO, 2007; APPD, 2007)     |  | This species is reported to have been recorded from <i>Agathis robusta</i> in Queensland (APPD, 2007). <b>Whitmore &amp; Page, 1997 ref not in IRA document reference list.</b>                                 |

**Biosecurity Australia's comments on New Zealand PRA on Wollemi pine nursery stock**

| <b>PARHOGENS</b>  |   |                                     |   |
|---|---|-------------------------------------|---|
| <i>Aecidium fragiforme</i> Ces.                                     | Present (APPD, 2007; Ramsden <i>et al.</i> , 2002)  |                                     | Rust fungus recorded on <i>Agathis dammara</i> , <i>A. macrophylla</i> , <i>A. vitiensis</i> and <i>A. palmerstonii</i> (Ramsden <i>et al.</i> 2002; Riley <i>et al.</i> , 2000). |
| <i>Alternaria</i> sp  | Present (APPD, 2007)                                | Present (Pennycook, 1989)           | <b>Farr <i>et al.</i> (1989) reference cited does not show that this particular species is associated with the host.</b>  |
| <i>Armillaria</i> sp  | Present (APPD, 2007)                                | Present (Pennycook, 1989)           | <b>Present in New Zealand.</b>  |
| <i>Athelia rolfsii</i> (Curzi) Tu & Kimbr.                          | Present (APPD, 2007)                                | Present (McKenzie & Dingley, 1996)  | <b>Host association not recorded in Farr <i>et al.</i> (1989) as stated in the PRA document.</b>  |
| <i>Botryosphaeria rhodina</i> (Berk. & M.A. Curtis) Arx             | Present (APPD, 2007)                                | Present (Landcare Research, 2007)   | Recorded on <i>Araucaria heterophylla</i> and <i>Araucaria cunninghamii</i> (Ramsden <i>et al.</i> 2002; CABI, 2007).   |
| <i>Botryosphaeria</i> sp.   | Present (Slippers <i>et al.</i> , 2005; APPD, 2007) |                                     | Present (Pennycook, 1989)   |
| <i>Fomitopsis pinicola</i> (Shaw) P. Karst.                         | Present (Gilbertson & Ryvarden, 1986)               |                                     | Recorded on <i>Agathis</i> spp. (CABI, 2007).   |
| <i>Fusicoccum mangiferum</i> (Syd. & P. Syd.) Johnson <i>et al.</i> | Present (APPD, 2007)                                |                                     | <b>Host association is not recorded in Slippers <i>et al.</i> (2005).</b>   |
| <i>Ganoderma lucidum</i> (Curtis) (Curt. ex Fr.) Karst.             | Present (APPD, 2007)                                |                                     | Recorded on <i>Agathis vitiensis</i> (Ramsden <i>et al.</i> 2002).  |
| <i>Leptosphaeria</i> sp   | Present (APPD, 2007)                                | Present (Pennycook, 1989)           | Some species of the genus occur on <i>Araucaria</i> (Farr <i>et al.</i> , 1989).  |
| <i>Macrophoma araucariae</i> Delacr                                 | <b>Not present in Mainland Australia</b>            |                                     | Recorded on <i>Araucaria heterophylla</i> from Norfolk Island (Ramsden <i>et al.</i> , 2002).   |
| <i>Meliola</i> sp   | <b>Not present in Mainland Australia</b>            |                                     | Recorded on <i>Araucaria heterophylla</i> from Norfolk Island (Ramsden <i>et al.</i> , 2002).   |
| <i>Pestalosphaeria gubae</i> sp. nov                                | Present (Yuan, 1996)                                |                                     | Recorded from <i>Agathis robusta</i> (CABI, 2007). Report from Northern Territory (Yuan, 1996).   |
| <i>Phellinus noxius</i> (Corner) G. Cunningham                      | Present (Ramsden <i>et al.</i> 2002)                |                                     | Recorded on <i>Agathis</i> spp. and <i>Araucaria</i> spp. (Ramsden <i>et al.</i> 2002).   |
| <i>Phytophthora boehmeriae</i> Sawada                               | Present (D'Souza <i>et al.</i> 1997)                | Present (Landcare Research, 2007)   | Recorded on <i>Araucaria heterophylla</i> (Ramsden <i>et al.</i> 2002).   |
| <i>Phytophthora cinnamomi</i> Rands                                 | Present (APPD, 2007)                                | Present (Flux <i>et al.</i> , 1993) | It has been reported to cause significant disease symptoms and mortality of juvenile <i>Wollemia nobilis</i> plants (Bullock <i>et al.</i> , 2000).                               |
| <i>Phytophthora</i> sp.   | Present (APPD, 2007)                                | Present (Pennycook, 1989)           | Some species of the genus are known to cause mortality in <i>Wollemia</i> pine ((Bullock <i>et al.</i> , 2000).   |

**Biosecurity Australia's comments on New Zealand PRA on Wollemi pine nursery stock**

|  |                                     |                                     |   |
|--|-------------------------------------|-------------------------------------|---|
| <i>Pythium</i> sp.   | Present (APPD, 2007)                | Present (Flux <i>et al.</i> , 1993) | <i>Pythium</i> spp. including <i>P. ultimum</i> has been recorded on <i>Araucaria heterophylla</i> in Norfolk Island and cause damping-off of <i>Agathis australis</i> in New Zealand (Ecroyd, 1981; Ramsden <i>et al.</i> , 2002). |
| <i>Servazziella longispora</i> (Servazzi) J. Reid & C. Booth | Present (Farr <i>et al.</i> , 1989) | Present (Farr <i>et al.</i> , 1989) | Recorded on <i>Araucaria heterophylla</i> (Ramsden <i>et al.</i> 2002; Farr <i>et al.</i> , 1989).  |

## **4 References**

- APPD (2007). Australian Plant Pest database. URL: <http://www.planthealthaustralia.com.au/APPD/queryForm.asp>.
- Brockerhoff, E. G., Knizek, M. and Bain, J. (2003). Checklist of indigenous and adventive bark and ambrosia beetles (Curculionidae: Scolytinae and Platypodinae) of New Zealand and interceptions of exotic species (1952–2000). *New Zealand Entomologist*, 26: 29–44.
- Bullock, S., Summerell, B. A., Gunn, L. V. (2000). Pathogens of the Wollemi pine, *Wollemia nobilis*. *Australasian Plant Pathology* 29(3): 211-214.
- CABI (2005). Crop Protection Compendium – Global Module. CAB International. Website: <http://www.cabi.org/compendia.asp>.
- CSIRO (2007). URL: <http://www.ento.csiro.au/aicn>
- Da Silva, W. (1997). On the trail of the lonesome pine. *New Scientists* 156 (2111): 36-39.
- Diehl, E., Cavalli-Malina, S., Mellender de Araujo (2002). Isoenzyme variation in the leaf cutting ants *Acromyrmex heyeri* and *Acromyrmex striatus* (Hymenoptera, Formicidae). *Genet. Mol. Biol.* 25 (2): 173-178.
- Dobrowolski, M. P. (1999). Population and sexual genetics of *Phytophthora cinnamomi* in Australia using microsatellite markers. PhD thesis, Murdoch University, Western Australia.
- D'Souza, N, Webster, J., Tay, F. (1997). Disease notes or new records: *Phytophthora boehmeriae* isolated from the first time in Western Australia. *Australasian Plant Pathology* 26, 204-204.
- Earle, J. (2006). Agathis. The Gymnosperm Database. <Http://conifers.org/arg/ag>.
- Ecroyd, C. E. (1981). Biological flora of New Zealand. 8. *Agathis australis* (D. Don) Lindl. (Araucariaceae) Kauri. *New Zealand Journal of Botany*, 20: 17–36.
- EPPO (2006). PQR database (version 4.5). Paris, France: European and Mediterranean Plant Protection Organization. [www.eppo.org](http://www.eppo.org).
- FAO (2006). International Standards for Phytosanitary Measures. ISPM No. 5. Glossary of Phytosanitary Terms. FAO, Rome.
- Farr, D. F., Bills, G. F., Chamuris, G. P., Rossman, A. Y. (1989). Fungi on plants and plant products in the United States. APS Press; St. Paul, Minnesota.
- Flux, A., Gadgil, P., Bain, J., Nuttall, M. (1993). Forest Health. Forest, tree and wood protection in New Zealand. The Ministry of Forestry, Wellington.
- Gilbertson, R.L. and Ryvarden, L. (1986). North American polypores. Vol. I. Abortiporus-Lindtneria. North American polypores. Vol. I. Abortiporus-Lindtneria. Oslo, Norway: Fungiflora A/S.
- Hales, D. F. and Lardner, R. M. (1988). Genetic evidence for the occurrence of a new species of *Neophyllaphis* Takahashi (Homoptera: Aphididae) in Australia. *Journal of the Australian Entomological Society*, 27: 81–85.
- Hawkeswood, T. J. (1990). Observations on the biology, host plants and immature stages of *Dihammus tincturatus* Pascoe (Coleoptera: Cerambycidae: Lamiinae) in Papua New Guinea. Part 1. General biology and host plants. *G. it. Entomology*, 5: 95–101.

- Hawkeswood, T. J. (1991). Review of the biology and host plants of the Australian weevil *Euthyrhinus mediatibundus* (Fabricius) (Coleoptera: Curculionidae). *Entomologist*, 110: 58–65.
- Huth, J, and Holzworth, P. (2005). Araucariaceae in Queensland. In *Australia and New Zealand Forest Histories, Araucarian Forests*. Edited by John Dargavel. Australian Forest History Society Inc. Occasional Publication No. 2, Kingston, ACT, Australia. URL: <http://cres.anu.edu.au/environhist/anzfh2huth&hollzworth.pdf>.
- ISPM (2006). International Standards for Phytosanitary Measures. ISPM No. 5. Glossary of Phytosanitary terms. FAO, Rome.
- ISPM (2007). International Standards for Phytosanitary Measures. ISPM No. 2. Framework for pest risk analysis. FAO, Rome.
- Johnston, P. R., Horner, I. J., Beever, R. E. (2004). *Phytophthora cinnamomi* in New Zealand's indigenous forests. Landcare Research, New Zealand.
- Landcare Research (2007). <http://nzfungi.landcareresearch.co.nz/html/data.asp?ID=&NAMEPKey=16543>
- McKenzie, E. H. C. (1998). Rust fungi of New Zealand – An introduction, and list of recorded species. *New Zealand Journal of Botany*, Vol. 36: 233-271.
- McKenzie, E. H. C. and Dingley, J. M. (1996). New plant disease records in New Zealand: miscellaneous fungal pathogens III. *New Zealand Journal of Botany*, 34: 263–272.
- Mecke, R., Mille, C., Engels, W. (2005). Araucaria beetles worldwide: evolution and host adaptations of a multi-genus phytophagous guide of disjunct Gondwana-derived biogeographic occurrence. Pro Araucaria online. [www.pro-araucaria-online.com](http://www.pro-araucaria-online.com).
- OEPP/EPPO (2004). *Phytophthora cinnamomi*. OEPP/EPPO Bulletin, 34: 201–207.
- Old, K. M., Dudzinski, M. J., Bell, C. J. (1988). Isozyme variability in field populations of *Phytophthora cinnamomi* in Australia. *Australian Journal of Botany* 36: 355-360.
- Pennycook, S.R. 1989. Plant diseases recorded in New Zealand. 3 Vol. Pl. Dis. Div., D.S.I.R., Auckland.
- Ramsden, M., McDonald, J., Wylie, F. R. (2002). Forest pests in the South Pacific region: A review of the major causal agents of tree disorders. Development of Forest Health Surveillance Systems for South Pacific Countries and Australia. ACIAR Project FST/2001/045.
- Ridley, G. S., Bain, J., Bulman, L. S., Dick, M. A., Kay, M. K. (2000). Threats to New Zealand's indigenous forests from exotic pathogens and pests. Science for Conservation. Department of Conservation. Wellington, New Zealand.
- Schneider, M. F. (1999). Key to the forest insects pests of Papua New Guinea. [Http://www.fzi.uni-freiburg.de?InsectPestKey-long%20version/](http://www.fzi.uni-freiburg.de?InsectPestKey-long%20version/)
- Sequeira, A., Farrell, B. D. (2002). Evolutionary origins of Gondwanan interactions: How old are Araucaria beetle herbivores? *Biological J. of the Linnean Society*, 74: 459-474.
- Slippers, B., Summerell, B. A., Crous, P. W., Coutinho, T. A., Wingfield, B. D., Wingfield, M. J. (2005). Preliminary studies on Botryosphaeria species from Southern Hemisphere conifers in Australasia and South Africa. *Australasian Plant Pathology*, 34: 213–220.

- Sporne, K. R. (1974). The morphology of Gymnosperms. 2<sup>nd</sup> ed. Hutchinson University Library, London.
- Upton, M. S. (1997). A twelve-year larval diapause in the Queensland kauri moth, *Agathiphaga queenslandensis* Dumbleton, (Lepidoptera: Agathiphagidae). *Entomologist*, 116: 142–143.
- Weste, G. (1983). Population dynamics and survival of *Phytophthora*. In: *Phytophthora*, its biology, taxonomy, ecology and pathology (Ed. By Erwin, D. C.: Bartnicki-Garcia, S., Tsao, P. H.), 237-258 pp. American Phytopathological Society, St. Paul, USA.
- Wood, S. L., Bright, D. E. (1992). A catalog of Scolytidae and Plat(Coleoptera), part 2: taxonomic index. *Great Basin Naturalist Memoirs* 13: 1-1533.
- Yuan, Z. Q. (1996). Fungi and associated tree diseases in Melville Island, Northern Territory, Australia. *Australian Systematic Botany*, 9: 337–360.