Australian Government

Biosecurity Australia

Provisional final import risk analysis report for fresh unshu mandarin fruit from Japan

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Cover image: Unshu mandarins ripening under hothouse cultivation in the off-season near Fujieda City, Japan. Photographed by Biosecurity Australia officer, July 2007.

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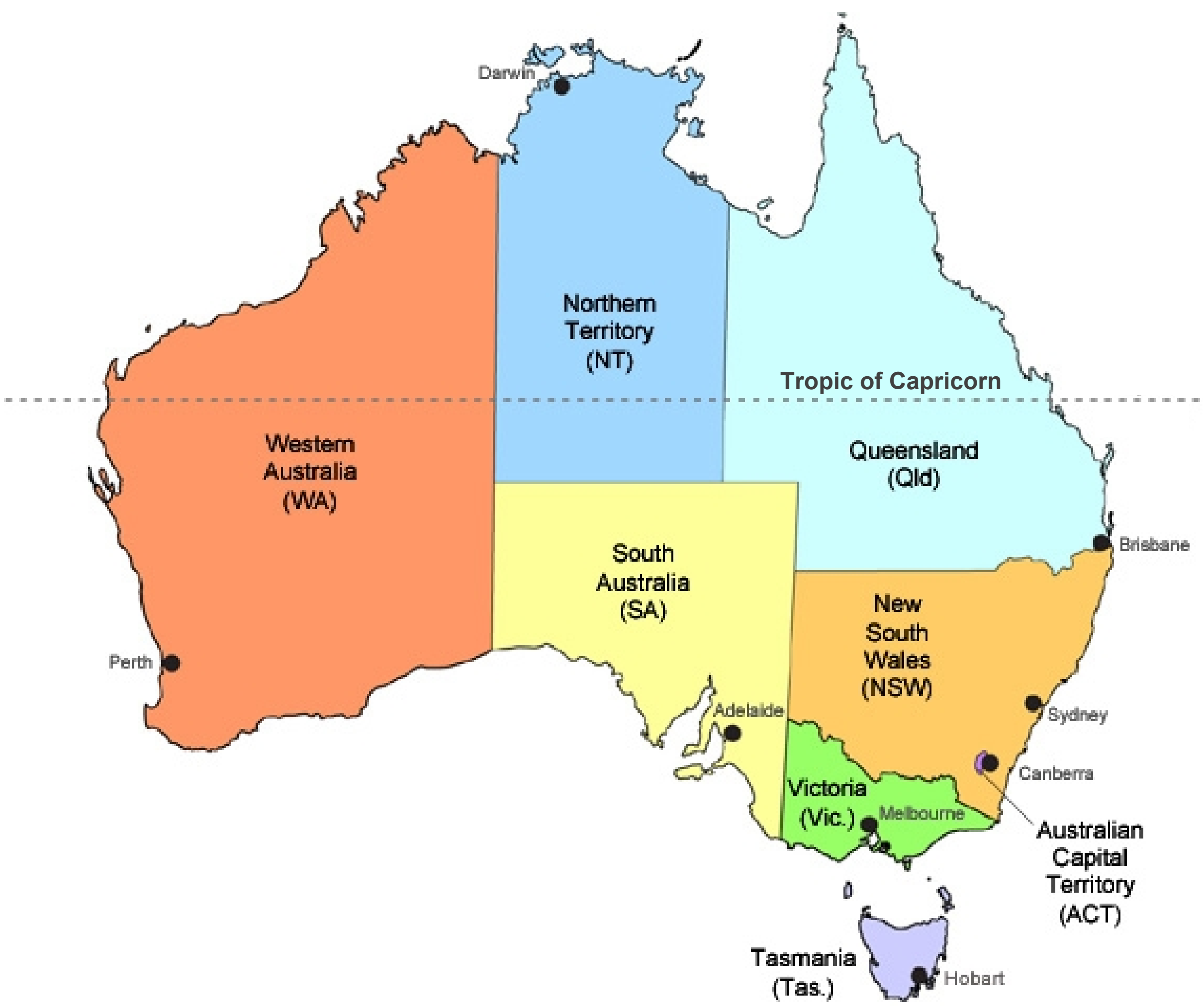


Acronyms and abbreviations

Term or abbreviation	Definition
ACG	Australian Citrus Growers Inc. (Citrus Australia Ltd; as of November 2008)
ALPP	Area of low pest prevalence
ALOP	Appropriate level of protection
APAL	Apple and Pear Australia Ltd
APHIS	Animal and Plant Health Inspection Service, United States Department of Agriculture
APPD	Australian Plant Pest Database (Plant Health Australia)
AQIS	Australian Quarantine and Inspection Service
BA	Biosecurity Australia
CABI	CAB International, Wallingford, UK
CAD	Chinese Ant Database
CMI	Commonwealth Mycological Institute
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DAFWA	Department of Agriculture and Food – Western Australia
DAWA	Department of Agriculture – Western Australia (previous name of DAFWA)
DOACS	Florida Department of Agriculture and Consumer Services
E	East
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization of the United Nations
FFTC	Food and Fertilizer Technology Centre (Taipei, Taiwan)
GPS	Global positioning system
ICA	Interstate Certification Assurance
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IRA	Import Risk Analysis
ISPM	International Standard for Phytosanitary Measures
IVA	Independent Verification Assurance
JAID	Japanese Ant Image Database
JSAE	Japanese Society of Applied Entomology and Zoology
JSCC	Japan Society for Culture Collections
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
MAFNZ	Ministry of Agriculture and Forestry – New Zealand
N	North
NaOCl	Sodium hypochlorite (bleach)
NPPO	National Plant Protection Organization
NSW	New South Wales
NT	Northern Territory
PC	Phytosanitary certificate

Term or abbreviation	Definition
Qld	Queensland
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia

Abbreviations of units

Term or abbreviation	Definition
Are	unit for area of 10 m^2
ºC	degree Celsius
ºF	degree Fahrenheit
kg	kilogram
km	kilometre
m	metre
μ	micrometre (one millionth of a metre)
ml	millilitre
mm	millimetre
ppm	parts per million
s	second

Summary

This import risk analysis assesses a proposal from Japan for market access to Australia for fresh unshu mandarin fruit.

Australia has existing quarantine policy that allows the importation of various citrus fruits from Israel, New Zealand, Spain and specific states of the United States of America (Arizona, California, Texas) for human consumption. There is no policy that exists for the importation of unshu mandarin fruit into Australia.

This provisional final report recommends that the importation of fresh unshu mandarin fruit (*Citrus unshiu* Marcow.) to Australia from four designated export areas in the Shizuoka Prefecture be permitted, subject to specific quarantine conditions.

This import policy allows fruit from four designated export areas surveyed for over 40 years and found free of citrus canker. However, as these areas are located in a production area where there is the potential for low pest prevalence, measures are required. The conditions include a requirement that the designated export areas are surveyed at least twice a year and found free from citrus canker.

The report takes account of stakeholders' comments on a 2002 technical issues paper and the 2008 draft import risk analysis report.

The report identifies pink citrus rust mite, apple heliodinid, mealybugs, leafroller moths, thrips, Japanese orange fly, citrus scab and citrus canker as pests that require quarantine measures to manage risks to a very low level in order to achieve Australia's appropriate level of protection (ALOP).

The recommended quarantine measures are a combination of risk management measures and an operational system that will reduce the risk associated with the importation of fresh unshu mandarin fruit from four designated export areas (Areas 1–4) near Fujieda City, Shizuoka Prefecture, into Australia to a very low level consistent with Australia's ALOP, specifically:

- inspection for pink citrus rust mite, apple heliodinid, mealybugs, leafroller moths and thrips, and remedial action if these pests are detected
- continuation of the existing surveillance program for Japanese orange fly to verify area freedom for the designated export areas
- orchard inspection, orchard control and orchard freedom from symptoms of citrus scab
- a systems approach for citrus canker, requiring the following mandatory measures:
  - unshu mandarin fruit for export to Australia to be sourced only from registered orchards within four designated export areas in Japan (Areas 1–4)
  - freedom from symptoms of citrus canker of the designated export areas for a minimum of two years prior to registration of orchards for export to Australia each season
  - freedom from symptoms of citrus canker during the growing season based on monitoring of the registered export orchards after petal fall and prior to harvest
  - an additional survey of the export areas if a typhoon should be recorded at the meteorological station in Shizuoka City before the end of August of each year

- copper sprays in accordance with the unshu mandarin spray calendar for Japan for the registered export orchards
- control for citrus leafminer in accordance with the unshu mandarin spray calendar for Japan for the registered export orchards
- restrictions on movement of host material into the export areas
- post-harvest chemical treatment

- a supporting operational system to maintain and verify the phytosanitary status of consignments. The Australian Quarantine and Inspection Service (AQIS) will verify that the recommended phytosanitary measures have occurred and will be present to pre-clear consignments prior to export.

Japan is to immediately notify AQIS of any changes to the current distribution of citrus greening outside of the export areas and the current movement restrictions for its host commodities.

Citrus rust thrips has been identified as a quarantine pest for Western Australia, western flower thrips has been identified as a quarantine pest for Tasmania and the Northern Territory and melon thrips has been identified as a quarantine pest for Western Australia, South Australia, Tasmania and the Northern Territory. The recommended quarantine measures take account of these regional differences.

This provisional final import risk analysis report is open to appeal. Stakeholders who believe there was a significant deviation from the IRA process set out in the *Import Risk Analysis Handbook 2007* that adversely affected their interests may appeal to the Import Risk Analysis Appeals Panel (IRAAP). The IRAAP has advised that written appeals must be received by Monday, 11 May 2009.

The appeals process is independent of Biosecurity Australia. The IRAAP will consider any appeal and report its findings to the appellant(s) and the Director of Animal and Plant Quarantine within 45 days of the closing day for appeals. At the conclusion of the appeal process, and after any issues arising from the appeal process have been addressed, the Chief Executive of Biosecurity Australia will provide a final report recommending a quarantine policy to the Director of Animal and Plant Quarantine for determination. The Director of Animal and Plant Quarantine makes the policy determination.

1 Introduction

1.1 Australia's biosecurity policy framework

Australia's biosecurity policies aim to protect Australia against the risks that may arise from exotic pests[1] entering, establishing and spreading in Australia, thereby threatening Australia's unique flora and fauna, as well as those agricultural industries that are relatively free from serious pests.

The import risk analysis (IRA) process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the risks that could be associated with proposals to import new products into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP), risk management measures are proposed to reduce the risks to an acceptable level. But, if it is not possible to reduce the risks to an acceptable level, then no trade will be allowed.

Successive Australian Governments have maintained a conservative, but not a zero-risk, approach to the management of biosecurity risks. This approach is expressed in terms of Australia's ALOP, which reflects community expectations through government policy and is currently described as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's IRAs are undertaken by Biosecurity Australia using teams of technical and scientific experts in relevant fields, and involves consultation with stakeholders at various stages during the process. Biosecurity Australia provides recommendations for animal and plant quarantine policy to Australia's Director of Animal and Plant Quarantine (the Secretary of the Australian Department of Agriculture, Fisheries and Forestry). The Director, or delegate, is responsible for determining whether or not an importation can be permitted under the *Quarantine Act 1908*, and if so, under what conditions. The Australian Quarantine and Inspection Service (AQIS) is responsible for implementing appropriate risk management measures.

More information about Australia's biosecurity framework is provided in Appendix C of this report and in the *Import Risk Analysis Handbook 2007* located on the Biosecurity Australia website www.biosecurityaustralia.gov.au.

1.2 This import risk analysis

1.2.1 Background

In 1989, Japan indicated that it wished to send fresh unshu mandarin fruit, *Citrus unshiu* Marcow., to Australia and subsequently provided pest lists in 1990 and 1992. In 1998, Japan advised that access for fresh unshu mandarin was their next priority after fuji apple (*Malus pumila* Miller *var. domestica* Schneider), for which Japan gained access from the Aomori Prefecture into Australia in December 1998.

In a letter in March 2001, Japan proposed to export fresh unshu mandarin fruit from the whole of the Shizuoka Prefecture. Following Japan's letter in March 2001, Biosecurity Australia

[1] A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2007b)

issued a Plant Biosecurity policy memorandum (PBPM 2001/05) advising stakeholders of Japan's import proposal for fresh unshu mandarin fruit from the whole of the Shizuoka Prefecture into Australia.

On 29 January 2002 (PBPM 2002/03), stakeholders were advised of the commencement of an IRA for the importation of fresh unshu mandarin fruit from Japan. This was followed by the release of a technical issues paper for this IRA (PBPM 2002/49) on 6 December 2002, in which stakeholders were invited to provide comments on the background to the IRA and preliminary results of pest categorisation. Comments made by stakeholders on the technical issues paper were considered and, where appropriate, incorporated into the draft IRA report (July 2008). Copies of the relevant memoranda are available on the Biosecurity Australia website www.biosecurityaustralia.gov.au.

In December 2003, following stakeholder comments on the technical issues paper and further discussions with Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) on the incidence of citrus canker within the Shizuoka Prefecture, Japan limited its proposal to four smaller designated export areas (Area 1–4) near Fujieda City within the Shizuoka Prefecture on Honshu Island. Fruit from these areas is exported to phytosanitary markets, including the USA and New Zealand which impose phytosanitary conditions for citrus canker. However, the designated export areas (Area 1–4) near Fujieda City have been monitored for citrus canker since export to the United States of America (USA) commenced in 1968 and have had no incidence of citrus canker during this period.

Officers from Biosecurity Australia observed the production of unshu mandarin in the designated export areas near Fujieda City in June 2006. In July 2007, officers from Biosecurity Australia visited the designated export areas to verify the commercial production practices, and the local packing house where fruit from the export areas is packed.

A draft IRA report was issued in July 2008 for stakeholder comment. Comments received were considered and, where appropriate, incorporated into this provisional final IRA report.

1.2.2 Scope

This report assesses the biosecurity risks associated with the importation into Australia of individual fresh unshu mandarin (*Citrus unshiu*) fruit, with all other vegetative parts removed, from the production area near Fujieda City, in the Shizuoka Prefecture, as described in Chapter 3. This production area includes the four designated areas from which fresh unshu mandarin fruit is currently exported with phytosanitary conditions to the USA and New Zealand (Figures 3.1 and 3.2).

The unrestricted risk for the identified quarantine pests is assessed for the production area, taking into account commercial production practices. Phytosanitary conditions for the export of fresh unshu mandarin fruit to the USA and New Zealand were not considered when assessing the unrestricted risk.

Export volumes to Australia are expected to be small, as the total area of the designated export areas (Areas 1–4) consists of only about 25 hectares. Export volumes of fresh unshu mandarin fruit to the USA from these designated export areas averaged a total of 230 tonnes per annum between 1995 and 2005 (APHIS 2006). Since February 2000, small quantities of fresh unshu mandarins have also been exported from the same export areas to New Zealand. During their site visit in 2007, Biosecurity Australia officers were informed that a total production of 600 tonnes was forecasted for the 2006/07 season.

This import policy specifically relates to the assessment of the identified pests, including citrus canker, and the potential for the introduction of these pests on the fruit pathway of unshu mandarin from four designated export areas (Areas 1–4) in Japan into Australia. This policy does not represent or replace Australia's import policy for any other citrus canker host commodities. Each future commodity import request will be assessed on its own merits.

1.2.3 Existing policy

International policy

Fresh mandarins/tangerines (*Citrus reticulata*) may be imported for human consumption into Australia from Israel, New Zealand, Spain and the USA (California, Arizona, Texas), subject to specific import conditions. Other fresh citrus fruit, including cumquat, calamondin, etrogs, grapefruit, lemon, lime, orange, pomelo, tangelo and tangor are also permitted entry into Australia from various exporting countries, subject to specific quarantine measures. Details of the current import requirements for citrus fruit are available at the AQIS Import Conditions database http://www.aqis.gov.au/icon.

Domestic arrangements

The Australian Government is responsible for regulating the movement of plants and plant products into and out of Australia. However, the state and territory governments are responsible for plant health controls within Australia. Legislation relating to resource management or plant health may be used by state and territory government agencies to control interstate movement of plants and their products.

1.2.4 Transition into the regulated process

The Australian Government announced changes to the IRA process on 18 October 2006. The new regulated process applies to all IRAs announced by Biosecurity Australia on or after the commencement of the *Quarantine Amendment Regulations 2007 (No.1)* on 5 September 2007.

On 12 September 2007, Biosecurity Australia announced in Biosecurity Australia Policy Memorandum (BAPM) 2007/20 the transitional arrangements for its current import proposal work program. In the memorandum, stakeholders were advised that the import proposal for fresh unshu mandarin fruit from Japan would be finalised under the regulated IRA process. It also advised that previous work or comparable steps already completed would not be repeated under the regulated process.

On 19 March 2008, Biosecurity Australia announced in Biosecurity Australia Advice (BAA) 2008/9 the formal commencement of an IRA under the regulated process to consider the proposal to import fresh unshu mandarin from Japan. It also advised that the analysis would be undertaken as a standard IRA requiring completion within 24 months. The IRA process is described in the *Import Risk Analysis Handbook 2007*.

Stakeholders were also advised that although the regulations allow a timeframe of 24 months to complete a standard IRA, in view of the significant body of work already undertaken, a draft report was expected to be released by 30 July 2008.

1.2.5 Contaminating pests

In addition to the pests of fresh unshu mandarin from designated export areas (Areas 1–4) near Fujieda City that are identified in this IRA, there are other organisms that may arrive with the fruit. These organisms could include pests of other crops or predators and parasitoids of other arthropods. Biosecurity Australia considers these organisms to be contaminating pests that could pose sanitary and phytosanitary risks. These risks are addressed by standard operating procedures.

1.2.6 Consultation

In August 2002, Biosecurity Australia released a technical issues paper for stakeholder consideration containing the background to this IRA and the categorisation of identified pests (BA 2002). Comments were received from five stakeholders and were incorporated into the draft IRA report (July 2008), where appropriate.

Comments were received from nine stakeholders on the draft IRA report. These were also considered and, where appropriate, have been incorporated into this provisional final IRA report.

1.2.7 Next steps

Stakeholders who believe there was a significant deviation from the IRA process set out in the *Import Risk Analysis Handbook 2007* that adversely affected their interests may appeal to the Import Risk Analysis Appeals Panel (IRAAP).

The appeals process is independent of Biosecurity Australia.

At the conclusion of the appeal process and after issues arising from the IRAAP process have been addressed, the Chief Executive of Biosecurity Australia will provide the final IRA report and recommendation for a policy determination to the Director of Animal and Plant Quarantine.

Further details of the appeal process may be found at Annex 6 of the *Import risk analysis handbook 2007*.

The Director of Animal and Plant Quarantine will then make a determination. The determination provides a policy framework for decisions on whether or not to grant an import permit and any conditions that may be attached to a permit. A policy determination represents the completion of the IRA process.

2 Method for pest risk analysis

In accordance with the International Plant Protection Convention, the technical component of a plant IRA is termed a 'pest risk analysis' (PRA). Biosecurity Australia has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for Pest Risk Analysis* (FAO 2007) and ISPM 11: *Pest Risk Analysis for Quarantine Pests, including analysis of environmental risks and living modified organisms* (FAO 2004).

A PRA is 'the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it' (FAO 2008). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2008).

Quarantine risk consists of two major components, the probability of a pest entering, establishing and spreading in Australia from imports and the consequences should this happen. These two components are combined to give an overall estimate of the risk.

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that minimal on arrival verification procedures will apply. Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is 'any legislation, regulation or official procedure having the purpose to prevent the introduction and spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests' (FAO 2008).

A glossary of the terms used is provided at the back of this IRA report.

The PRA was conducted in the following three consecutive stages.

2.1 Stage 1: Initiation

Initiation identifies the pest(s) and pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

The initiation point for this PRA was the receipt of a technical submission from the National Plant Protection Organisation (NPPO) for access to the Australian market for the commodity. This submission included information on the pests associated with the production of the commodity, including the plant part affected, and the existing commercial production practices for the commodity.

The pests associated with the crop and the exported commodity were tabulated from information provided by the NPPO of the exporting country, literature and database searches, and evidence that the pest is likely to infest or infect the commodity. This information is set out in Appendix A.

For this PRA, the 'PRA area' is defined as Australia for pests that are absent, or of limited distribution and under official control. For areas with regional freedom from a pest, the 'PRA area' may be defined on the basis of a state or territory of Australia or may be defined as a region of Australia consisting of parts of a state or territory or several states or territories.

For pests that had been considered by Biosecurity Australia in other risk assessments and for which import policies already exist, a judgement was made on the likelihood of entry of pests on the commodity and whether existing policy is adequate to manage the risks associated with its import. This judgement was based on ISPM 11 (FAO 2004) and included an assessment of the biology of the pest, environmental conditions and any significant differences between the pathways for entry. Where appropriate, the previous policy has been adopted.

2.2 Stage 2: Pest risk assessment

A pest risk assessment (for quarantine pests) is: 'the evaluation of the probability of the introduction and spread of a pest and of the likelihood of associated potential economic consequences' (FAO 2008).

In this PRA, pest risk assessment was divided into the following interrelated processes:

2.2.1 Pest categorisation

Pest categorisation identifies which of the pests identified in Stage 1 require a pest risk assessment. The categorisation process examines, for each pest, whether the criteria in the definition for a quarantine pest are satisfied. A 'quarantine pest' is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled, as defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2008).

The pests identified in Stage 1 were categorised using the following primary elements to identify the quarantine pests for the commodity being assessed:

- identity of the pest
- presence or absence in the PRA area
- regulatory status
- potential for establishment and spread in the PRA area
- potential for economic consequences (including environmental consequences) in the PRA area.

The results of pest categorisation are set out in Appendix A. The quarantine pests identified during pest categorisation were carried forward for pest risk assessment and are listed in Table 4.1.

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2004). A summary of this process is given below, followed by a description of the qualitative methodology used in this IRA.

Probability of entry

The probability of entry describes the probability that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state in the PRA area and subsequently be transferred to a host. It is based on pathway scenarios depicting necessary steps in the sourcing of the commodity for export, its processing, transport and storage, its utilisation in Australia and the generation and disposal of waste. In particular, the ability of the pest to survive is considered for each of these various stages.

The probability of entry estimates for the quarantine pests for a commodity are based on the use of the existing commercial production, packaging and shipping practices of the exporting country. Details of the existing commercial production practices for the commodity are set out in Section 3. These practices are taken into consideration by Biosecurity Australia when estimating the probability of entry.

For the purpose of considering the probability of entry, Biosecurity Australia divides this step of this stage of the PRA into two components:

Probability of importation: the probability that a pest will arrive in Australia when a given commodity is imported

Probability of distribution: the probability that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Factors considered in the probability of importation include:

- distribution and incidence of the pest in the source area
- occurrence of the pest in a life-stage that would be associated with the commodity
- volume and frequency of movement of the commodity along each pathway
- seasonal timing of imports
- pest management, cultural and commercial procedures applied at the place of origin
- speed of transport and conditions of storage compared with the duration of the lifecycle of the pest
- vulnerability of the life-stages of the pest during transport or storage
- incidence of the pest likely to be associated with a consignment
- commercial procedures (e.g. refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors considered in the probability of distribution include:

- commercial procedures (e.g. refrigeration) applied to consignments during distribution in Australia
- dispersal mechanisms of the pest, including vectors, to allow movement from the pathway to a host
- whether the imported commodity is to be sent to a few or many destination points in the PRA area
- proximity of entry, transit and destination points to hosts
- time of year at which import takes place
- intended use of the commodity (e.g. for planting, processing or consumption)
- risks from by-products and waste.

Probability of establishment

Establishment is defined as the ‘perpetuation for the foreseeable future, of a pest within an area after entry’ (FAO 2008). In order to estimate the probability of establishment of a pest, reliable biological information (lifecycle, host range, epidemiology, survival, etc.) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment.

Factors considered in the probability of establishment in the PRA area include:

- availability of hosts, alternative hosts and vectors
- suitability of the environment
- reproductive strategy and potential for adaptation
- minimum population needed for establishment
- cultural practices and control measures.

Probability of spread

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2008). The probability of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the probability of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread.

Factors considered in the probability of spread include:

- suitability of the natural and/or managed environment for natural spread of the pest
- presence of natural barriers
- the potential for movement with commodities, conveyances or by vectors
- intended use of the commodity
- potential vectors of the pest in the PRA area
- potential natural enemies of the pest in the PRA area.

Assigning qualitative likelihoods for the probability of entry, establishment and spread

In its qualitative PRAs, Biosecurity Australia uses the term 'likelihood' for the descriptors it uses for its estimates of probability of entry, establishment and spread. Qualitative likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 2.1). Descriptive definitions for these descriptors and their indicative probability ranges are given in Table 2.1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors. These indicative probability ranges are not used beyond this purpose in qualitative PRAs. The standardised likelihood descriptors and the associated indicative probability ranges provide guidance to the risk analyst and promote consistency between different risk analyses.

Table 2.1: Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition	Indicative probability (P) range
High	The event would be very likely to occur	$0.7 < P \le 1$
Moderate	The event would occur with an even probability	$0.3 < P \le 0.7$
Low	The event would be unlikely to occur	$0.05 < P \le 0.3$
Very low	The event would be very unlikely to occur	$0.001 < P \le 0.05$
Extremely low	The event would be extremely unlikely to occur	$0.000001 < P \le 0.001$
Negligible	The event would almost certainly not occur	$0 \le P \le 0.000001$

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2.2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the probability of importation is assigned a likelihood of ‘low’ and the probability of distribution is assigned a likelihood of ‘moderate’, then they are combined to give a likelihood of ‘low’ for the probability of entry. The likelihood for the probability of entry is then combined with the likelihood assigned to the probability of establishment (e.g. ‘high’) to give a likelihood for the probability of entry and establishment of ‘low’. The likelihood for the probability of entry and establishment is then combined with the likelihood assigned to the probability of spread (e.g. ‘very low’) to give the overall likelihood for the probability of entry, establishment and spread of ‘very low’.

Table 2.2: Matrix of rules for combining qualitative likelihoods

	High	**Moderate**	**Low**	**Very low**	**Extremely low**	**Negligible**
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate		Low	Low	Very low	Extremely low	Negligible
Low			Very low	Very low	Extremely low	Negligible
Very low				Extremely low	Extremely low	Negligible
Extremely low					Negligible	Negligible
Negligible						Negligible

Time and volume of trade

One factor affecting the likelihood of entry is the volume and duration of trade. If all other conditions remain the same, the overall likelihood of entry will increase as time passes and the overall volume of trade increases.

Biosecurity Australia normally considers the likelihood of entry on the basis of the estimated volume of one year’s trade. This is a convenient value for the analysis that is relatively easy to estimate and allows for expert consideration of seasonal variations in pest presence, incidence and behaviour to be taken into account. The consideration of the likelihood of entry, establishment and spread and subsequent consequences takes into account events that might happen over a number of years even though only one year’s volume of trade is being considered. This difference reflects biological and ecological facts, for example where a pest or disease may establish in the year of import but spread may take many years.

The use of a one year volume of trade has been taken into account when setting up the matrix that is used to estimate the risk and therefore any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on Biosecurity Australia’s method that uses the estimated volume of one year’s trade are consistent with Australia’s policy on appropriate level of protection and meet the Australian Government’s requirement for ongoing quarantine protection. Of course, if there are substantial changes in the volume and nature of the trade in specific commodities then Biosecurity Australia has an obligation to review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this PRA, Biosecurity Australia assumed that a small volume of specialised trade will occur (refer to Chapter 3).

2.2.3 Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the likely consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), ISPM 5 (FAO 2008) and ISPM 11 (FAO 2004).

Direct pest effects are considered in the context of the effects on:

- plant life or health
- other aspects of the environment.

Indirect pest effects are considered in the context of the effects on:

- eradication, control, etc.
- domestic trade
- international trade
- environment.

For each of these six criteria, the consequences were estimated over four geographic levels, defined as:

Local: an aggregate of households or enterprises (a rural community, a town or a local government area).

District: a geographically or geopolitically associated collection of aggregates (generally a recognised section of a state or territory, such as 'Far North Queensland').

Regional: a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).

National: Australia wide (Australian mainland states and territories and Tasmania).

For each criterion, the magnitude of the potential consequence at each of these levels was described using four categories, defined as:

Indiscernible: Pest impact unlikely to be noticeable.

Minor significance: Expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion's intrinsic value. Effects would generally be reversible.

Significant: Expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.

Major significance: Expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic 'value' of non-commercial criteria.

Values were translated into a qualitative impact score (A–G)[2] using Table 2.3.

Table 2.3: Decision rules for determining the consequence impact score

Impact score	Local	District	Regional	National
G	Major significance	Major significance	Major significance	Major significance
F	Major significance	Major significance	Major significance	Significant
E	Major significance	Major significance	Significant	Minor significance
D	Major significance	Significant	Minor significance	Indiscernible
C	Significant	Minor significance	Indiscernible	Indiscernible
B	Minor significance	Indiscernible	Indiscernible	Indiscernible
A	Indiscernible	Indiscernible	Indiscernible	Indiscernible
	Geographic level			

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 2.4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

Table 2.4: Decision rules for determining the overall consequence rating for each pest

Rule	The impact scores for consequences of direct and indirect criteria	Overall consequence rating
1	Any criterion has an impact of 'G'; or more than one criterion has an impact of 'F'; or a single criterion has an impact of 'F' and each remaining criterion an 'E'.	Extreme
2	A single criterion has an impact of 'F'; or all criteria have an impact of 'E'.	High
3	One or more criteria have an impact of 'E'; or all criteria have an impact of 'D'.	Moderate
4	One or more criteria have an impact of 'D'; or all criteria have an impact of 'C'.	Low
5	One or more criteria have an impact of 'C'; or all criteria have an impact of 'B'.	Very Low
6	One or more but not all criteria have an impact of 'B', and all remaining criteria have an impact of 'A'.	Negligible

[2] In earlier qualitative IRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating 'indiscernible' at all four levels. This combination might be applicable for some criteria. In this report, the impact scale of A-F has changed to become B-G and a new lowest category A ('indiscernible' at all four levels) was added. The rules for combining impacts in Table 2.4 were adjusted accordingly.

2.2.4 Estimation of the unrestricted risk

Once the above assessments are completed, the unrestricted risk can be determined for each pest or groups of pests. This is determined by using a risk estimation matrix (Table 2.5) to combine the estimates of the probability of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the product of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (e.g. low, moderate, high) but the vertical axis refers to likelihood and the horizontal axis refers to consequences. Accordingly, a 'low' likelihood combined with 'high' consequences, is not the same as a 'high' likelihood combined with 'low' consequences – the matrix is not symmetrical. For example, the former combination would give an unrestricted risk rating of 'moderate', whereas, the latter would be rated as a 'low' unrestricted risk.

Table 2.5: Risk estimation matrix

Likelihood of pest entry, establishment and spread						
High	Negligible risk	**Very low risk**	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	**Very low risk**	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	**Very low risk**	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	**Very low risk**	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	**Very low risk**	Low risk
Negligible	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	**Very low risk**
	Negligible	**Very low**	**Low**	**Moderate**	**High**	**Extreme**
	Consequences of pest entry, establishment and spread					

2.2.5 Australia's appropriate level of protection (ALOP)

The SPS Agreement defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Like many other countries, Australia expresses its ALOP in qualitative terms. Australia's ALOP, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 2.5 marked 'very low risk' represents Australia's ALOP.

2.3 Stage 3: Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve Australia's ALOP, while ensuring that any negative effects on trade are minimised.

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the appropriate measures to be used. Where the unrestricted risk estimate exceeds Australia's ALOP, risk management measures are required to reduce this risk to a very low level. The guiding principle for risk management is to manage risk to achieve Australia's ALOP. The effectiveness of any proposed phytosanitary measure (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure it reduces the restricted risk for the relevant pest or pests to meet Australia's ALOP.

ISPM 11 (FAO 2004) provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the probability of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments – e.g., inspection or testing for freedom from pests, prohibition of parts of the host, a pre-entry or post-entry quarantine system, specified conditions on preparation of the consignment, specified treatment of the consignment, restrictions on end-use, distribution and periods of entry of the commodity
- options preventing or reducing infestation in the crop – e.g., treatment of the crop, restriction on the composition of a consignment so it is composed of plants belonging to resistant or less susceptible species, harvesting of plants at a certain age or specified time of the year, production in a certification scheme
- options ensuring that the area, place or site of production or crop is free from the pest – e.g., pest-free area, pest-free place of production or pest-free production site
- options for other types of pathways – e.g., consider natural spread, measures for human travellers and their baggage, cleaning or disinfestation of contaminated machinery
- options within the importing country – e.g., surveillance and eradication programs
- prohibition of commodities – if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the risk exceeds Australia's ALOP. These are presented in the 'Pest Risk Management' section of this report.

3 Japan's commercial production practices for *Citrus unshiu*

3.1 Assumptions used to estimate unrestricted risk

Biosecurity Australia took into consideration the following information on the existing commercial production practices in Japan when estimating the unrestricted risks of pests likely to be associated with fresh unshu mandarin fruit produced in the production area near Fujieda City in the Shizuoka Prefecture. The information was verified when officers from Biosecurity Australia travelled to Japan in June 2006 and July 2007 to observe the existing commercial production practices and processing procedures for fresh unshu mandarin fruit in the production area and a nearby registered packing house for export unshu mandarin. These visits clarified Biosecurity Australia's understanding of the cultivation and harvesting methods, pest control and packing and transport protocols recommended to produce and export fresh unshu mandarin fruit to Australia. These protocols conform to commercial production practices (e.g. orchard management, hygiene and quality control).

3.2 Production area and designated export areas

The production area is near Fujieda City containing the four designated export areas (Figure 3.2) from which fresh unshu mandarin fruit would be exported to Australia. It is located in the Shizuoka Prefecture in the central part of Honshu Island that is part of the most northern citrus producing region in Japan (Figure 3.1). The production area is situated in the foothills of Mount Fuji, in the north-western inland region of Shizuoka Prefecture. These foothills reach 200–300 m in height.

Endemic *Cryptomeria japonica* forest and some deciduous mixed forest cover the ridgeline of hills surrounding this production area (Figure 3.3). These forested ridgelines present a natural buffer separating this unshu production area from other citrus growing areas within the Fujieda region. Horticultural production in the production area consists of unshu mandarin, bamboo and tea plantations (Figure 3.4). All four designated unshu mandarin export areas are situated on the lower slopes of steep, terraced hillsides (Figures 3.3 and 3.4). The export areas are uninhabited, but there is some habitation along the road within the production area. The closest population centre is Fujieda City, which lies to the east of the production area.

Japan indicated that the four designated export areas have a combined size of 25 hectares, consist of 150 orchards and 25 518 unshu mandarin trees. The majority of orchards within the four designated export areas participate in the export trade. These orchards are well established, consisting of mature, fruiting unshu mandarin trees. MAFF provided information that the orchards in the designated export areas commenced fruit exports from the existing trees to the USA more than 40 years ago. Mechanisation of orchards is minimal due to the steep terrain.

Figure 3.1: Major citrus growing areas in Japan

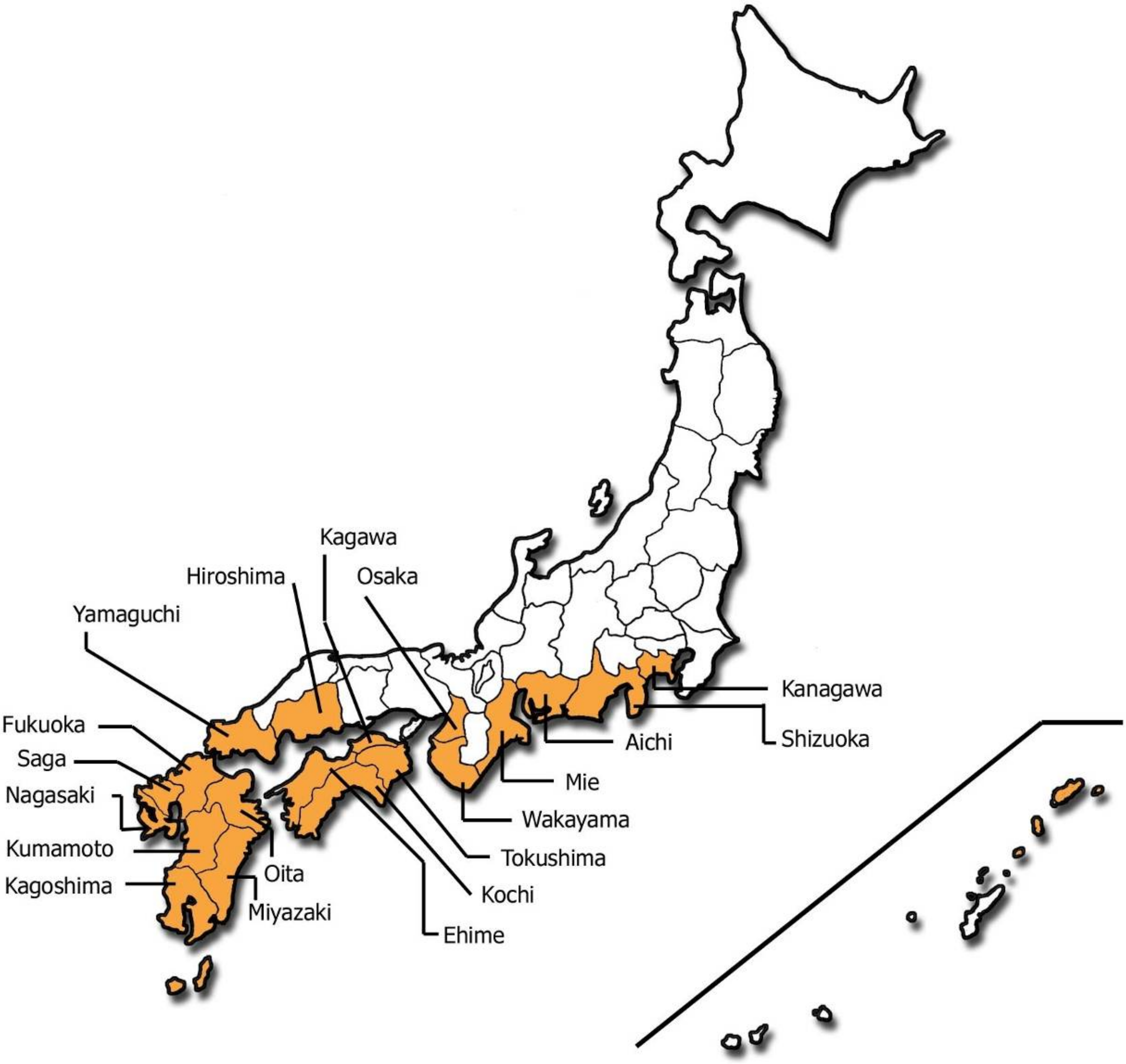
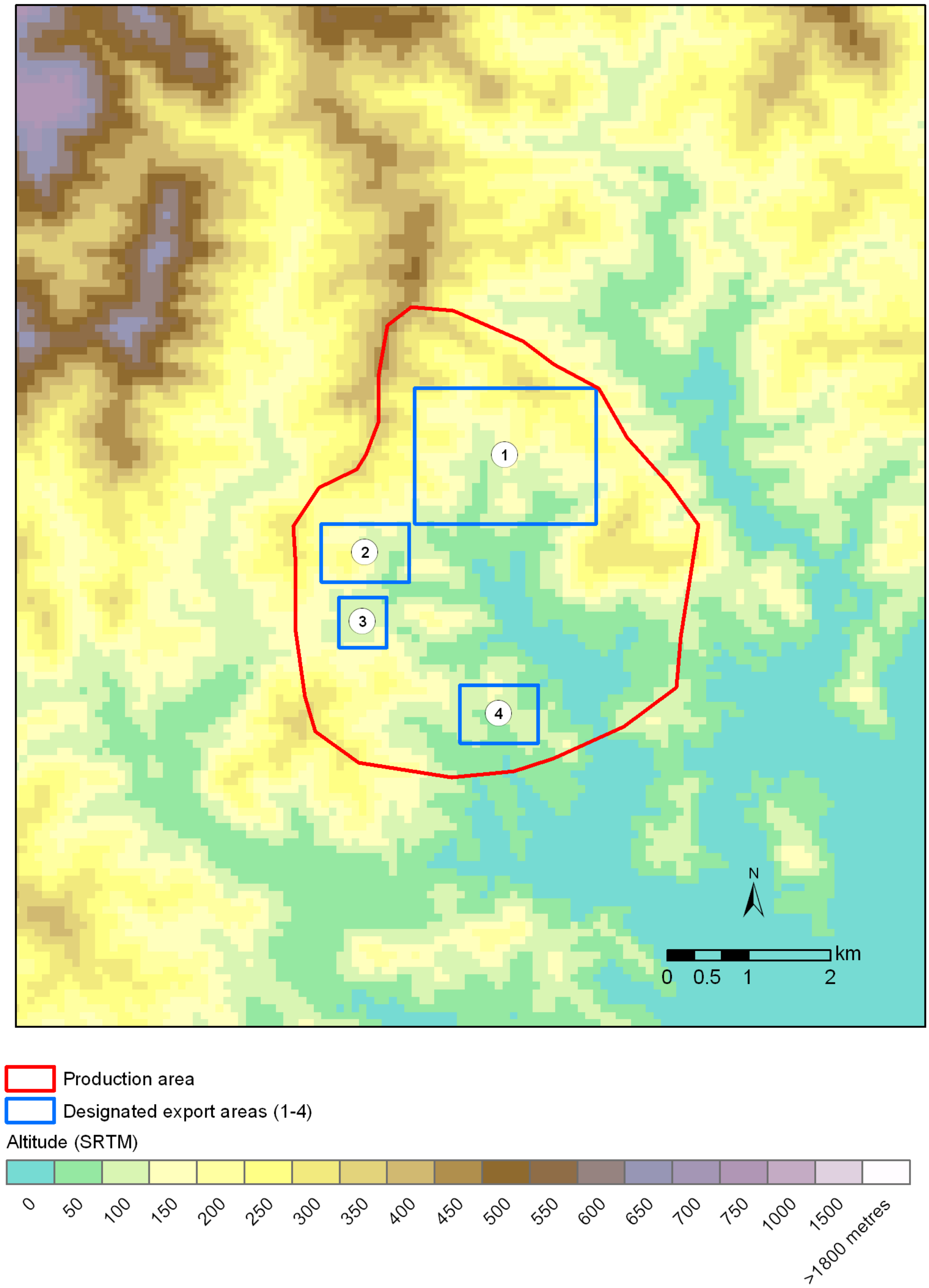


Figure 3.2: The unshu mandarin production area and the designated export areas (Areas 1–4) near Fujieda City, Shizuoka Prefecture



SRTM : Shuttle Radar Topographic Mission data

The outline that defines the production area is provided as a series of coordinates in ArcGIS. These coordinates are set out in Table 3.1.

Table 3.1: Coordinates for the production area

	Latitude	Longitude		Latitude	Longitude
1	N 3° 57'28"	E 138°13'29"	**15**	N 34°54'26"	E 138°13'08"
2	N 34°57'26"	E 138°13'47"	**16**	N 34°54'39"	E 138°12'50"
3	N 34°57'14"	E 138°14'13"	**17**	N 34°54'53"	E 138°12'46"
4	N 34°57'05"	E 138°14'27"	**18**	N 34°55'19"	E 138°12'43"
5	N 34°56'55"	E 138°14'45"	**19**	N 34°55'45"	E 138°12'43"
6	N 34°56'36"	E 138°14'56"	**20**	N 34°56'00"	E 138°12'43"
7	N 34°56'17"	E 138°15'10"	**21**	N 34°56'16"	E 138°12'54"
8	N 34°56'01"	E 138°15'25"	**22**	N 34°56'23"	E 138°13'08"
9	N 34°55'17"	E 138°15'17"	**23**	N 34°56'29"	E 138°13'11"
10	N 34°54'56"	E 138°15'14"	**24**	N 34°56'42"	E 138°13'15"
11	N 34°54'41"	E 138°14'52"	**25**	N 34°57'01"	E 138°13'15"
12	N 34°54'28"	E 138°14'27"	**26**	N 34°57'20"	E 138°13'19"
13	N 34°54'23"	E 138°14'09"	**27**	N 34°57'28"	E 138°13'29"
14	N 34°54'21"	E 138°13'44"			

Since the draft report, MAFF provided the coordinates that define the four designated export areas. These are listed in Table 3.2.

Table 3.2: Coordinates for the four designated export areas

Export areas	Latitude	Longitude
Area 1	N 34º56'56" to N 34º56'02"	E 138º13'31" to E 138º14'43"
Area 2	N 34º56'02" to N 34º55'39"	E 138º12'54" to E 138º13'29"
Area 3	N 34º55'33" to N 34º55'13"	E 138º13'01" to E 138º13'20"
Area 4	N 34º54'58" to N 34º54'35"	E 138º13'49" to E 138º14'20"

Figure 3.3: Orchard within the designated export areas

Figure 3.4: Orchard within the designated export areas surrounded by tea, bamboo and mixed tree vegetation

Figure 3.5: Mature unshu mandarin tree grafted on *Poncirus trifoliata*

Figure 3.6: Slashed interrows

Figure 3.7: Fruit processing plant

Figure 3.8: Packing box for unshu mandarin fruit destined for the USA

3.3 Climate in the production area

In 2007 Japan provided climatic information for the production area from the closest meteorological station at Shizuoka City (Table 3.3). Shizuoka City is situated in the coastal lowlands of Shizuoka Prefecture about 50 km to the north-east of the production area. The Prefecture, except for the northern mountainous region, has a mild oceanic climate throughout the year. Seasons in all parts of the Prefecture are distinct; the spring is mild, followed by a rainy (>1000 mm average rainfall) and then hot and sunny summer, cool autumn and cool and dry winter. The average annual temperature within the Prefecture is 16ºC and the average annual rainfall is 2360 mm (Anon 2008).

Table 3.3: Rainfall and temperature figures for Shizuoka City

Averages for the years 2002 to 2006

Month	Rainfall (mm)	Minimum Temperature (ºC)	Maximum Temperature (ºC)
January	86.3	–2.7	17.9
February	97.7	–1.5	20.2
March	183.0	–0.6	22.4
April	175.3	5.7	29.1
May	210.1	10.5	29.8
June	298.3	14.9	33.2
July	373.9	20.2	35.6
August	335.9	20.3	36.0
September	212.7	16.3	33.5
October	342.1	9.6	30.0
November	132.9	4.8	24.4
December	77.4	–1.0	20.4

During summer and early autumn (generally July to October), Japan experiences a number of strong weather events known as typhoons. An average of three typhoons per year approach the coastline of the Tokai region, which includes the Aichi, Gifu, Mie and Shizuoka Prefectures (Table 3.4). The impact of typhoons is felt on the flat coastal lowlands, including the coastline of Shizuoka Prefecture. Biosecurity Australia officers, during their site visit in 2007, were advised that the mountainous inland terrain that surrounds the production area provides shelter from typhoons.

Table 3.4: Number of typhoons that approached the Tokai region

Month	Typhoon events from 2001 to 2006[§*]					
	2001	2002	2003	2004	2005	2006
May	–	–	1	1	–	–
June	–	–	–	2	–	–
July	–	2	–	1	1	–
August	1	1	1	2	1	1
September	2	–	1	2	1	–
October	1	1	–	2	–	–
November	–	–	–	–	–	–
TOTAL	**4**	**4**	**3**	**10**	**3**	**1**

[§]A typhoon event is registered for a prefecture when its centre came within 300 km [or less] of their bureau of meteorology. *No typhoon events were recorded during the months of December to April.

3.4 Commercial production and export information

3.4.1 Description of unshu mandarin

Unshu mandarin (*Citrus unshiu* Marcow.) is widely known as satsuma mandarin or unshu mikan in Japan. This mandarin probably originates in Japan (USDA 2008). For this reason, reference to unshu mandarin or satsuma mandarin and information pertaining to both are considered equivalent and are used interchangeably in this report.

Japan stated that citrus production in the export areas is limited to unshu mandarins, consisting of the Aoshima and Miyagawa Wase varieties grafted on the trifoliate orange (*Poncirus trifoliata*) rootstock (Figure 3.5). Both of these seedless varieties are grown in about equal proportion in the export areas. Trees are relatively small (about 2 metres in height) and thornless. Leaf flush of these mature trees occurs once per year during spring/early summer in June/July, prior to flowering. Fruit of both varieties ripens during December. This report assesses the fruit of the species unshu mandarin (*C. unshiu* Marcow.).

3.4.2 Production

Orchards within the designated export areas are well established and consist of mature trees at a density of about 1000 trees per hectare. The commercial life of an orchard is estimated to be 30–40 years. In the Shizuoka Prefecture, yields of unshu mandarin average 15 tonnes per hectare. Mature (i.e. more than 10 year old) plantings can achieve yields of about 30 tonnes per hectare (Harty and Anderson 1997).

On their field visit to orchards in the proposed unshu mandarin export areas in July 2007, Biosecurity Australia officers observed that the health of unshu mandarin trees, developing fruit and general orchard hygiene was very good. This included orchards that were not registered for the existing export programs to the USA and New Zealand and instead supply the domestic market.

Unshu mandarin trees in the designated export areas were of equal size and evenly spaced. Foliage, stems and fruit were healthy. Citrus leafminer damage was only found in single incidences in orchards that were visited. Leaves appeared to be free from wind damage.

The hygiene and maintenance standard of orchards not registered for any of the existing export programs appeared to be the same as that of export orchards. Very few replanted unshu mandarin trees were observed. No obvious overgrown and neglected orchards were encountered in the whole of the visited production area. The number of unshu mandarin orchards in the visited area is declining as these orchards, for economic reasons, are replaced with either tea or *Cryptomeria* plantations.

3.4.3 Cultivation practices

Unshu mandarin trees within the designated export areas are well established (Figure 3.5). Mature trees are pruned during February to March prior to a single annual leaf flush during spring/early summer in June/July. This is in contrast to immature unshu trees, which would flush three times per year during spring, summer and autumn. Biosecurity Australia officers visiting the designated export areas in 2007 were informed that fruit set does not undergo thinning.

Orchards are slashed (by hand) for weed control. There is no evidence of intercropping between tree rows (Figure 3.6). Pesticide control in the designated export areas is carried out manually without the use of mechanised spray equipment. The existing commercial practice for the control of insect pests and diseases of unshu mandarin production in Japan are listed in Table 3.5.

Japan informed Biosecurity Australia that all orchards exporting fruit to Australia would operate under existing commercial practices. Growers are responsible for maintaining adequate records relating to pest control, spray diaries and orchard monitoring to confirm that the nominated existing commercial practices are used, and exporters will need to comply with other relevant standards such as Australian Food Standards[3].

[3] Biosecurity Australia does not specifically consider chemical residue issues in the IRA process as it is not under the jurisdiction of the agency. All food, i.e. imported and domestically produced food, available for sale in Australia, is required to comply with the Australia New Zealand Food Standards Code (the FSC). Food Standards Australia New Zealand (FSANZ) is the Australian Government body responsible for the FSC. FSANZ randomly tests all food commodities to ensure that they are within Australia's maximum residue limits (MRLs). FSANZ also recommends to AQIS appropriate monitoring and testing of imported foods, including horticultural products. Currently, horticultural products are deemed a low food safety risk by FSANZ and testing is therefore conducted by AQIS Imported Food Safety on a random basis at the rate of 5% of imported consignments in addition to items where there is reason to suspect that there may be residue issues.

Table 3.5: The indicative unshu mandarin spray calendar (2007) for Japan[4]

Spray period	Applicable pest/s	Active ingredient
Late December to mid-January or March	Scale insects, Citrus red mite Citrus canker, Melanose	Machine oil Copper sulphate and copper carbonate
Mid to end April	Citrus red mite Citrus scab	Machine oil Imibenconazole
Mid to end May (early petal fall period)	Botrytis rot, Grey mould Citrus canker Citrus scab	Cyprodinil, Fludioxonil Copper sulphate and copper carbonate Kresoxim-methyl
Early to mid June	Yellow tea thrips Melanose, Black spot Citrus red mite, Arrowhead scale Citrus scab	Imidacloprid Mancozeb Machine oil Diethofencarb; Thiophanate-methyl
Early July	Yellow tea thrips Melanose, Black spot	Chloropenable Mancozeb
Mid-July	Melanose, Black spot White-spotted longicorn beetle	Mancozeb Acetamprid
Late July	Yellow tea thrips Melanose, Black spot Citrus leafminer Citrus red mite Scale insects, including *Ceroplastes* spp.	Thiamethoxam Mancozeb Acephate Bifenazate Methidathion
Mid to late August	Yellow tea thrips Melanose, Black spot Scale insects	Acetamprid Mancozeb Methidathion
Mid-September	Yellow tea thrips Shield bugs Leafroller moths Melanose, Black spot Brown rot	Acephate; Bifenthrin; Spirodiclofen; Etoxazole Bifenthrin; Fenpropathrin Dichlorvos Mancozeb Kresoxim-methyl
After mid-October	Citrus red mite Leafhoppers	Acequinocyl; Milbemectin Fenpropathrin
Before harvesting	Post-harvest disease (e.g. Blue mould, Green mould, White mould)	Iminoctadine acetate; Benomyl; Thiophanate-methyl

[4] This calendar summarises the individual active ingredients commonly used for the control of the listed pests during the unshu mandarin production season for the whole of Japan. Spray applications will vary between the unshu production regions in Japan, depending on the absence/presence of the pest and its varying pest pressure between production seasons.

3.4.4 Post-harvest

Fruit is harvested by hand and immediately and directly transported to the current packing house. The current packing house is situated about 5 km from the designated export areas in nearby Fujieda City (Figure 3.2). The packing house receives citrus fruit for processing, for the domestic market and a number of existing export markets. Fruit grown on about 25 hectares is packed for export.

The current packing house viewed by Biosecurity Australia officers in 2007 was built in 1998 and received its first fruit for processing in 1999. Two methyl bromide fumigation chambers (remodelled containers) are present at the facility. An image of the packing house is shown in Figure 3.7 and the schematic processing steps at this facility are presented in Figure 3.9. Fruit processing is fully segregated depending on its destination to either the domestic market or to any of the export markets.

On receipt at the facility, the fruit is identified according to the registered grower and processed on an orchard basis. It is then loaded onto a conveyor belt and sorted visually for blemishes, bruises, peel puff and colour. Fruit for export to the USA is then fully submersed for two minutes in a post-harvest dip, which consists of a chlorine solution with a minimum of 200 ppm of available chlorine. New Zealand does not require a post-harvest dip. After cool air drying, fruit undergoes further sorting and testing for fruit sugar content. It then is packaged into 8 kg cardboard boxes (Figure 3.8), each containing 50–60 fruit. Fruit is not waxed.

Fruit is processed on the day of picking. There is no processing of fruit at night. On the following day after inspection, cartons destined for export are palletised and moved in secure, fully enclosed transport trucks to the port of export at Shimizu in the Shizuoka Prefecture. On arrival at the port, cartons are re-loaded at a bonded warehouse from the fully enclosed truck into a sea container. The container is sealed and customs procedures are completed.

Japan advised that fruit destined for markets in the USA and New Zealand are shipped in refrigerated containers maintained at 6ºC and 4ºC, respectively. Voyages to these countries take about four and two weeks, respectively. Biosecurity Australia has not been advised of the reason for the variation between shipping temperatures.

Post-harvest treatment is not included in assessing the unrestricted risk for the identified quarantine pests (Chapter 4).

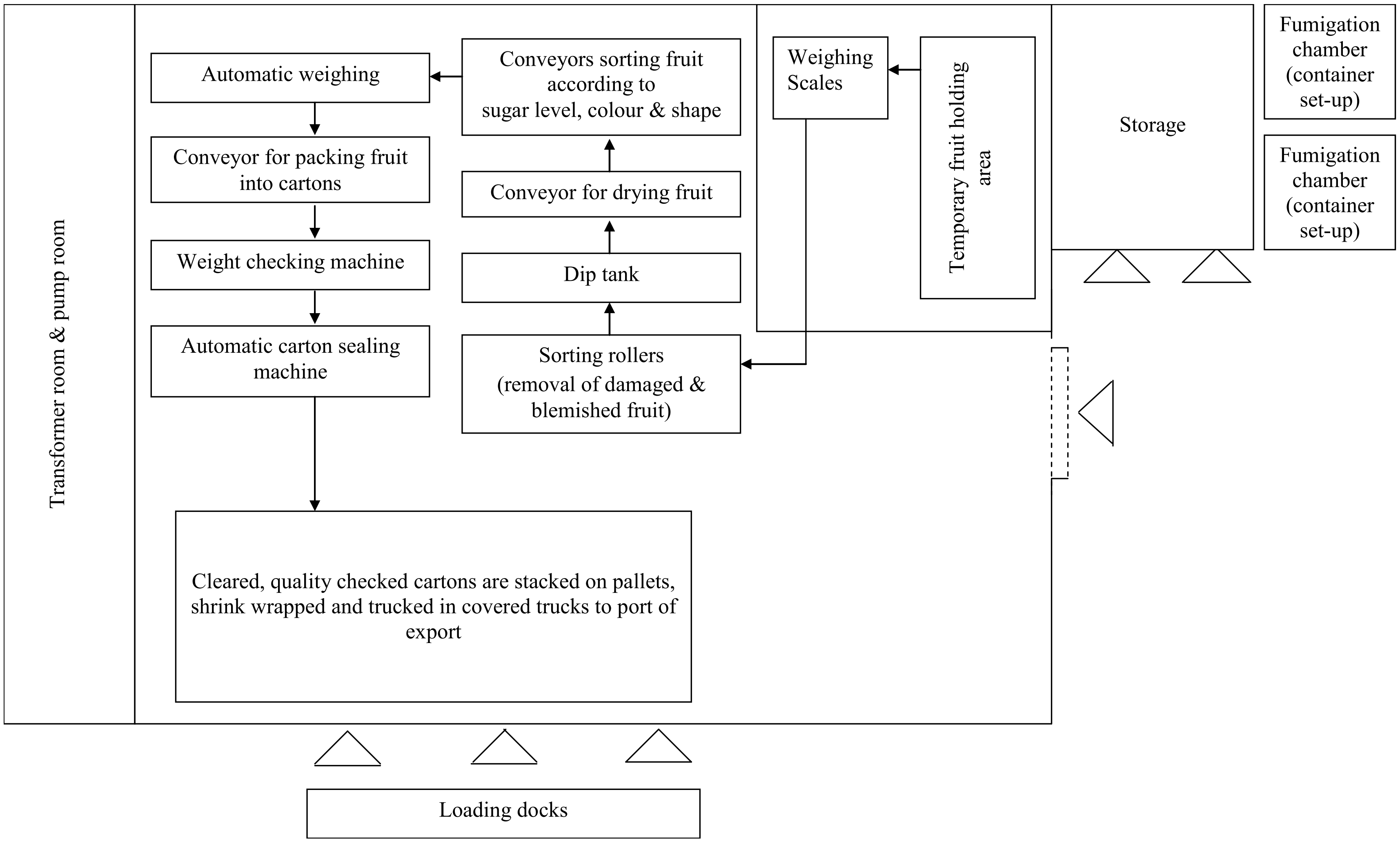
3.4.5 Exports

Japan stated that the designated export areas to Australia already have established export programs in place. Japan has been exporting to countries with phytosanitary requirements such as the USA, New Zealand and Thailand since 1968, 2000 and 2007, respectively.

Export quantities from the designated export areas have been small. Exports to the USA averaged a total of 230 tonnes per year from 1995 to 2005 (APHIS 2006). Since February 2000, small quantities of fresh unshu mandarins have also been exported from the same export areas to New Zealand. An above average production of 600 tonnes was expected for the combined designated export areas for the 2007/08 harvest season.

Fruit ripens during December (refer to Section 3.4.1), the expected export season.

Figure 3.9: Schematic layout of the processing steps at the current packing house at Fujieda City



4 Pest risk assessments for quarantine pests

4.1 Quarantine pests for pest risk assessment

Pest categorisation (Appendix A), using the pest list for Japan, identified 34 pests associated with fresh unshu mandarin fruit from the production area. These quarantine pests are listed in Table 4.1.

Table 4.1: Quarantine pests for fresh unshu mandarin fruit from the production area

The relevant state or territory for pests of regional concern are shown in parentheses.

Pest	Common name
Eriophyid mites [Acarina: Eriophyidae]	
Aculops pelekassi (Keifer, 1959)	Pink citrus rust mite
Spider mites [Acarina: Tetranychidae]	
Panonychus citri (McGregor, 1916) (WA, NSW)	Citrus red mite
Armoured scales [Hemiptera: Diaspididae]	
Howardia biclavis (Comstock, 1883) (WA, SA)	Mining scale
Ischnaspis longirostris (Signoret, 1982) (WA)	Black thread scale
Lepidosaphes gloverii (Packard, 1869) (SA)	Glover scale
Lepidosaphes pinnaeformis Bouché, 1851 (WA)	Purple scale
Lopholeucaspis japonica (Cockerell, 1897)	Pear white scale
Morganella longispina (Morgan, 1889) (WA, SA)	Plumose scale
Parlatoria cinerea Doane and Hadden, 1909	Armoured scale
Parlatoria pergandii Comstock, 1881(WA, SA)	Chaff scale
Parlatoria theae (Cockerell, 1896)	Tea parlatoria scale
Parlatoria ziziphi (Lucas, 1853)	Citrus scale
Pseudaonidia duplex (Cockerell, 1896)	Camphor scale
Pseudaonidia trilobitiformis (Green, 1896) (WA, SA)	Trilobite scale
Unaspis euonymi (Comstock, 1881)	Euonymus scale
Unaspis yanonensis (Kuwana, 1923)	Arrowhead scale
Mealybugs [Hemiptera: Pseudococcidae]	
Planococcus kraunhiae (Kuwana, 1902)	Japanese mealybug
Planococcus lilacinus (Cockerell, 1905)	Coffee mealybug
Pseudococcus comstocki (Kuwana, 1902)	Comstock mealybug
Pseudococcus cryptus Hempel, 1918	Citrus mealybug

Pest	Common name
Leafroller moths [Lepidoptera: Tortricidae]	
Adoxophyes dubia Yasuda, 1998	Leafroller moths
Adoxophyes honmai Yasuda, 1988	
Adoxophyes orana fasciata Walsingham, 1900	
Homona magnanima Diakonoff, 1948	
Bagworms [Lepidoptera: Psychidae]	
Eumeta japonica (Heylaerts, 1884)	Giant bagworm
Eumeta minuscula Butler, 1881	Tea bagworm
Thrips [Thysanoptera: Thripidae]	
Chaetanaphothrips orchidii (Moulton, 1907) (WA)	Citrus rust thrips
Frankliniella intonsa (Trybom, 1895)	Intonsa flower thrips
Frankliniella occidentalis (Pergande, 1895) (NT, Tas.)	Western flower thrips
Thrips palmi Karny 1925 (NT, SA, Tas., WA)	Melon thrips
Heliodinids [Lepidoptera: Oecophoridae]	
Stathmopoda auriferella (Walker, 1864)	Apple heliodinid
Fruit flies [Diptera: Tephritidae]	
Bactrocera tsuneonis (Miyake, 1919)	Japanese orange fly
Fungi [Miriangiales: Elsinoaceae]	
Sphaceloma fawcettii Bitanc. & Jenkins 1936	Citrus scab (exotic pathotypes)
Bacteria [Xanthomonadales: Xanthomonadaceae]	
Xanthomonas citri subsp. *citri* (*ex* Hasse 1915) Gabriel *et al.* 1989	Citrus canker

The estimated likelihoods and consequences of entry, establishment and spread for quarantine pests are presented in this section. The results of these estimates are summarised in Table 4.4, together with the overall unrestricted risk estimates.

4.2 Pink citrus rust mite

Aculops pelekassi

In previous policy developed for the importation of sweet oranges from Italy into Australia (BA 2005), *Aculops pelekassi*, the pink citrus rust mite, had an unrestricted risk rating of **LOW**. This exceeds Australia's ALOP. A summary of the risk assessment for *Aculops pelekassi* is listed in Table 4.4. This risk rating has been reviewed. On the basis of similar commercial production practices in Italy and Japan, it has been concluded that the risk rating is valid for this risk analysis.

The unrestricted risk estimate for *A. pelekassi* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.3 Citrus red mite

*Panonychus citri**

(*of regional quarantine concern to Western Australia and New South Wales)

In previous policy developed for the importation of sweet oranges from Italy into Australia (BA 2005), *Panonychus citri*, the citrus red mite, had an unrestricted risk rating of **VERY LOW**, which achieves Australia's ALOP. A summary of the risk assessment for *Panonychus citri* is listed in Table 4.4. This risk rating has been reviewed. On the basis of similar commercial production practices in Italy and Japan, it has been concluded that the risk rating is valid for this risk analysis.

4.4 Armoured scales

*Howardia biclavis**#; *Ischnaspis longirostris**, *Lepidosaphes gloverii*#; *Lepidosaphes pinnaeformis**; *Lopholeucaspis japonica*; *Morganella longispina**#; *Parlatoria cinerea*; *Parlatoria pergandii**#; *Parlatoria theae;* *Parlatoria ziziphi*; *Pseudaonidia duplex*; *Pseudaonidia trilobitiformis**#; *Unaspis euonymi*; *Unaspis yanonensis*

(*of regional quarantine concern to Western Australia, #of regional quarantine concern to South Australia)

4.4.1 Introduction

Armoured scale insects are sessile, small (2–4 mm long), their body is covered with hard, waxy 'armour' and they are relatively inconspicuous. The armour covers adult females and immature males. First instars or crawlers are mobile and are the dispersal stage. The reproductive rates for armoured scales are temperature dependent and more generations are produced in tropical climates.

In previous policy developed for the importation of sweet oranges from Italy into Australia (BA 2005) and Tahitian limes from New Caledonia into Australia (BA 2006), the armoured scales *Parlatoria pergandii, Parlatoria ziziphi, Unaspis yanonensis*, *Lepidosaphes gloverii, Morganella longispina*, *Parlatoria cinerea* and *Pseudaonidia trilobitiformis* were assigned an unrestricted risk rating of **VERY LOW**, which achieves Australia's ALOP. A summary of the risk assessments for these armoured scales is listed in Table 4.4. These risk ratings have been reviewed. On the basis that similar commercial production practices are used in Italy, New Caledonia and Japan, it has been concluded that these risk ratings are valid for this risk analysis.

The armoured scales considered further in this import risk assessment are *Howardia biclavis, Ischnaspis longirostris*, *Lepidosaphes pinnaeformis, Lopholeucaspis japonica*, *Parlatoria theae, Pseudaonidia duplex* and *Unaspis euonymi.* These species have been grouped together because of their related biology and taxonomy. In this assessment, the term 'armoured scales' is used to refer to these species, unless otherwise specified.

4.4.2 Probability of entry

Probability of importation

The likelihood that armoured scales will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **HIGH**.

- Armoured scales are sessile, often inconspicuous and feed on fruit.
- First instar nymphs (or crawlers) of armoured scales can move onto fruit. Second instars are permanently attached to fruit by embedding mouthparts into the host tissue for feeding purposes (Beardsley and Gonzalez 1975; Hely *et al*. 1982; Smith *et al*. 1997; Fasulo and Brooks 2004). Subsequent instars are sessile and usually remain attached to their host, including fruit (Taverner and Bailey 1995; Fasulo and Brooks 2004).
- Armoured scales have a relatively hard, impermeable, external covering or 'scale' (Smith *et al*. 1997) that can protect them from physical and chemical damage (Foldi 1990a). Commercial fruit cleaning procedures may not eliminate all viable scales present on the fruit surface (Taverner and Bailey 1995).
- Given that fruit would provide an ample food supply during transit, adults and crawlers are likely to survive storage and transport.
- The small size of armoured scales (adult females are about 2 mm) makes them difficult to detect, especially at low population levels.

The small size, sessile nature of most life stages, and hard external covering of almost all life stages that provides protection to scales insects all support a risk rating for importation of 'High'.

Probability of distribution

The likelihood that armoured scales will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan is: **LOW**.

- Unshu mandarin fruit is intended for human consumption and adults and immature stages may remain on the fruit during retail distribution. Infested fruit is likely to be consumed. Disposal of waste fruit or peel is likely to be via commercial or domestic rubbish systems. However, some fruit waste may be disposed of in the home garden which provides an opportunity for these pests to transfer to susceptible hosts in the vicinity.
- Armoured scales lack a natural dispersal mechanism that allows for the movement of scale species from discarded fruit waste to a suitable host. This is a significant limiting factor in their distribution. Although first instar nymphs (or crawlers) are mobile, they only disperse over short distances. First instars would have to be present for armoured scales to move from waste material to a host plant. Of the adult stages, only the short-lived males are capable of short flight while females remain sessile (CSIRO 1991).

  Armoured scales are likely to survive local storage and transportation because scale insects generally tolerate cold temperatures and overwinter at various stages of growth. For example, *L. japonica, L. pinnaeformis, I. longirostris, U. euonymi* and *P. theae* all occur in temperate regions of the world (refer to Appendix B). In north-eastern Asia, *L. japonica* readily overwinters at temperatures of -20ºC to -25ºC (CABI and EPPO 1997c; CAB International 2007).

The limited mobility of almost all life stages of armoured scales and the disposal of most waste by municipal garbage collection, support a risk rating for distribution of 'Low'.

Probability of entry (importation × distribution)

The likelihood that armoured scales will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan, is: **LOW**.

4.4.3 Probability of establishment

The likelihood that armoured scales will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to its survival and reproduction, is: **HIGH**.

- All seven assessed scale species have a wide host range. *Lopholeucaspis japonica* feeds mostly on temperate and subtropical tree species, including *Acer*, *Pyrus*, *Ficus*, *Diospyros kaki* (persimmon), and woody ornamentals such as *Camellia* spp. (Ben-Dov *et al.* 2005; Appendix B). This would favour its establishment in more southern regions of Australia.

  Pseudaonidia duplex feeds on major crops in Asia and in the Pacific region, including citrus, litchi, tea and ornamental trees (e.g. *Acer, Alnus, Castanea*). The host range of *U. euonymi* includes *Citrus, Prunus, Olea, Hibiscus* and others. Hosts of *P. theae* include *Citrus, Diospyros, Pyrus, Ribes, Rosa* and others (Ben-Dov *et al.* 2005; Appendix B). All of these scale species would adapt to large areas of similar climatic conditions in Australia, including temperate and tropical areas.

  Howardia biclavis is already present on the eastern seaboard of Australia (Donaldson and Tsang 2006). Its host range includes many tropical fruit tree species such as mango, litchi and custard apple, native species such as *Randia*, *Morinda* and *Psychotria*, introduced ornamental vines (*Lonicera*), shrubs (e.g. *Gardenia*, *Buddleia*) and tree species (*Castanea*, *Khaya*) (Ben-Dov *et al.* 2005; Appendix B). *Ischnaspis longirostris* feeds on citrus, coconut, coffee, mango and other woody plants and *L. pinnaeformis* on *Citrus, Prunus, Pyrus, Magnolia, Quecus* and others (Ben-Dov *et al.* 2005; Appendix B). Many of these hosts occur in Western Australia and climatic conditions, in parts of this state, are similar to the eastern seaboard where these pests are already established.
- Moderate to high humidity, without precipitation, favours survival of armoured scale crawlers (Watson 2005).
- *Howardia biclavis* reproduces parthenogenetically (Brown 1965) which is advantageous for the establishment of a species into a new environment. In Japan, this species has one generation per year (Murakami 1970).

  In Japan, *Lopholeucaspis japonica* overwinters in the fertilised female stage and oviposits at the end of spring. Winged males emerge in summer and mate with the females prior to the overwintering phase (Murakami 1970).

  In Louisiana in the USA, *Pseudaonidia duplex* has three generations per year (Ben-Dov *et al.* 2005).
- Reproduction of scale species coincides with warm spring and summer temperatures. It therefore can be expected that the reproductive rate for all seven scale species will be higher in Australia than in Japan, considering the expanse of suitable climatic regions.
- Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide application) but not all hosts, because of the wide host plant range of these scale species (see above).

The wide host plant range, adaptability of armoured scales over a wide climatic range and limited pesticide effectiveness to control these pests support a risk rating for establishment of 'High'.

4.4.4 Probability of spread

The likelihood that armoured scales will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the expansion of the geographic distribution of the pest, is: **MODERATE**.

- Adults and nymphs may be moved within and between orchards (or other commercial production sites) with the movement of equipment, personnel and infested plant material (Dreistadt *et al.* 1994).
- Armoured scales lack active long range dispersal mechanisms which moderates their rate of spread by self-propelled dispersal. The first instar nymphs are the primary dispersal phase within the scale's life-cycle and can disperse by crawling, and also by dispersal on wind currents or using other vectors (Beardsley and Gonzalez 1975; Greathead 1990). However, subsequent instars are sessile and do not actively disperse once a feeding site has been selected. Adult females are flightless and remain on the host (Hely *et al*. 1982), while males fly weakly and only persist in the environment for a few hours (Beardsley and Gonzalez 1975). Animal and human activities (e.g. transport of contaminated equipment and plant material) may aid distribution (Greathead 1990; Dreistadt *et al*. 1994; Smith *et al*. 1997).
- The Australian climate is expected to be conducive to the spread of all seven scale species, of which *H. biclavis, I. longirostris* and *L. pinnaeformis* are already established along the eastern seaboard (Donaldson and Tsang 2006; APPD 2008). All of the seven assessed species have an extensive range of hosts, which also occur in Western Australia. Climatic conditions in parts of Western Australia are similar to the eastern seaboard.

  The world distribution of *I. longirostris*, *L. japonica, L. pinnaeformis, U. euonymi* and *P. theae* all suggest that these species would spread, specifically in the southern temperate environments, once they became established in Australia. Similarly the distribution of *P. duplex* throughout Asia and the Pacific region suggests that suitable climatic conditions would exist in Australia (see *Establishment*, above; Ben-Dov *et al.* 2005).
- Experience with the establishment of *H. biclavis, I. longirostris* and *L. pinnaeformis* on the eastern seaboard of Australia indicates that after two or more generations, armoured scales are likely to persist indefinitely and spread.

The lack of a natural mechanism for long distance dispersal and the restricted mobility to first instar nymphs support a risk rating of armoured scales for spread of 'Moderate'.

4.4.5 Probability of entry, establishment and spread

The likelihood that armoured scales will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **LOW**.

4.4.6 Consequences

Assessment of the potential consequences (direct and indirect) of armoured scales for Australia is: **LOW**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: D – significant at the district level Armoured scales can cause direct harm to a wide range of plant hosts, affecting fruit quality and plant health (Beardsley and Gonzalez 1975; Smith *et al.* 1997). Infestation by armoured scales can cause direct damage to fruit. The feeding of scales causes defoliation, reduced fruit size and green spots on mature fruit at places where scales were fixed (OEPP/EPPO 2004). Infested hosts are often susceptible to secondary attack by fungi and wood-boring insects (CAB International 2007). Damage caused to plants includes damage to trunks, limbs and twigs and occasionally leaves and fruit (Murakami 1970). Damage caused by armoured scales in some instances can cause twig dieback and extensive drying and splitting of the bark on the trunk and main limbs (Smith *et al*. 1997). All seven species assessed, like other members of the Diaspididae, do not excrete honeydew and there is no issue with associated sooty mould or ants (Foldi 1990b).
Other aspects of the environment	**Impact score**: C – significant at the local level All seven species assessed have a wide host range, including numerous garden plants and amenity trees in tropical, subtropical and some temperate regions (Beardsley and Gonzalez 1975; Ben-Dov *et al.* 2005). All seven species are therefore likely to become widespread if introduced due to extending their current distribution. These species could also compete with native scale species, disrupt natural biocontrol methods for other pests, and alter aspects of the biotic environment such as native invertebrates and species known to predate scales (Smith *et al.* 1997).
Indirect	
Eradication, control etc.	**Impact score**: D – significant at the district level Additional programs to eradicate scales on their host plants may be necessary. Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide applications) but not all hosts (e.g. *Malus* (apples) and *Pyrus* (pears) where specific integrated pest management programs are used (APAL 2008). Existing IPM programs may be disrupted because of the need to re-introduce or increase the use of organophosphate insecticides. This may result in a subsequent increase in the cost of production. Additionally, costs for crop monitoring and consultant's advice to manage these pests may be incurred by the producer.
Domestic trade	**Impact score**: C – significant at the local level The damage by scales to fruit is green spots, and such fruits are downgraded for fresh fruit markets (Beardsley and Gonzalez 1975; Brooks and Knapp 1983). The presence of these pests in commercial production areas may have a significant effect at the local level due to resulting trade restrictions on the sale or movement of a wide range of commodities, including nursery stock, between areas in Western Australia and between states/territory. These restrictions may lead to a loss of markets.
International trade	**Impact score**: C – significant at the local level The presence of these scales in commercial production areas of a range of commodities would have a significant effect at the local level due to limitations of accessing international markets where these pests are absent.
Environmental and non-commercial	**Impact score**: B – minor at the local level Additional pesticide applications or other control activities would be required to control these pests on susceptible crops. Any additional insecticide usage may affect the environment.

4.4.7 Unrestricted risk estimate

The unrestricted risk for *Howardia biclavis, Ischnaspis longirostris, Lepidosaphes pinnaeformis, Lopholeucaspis japonica, Parlatoria theae, Pseudaonidia duplex* and *Unaspis euonymi* is: **VERY LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for the armoured scales of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for these pests.

4.5 Mealybugs

Planococcus kraunhiae; *Planococcus lilacinus*; *Pseudococcus comstocki*; *Pseudococcus cryptus*

4.5.1 Introduction

Mealybugs are sucking insects that injure plants by sucking sap and producing honeydew, which serves as a substrate for the development of sooty moulds. The sooty mould prevents photosynthesis in addition to making the plant, including the fruit, unsightly. Many mealybug species pose serious problems to agriculture, particularly when introduced into new areas of the world where their natural enemies are not present (Miller *et al.* 2002).

The pathway for entry of mealybugs is that eggs, juveniles or adult females may be present in sheltered areas, such as the calyx or the stem end, of imported fruit.

The mealybugs considered in this import risk assessment are *Planococcus kraunhiae*, *Planococcus lilacinus*, *Pseudococcus comstocki* and *Pseudococcus cryptus.* These species have been grouped together because of their related biology and taxonomy. In this assessment, the term 'mealybugs' is used to refer to these species, unless otherwise specified.

4.5.2 Probability of entry

Probability of importation

The likelihood that mealybugs will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **HIGH**.

- Mealybugs generally live around the calyx of the fruit from flowering onwards. They generally remain anchored to the host, and due to their small size (0.5–4 mm) may be difficult to detect on fruit during sorting, especially at low population levels (Taverner and Bailey 1995).
- Mealybugs have a protective coating and routine packing house procedures (washing and grading) may not remove all mealybugs from the fruit. Although mealybugs may be affected by the washing, they are not destroyed by it. This is particularly true of those adult females and/or nymphs that have found protective spaces around the calyx or are protected by waxy cocoons.

The association of mealybugs with fruit, their inconspicuousness and protective coating to withstand packing house procedures all support a risk rating for importation of 'High'.

Probability of distribution

The likelihood that mealybugs will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan is: **MODERATE**.

- The pests are likely to survive storage and transportation, as mealybugs are capable of hibernation during cold periods (Smith *et al.* 1997). Fresh unshu mandarin fruit exported to New Zealand and the USA is shipped from Japan in refrigerated containers maintained at 4ºC to 6ºC for about 2 to 4 weeks (refer to Chapter 3). *Pseudococcus cryptus* is able to survive for up to 42 days when stored at 0°C (Hoy and Whiting 1997). The distributional range of *Ps. comstocki* and *Pl. kraunhiae* includes temperate climatic zones (CAB International 2007). Therefore, these species are likely to survive the temperatures during transportation to Australia.
- Unshu mandarin fruit is intended for human consumption. Adults and immature stages may remain on fruit during distribution. Peel is unlikely to be consumed, and its disposal as waste may aid dispersal of viable mealybugs.
- Disposal of infested fruit or peel into the environment provides the potential for these pests to transfer to susceptible hosts in the vicinity. All nymphal and adult stages can walk. Male mealybugs are winged at emergence and can fly, though their wings are fragile. Males only live for a short time (2–7 days) (Mau and Kessing 2000).
- Crawlers are the primary dispersal phase in mealybugs' life-cycle (Ben-Dov 1994). The lack of active (by flight) long distance dispersal mechanisms of most mealybug life stages may moderate the rate of distribution of these species.

The ability of mealybugs to survive cold periods by hibernation, their potential to remain associated with fruit peel and their lack of an active dispersal mechanism for most of their life stages all support a risk rating for distribution of 'Moderate'.

Probability of entry (importation × distribution)

The likelihood that mealybugs will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan, is: **MODERATE**.

4.5.3 Probability of establishment

The likelihood that mealybugs will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to their survival and reproduction, is: **HIGH**.

- Many mealybugs, including the four species assessed, are considered invasive and have been introduced into new areas and become established (Miller *et al.* 2002). These mealybug species have shown that they have the ability to establish after being introduced into new environments. For example *Pl. lilacinus* is native to the Afrotropical region (Miller *et al.* 2002) and is now established in the Palaearctic, Malaysian, Oriental, Australasian and Neotropical regions (CAB International 2007). Similarly, the distributional ranges of *Pl. kraunhiae* and *Ps. comstocki*, which originate in Asia, have expanded into North America and Europe. *Pseudococcus cryptus* is spreading in Asia (CAB International 2007) and is particularly a pest of citrus in Israel, into which it was introduced in 1937 (Ben-Dov *et al.* 2005).
- All four mealybug species are polyphagous and their host plants include common commercial and ornamental plant species in Australia. *Planococcus lilacinus* attacks over 65 genera in 35 plant families. Hosts of *Pl. kraunhiae* include *Citrus*, *Diospyros kaki* (persimmon), *Magnolia grandiflora* and *Portulaca*; hosts of *Ps. comstocki* include *Citrus*, *Musa*, *Pyrus communis* (pear), poplar, honeysuckle and gardenias, and hosts of *Ps.*

cryptus include *Citrus*, *Vitis vinifera* (grapes)*, Mangifera indica* (mango), guava and *Bauhinia* (CAB International 2007, Appendix B).

- The peel of infested fruit is likely to be disposed of by commercial or domestic rubbish systems. However, some fruit waste may be disposed of in the home garden, which provides an opportunity for these pests to transfer to susceptible hosts in the vicinity.
- The capacity of mealybugs to produce large numbers of offspring and the consequent persistence of these pests makes them successful colonisers, despite their limited ability to self-disperse. Mealybugs have a relatively high reproductive rate, providing the capacity to rapidly establish a significant population after an incursion. Adult females are generally long-lived and fecund.
- Reproduction of *Ps. comstocki* has two generations per year on apple in New York in the USA; and three generations per year on apple in China and Korea (Agnello *et al.* 1992; Joen *et al.* 2003; Liu 2004). In Crimea, females lay 100–250 eggs each and the first generation develops in 27–30 days and the second in 45–50 (CAB International 2007). This species overwinters in bark crevices, soil or roots (Agnello *et al.* 1992; CAB International 2007). Reproduction, survival and longevity are also greatest at temperatures between 22°C and 26°C and reduced at 30°C (Heidari 1999). The gross reproduction rate was 57–249 eggs per female (Heidari 1999). In Russia, low winter temperatures, and fluctuations in temperature and relative humidity in spring, resulted in a low population density during the development of the first generation (Oganesyan and Babayan 1979). Similar climatic conditions can be found in Australia and it is expected that all species would reproduce in the event that they would be introduced.
- Information on the biology of *Pl. lilacinus*, *Pl. kraunhiae* and *Ps. cryptus* is scarce. The complete lifecycle of *Pl. lilacinus* in Java is about 40 days. Regarding *Pl. kraunhiae*, the lower developmental threshold temperatures for nymphal development on citrus leaves were reported as 8.0°C and 519 degree days (Arai 1996).

The generalist feeding behaviour, past invasive history in other countries and relatively high fecundity of these mealybug species all support a risk rating for establishment of 'High'.

4.5.4 Probability of spread

The likelihood that mealybugs will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the expansion of the geographic distribution of the pest, is: **HIGH**.

- The Australian climate is likely to be conducive for the spread of all four mealybug species. The world distribution suggests that all species could be expected to become widespread once established in Australia (see *Establishment*, above; CAB International 2007).
- As all four species are polyphagous (see *Establishment*, above), susceptible hosts are likely to be available adjacent to sites of establishment, and therefore increase the potential for spread.
- Lack of a longer range active dispersal mechanism may moderate the rate at which mealybugs spread. However, first instar nymphs which are the primary dispersal phase within the mealybug's life-cycle, are capable of active dispersal by crawling and passive dispersal by wind currents and movement of adults or nymphs on infected plant material or on animals (Ben-Dov 1994). Females are wingless, but retain legs and mobility until ovisac development and egg production commences (CAB International 2007). Adult

males, although winged are fragile, non-feeding and short-lived (2–7 days) (Mau and Kessing 2000).

- From experience in the USA, after establishment of second and subsequent generations of mealybugs, they are likely to persist indefinitely and will spread (Miller *et al*. 2002).

Polyphagy, dispersal of nymphs and adults, and the past history of spread in other countries of all four species all support a risk rating for spread of 'High'.

4.5.5 Probability of entry, establishment and spread

The likelihood that mealybugs will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **MODERATE**.

4.5.6 Consequences

Assessment of the potential consequences (direct and indirect) of mealybugs for Australia is **LOW**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: D – significant at the district level Internationally, all four mealybug species, i.e. *Planococcus kraunhiae*, *Planococcus lilacinus*, *Pseudococcus comstocki*, and *Pseudococcus cryptus* are economically significant pests of many crops (refer to Appendix B; refer to *Establishment*, above). They can cause direct harm due to their extraction of sap from their hosts. This direct damage and the development of sooty mould that grows on honeydew excreted by these species can reduce fruit quality, photosynthesis, tree vigour and productivity (CAB International 2007). Although the mouth parts of mealybugs rarely penetrate beyond the fruit epidermis, spotting of fruit at feeding sites and fruit distortion can occur (CAB International 2007). Existing biological control programs and insecticide treatments would reduce the impact of these pests in commercial production.
Other aspects of the environment	**Impact score**: C – significant at the local level All four mealybug species have a wide host range, which includes commercial fruit trees, ornamental shrubs and creepers, amenity trees of tropical, subtropical and temperate distribution and natives (Appendix B; refer to *Establishment*, above). These mealybug species are therefore likely to become widespread if introduced into a new environment. They also could compete with native mealybugs, disrupt natural biocontrol methods for other pests, and alter aspects of the biotic environment such as native invertebrates and species known to predate mealybugs (CAB International 2007). The wide host range and potential for some impact on plant vigour suggests that impacts on amenity plants and ecological communities are likely.
Indirect	
Eradication, control etc.	**Impact score**: D – significant at the district level Additional programs to minimise the impact of these pests on host plants may be necessary. Existing control programs can be effective for some hosts (for example, broad spectrum pesticide applications) but not all hosts (for example, where specific integrated pest management programs are used). Existing IPM programs may be disrupted because of the need to re-introduce or increase the use of organophosphate insecticides. Alternatively, new bio-control agents may need to be introduced to supplement IPM programs to control these mealybug species. This may result in a subsequent significant increase in cost of production. Additionally, costs for crop monitoring and advice by consultants to manage the pest may be incurred by the producer. Attacked fruit is considered of lower quality and is often unmarketable.

Domestic trade	**Impact score**: D – significant at the district level Domestic trade is likely to be disrupted as a result of the entry, establishment and spread of exotic mealybugs. Furthermore, interstate trading restrictions may be introduced, leading to a loss of markets for a number of commodities, which in turn would require industry adjustment. The scope and severity of restrictions are difficult to estimate. However, these pests are polyphagous and therefore impacts are likely to be felt on a broad range of industries. The presence of any of these mealybugs on a commercial crop may result in intrastate and interstate restrictions on the sale and movement of a wide range of fruit and other commodities.
International trade	**Impact score**: D – significant at the district level The presence of these pests in commercial production areas of a range of commodities that are hosts to these mealybugs may limit access to overseas markets where these pests are absent.
Environmental and non-commercial	**Impact score**: B – minor at the local level Mealybugs introduced into a new environment will compete for resources with native species. While existing mealybug eradication programs, which include biological control, may contain introduced mealybugs, additional pesticide applications or other activities would be necessary to manage these pests on susceptible crops. Any additional insecticide usage may affect the environment.

4.5.7 Unrestricted risk estimate

The unrestricted risk for *Planococcus kraunhiae*, *Planococcus lilacinus*, *Pseudococcus comstocki* and *Pseudococcus cryptus* is: **LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for the mealybugs of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.6 Leafroller moths

Adoxophyes dubia; *Adoxophyes honmai*; *Adoxophyes orana fasciata; Homona magnanima*

4.6.1 Introduction

There are over 5000 described species of Tortricidae (leafrollers) and the family is considered one of the largest of the so-called micro-Lepidoptera. A large number are still to be described, particularly in the tropics. The family is more strongly represented in temperate and tropical upland regions than in the lowland tropics, although it is worldwide in distribution (Meijerman and Ulenberg 2000).

The family is of great economic importance, as the larvae of many species cause major damage to horticultural crops, including pome and stone fruits, citrus fruits, grapes, ornamental crops, tea, coffee, cereals and cotton (Meijerman and Ulenberg 2000). Leafroller moth larvae damage fruit by chewing large holes that usually cause fruit rot on a wide range of economic species (CAB International 2007).

Adoxophyes spp. have previously been identified as of quarantine concern on Fuji apple from Aomori Prefecture in Japan (AQIS 1998), and on Korean pear from the Republic of Korea (AQIS 1999). In the import risk analysis for Fuji apples from Japan the leafroller species was specified as *Adoxophyes orana fasciata* (AQIS 1998). MAFF identified *Adoxophyes orana fasciata* and *Adoxophyes* sp. [Lepidoptera: Tortricidae] as pests associated with unshu mandarin (MAFF 1990). In Japan, "*Adoxophyes* sp." is currently considered to comprise the two species *A. dubia* and *A. honmai*.

The leafroller moths considered in this import risk assessment are *Adoxophyes dubia, A. honmai, A. orana fasciata* and *Homona magnanima.* These species have been grouped together because of their related biology and taxonomy. In this assessment, the term 'leafroller moths' is used to refer to these species, unless otherwise specified.

4.6.2 Probability of entry

Probability of importation

The likelihood that leafroller moths will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **LOW**.

- *Adoxophyes* species and *H. magnanima* are associated with unshu mandarin fruit throughout Japan (MAFF 2003; Sakamaki and Hayakawa 2004).
- *Adoxophyes* species are present in the designated export areas in the Shizuoka Prefecture (Sakamaki and Hayakawa 2004). MAFF advised that a tortricid moth had been intercepted on unshu fruit for export to the USA and New Zealand on two occasions during the past ten years.
- Up to 400 eggs can be laid by a single *Adoxophyes* female and up to 700 eggs of *H. magnanima* on fruit, leaves, and trunks of host plants in severe infestations (Carter 1984; CAB International 2004). *Homona magnanima* lays its eggs in masses on the upper side of leaves (CAB International 2007). The presence of silk webbing on leaves and fruit indicates the presence of *Adoxophyes* species and *H. magnanima*, allowing detection by fruit sorters and packers.
- *Adoxophyes* species have 2–7 generations per year and *H. magnanima* has 4 generations per year. Adults reproduce rapidly, particularly in warm climates. Japan advised in 1999 that *Adoxophyes* sp. in Kyushu (southern Japan) has five generations, and in most other regions there are four generations per year. An Australian native species has seven generations per year (Smith *et al.* 1997). A temperature increase of only 2–3^{o}C can induce earlier adult emergence and an extra one or two generations per year in Japanese species of *Adoxophyes* (Yamaguchi *et al.* 2001). The longevity of adults of *Adoxophyes privatana*, a Chinese species, varies from 2–22 days (Meijerman and Ulenberg 2000). The life span of adult *H. magnanima* is about 10 days (CAB International 2007). The occurrence of adult tortricid activity ceases by October prior to commencement of the proposed export season (early December).
- Larvae of *Adoxophyes* species and *H. magnanima* damage the fruit by eating holes into the rind and flesh. The damage to fruit is conspicuous, allowing a significant degree of detection during pre-export inspections. The second generation of larvae of *Adoxophyes orana* penetrate shallowly into the fruit flesh to form large irregular depressions before entering diapause. Point-like holes are left in the fruit tissue from larval feeding, which consists of sting-feeding. Larvae of *Adoxophyes* species and *H. magnanima* are external feeders and do not enter fruit. Surface grazing causes injury to extensive areas of the fruit skin. These activities result in a down-grading of the economic value of the fruit (Meijerman and Ulenberg 2000).
- *Adoxophyes* species mainly inhabit the temperate regions of Japan (Yasuda 1998a; Sakamaki and Hayakawa 2004). Similar climatic conditions occur in the southern parts of

Australia. *Adoxophyes* species may survive commercial cold storage and transportation, because diapausing larvae tolerate freezing temperatures on apple (Jo and Kim 2001). The study by Jo and Kim (2001) indicates that *Adoxophyes orana* is a freeze-susceptible species and that diapause significantly enhanced cold hardiness.

- Japanese plant quarantine records from 1989–1998 indicate that there were no records of any development stage of tortricids during pre-export inspections of fresh unshu mandarins transported to overseas markets. The number of shipments inspected was 3073, totalling 14 507 tonnes of fruit.

The association of egg and larval stages with citrus fruit and the ability of larvae to survive cold temperatures by entering diapause support a risk rating for importation of 'Moderate'.

Probability of distribution

The likelihood that leafroller moths will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan is: **MODERATE**.

- Although adults will most likely move off the fruit when disturbed, immature forms, i.e. the larval and pupal life stages, may remain within fruit during distribution via wholesale or retail trade. In trade *Adoxophyes* species and *H. magnanima* may be carried on vegetative, above-ground plant parts of cutflowers or other host plants.
- Pupation may occur during transport and live adult leafrollers could emerge soon after consignments arrive in Australia.
- Uneaten fruit that is not discarded is likely to be a suitable site for larvae to complete their development, but discarded fruit in compost bins or pits is likely to degrade quickly. Discarded fruit is unlikely to be suitable for larvae to complete development. This would impede on the successful distribution of these pests.
- Sexual reproduction is essential for leafrollers (Weires and Riedl 1991). After successful pupation, adults would need to locate a mate, which will constrain their capacity to distribute in a reproductively viable state to a host.
- The ability for flight increases the dispersal of leafrollers and the likely chances to locate a host. Adults are winged, and highly mobile. Adults of *A. honmai* and *H. magnanima* can fly about 5 km per night (Shirai and Kosugi 1997, 2000). At the age of two days both sexes of *Adoxophyes honmai* displayed maximum flight duration. Females could travel 9.6 km and males 8.5 km. These distances were obtained from continuous measurements over a 24 hour period (Shirai and Kosugi 2000).

The ability of immature life stages to remain with fruit moderated by the need to complete development and find a mate for sexual reproduction support a risk rating for distribution of 'Moderate'.

Probability of entry (importation × distribution)

The likelihood that leafroller moths will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan, is: **LOW**.

4.6.3 Probability of establishment

The likelihood that leafroller moths will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to their survival and reproduction, is: **HIGH**.

- *Adoxophyes* species and *H. magnanima* are pests of a very wide range of fruit crop plants and ornamental species such as pome and stone fruits, citrus fruits, grapes, ornamentals, tea, coffee, cereals and cotton (Carter 1984; Meijerman and Ulenberg 2000; CAB International 2004). *Adoxophyes honmai* is a pest of *Eucalyptus* spp. (Nasu *et al.* 2004), which is endemic to Australia. A food source distributed across the country is more likely to support the establishment of moth populations.
- Adults can reproduce rapidly, and several generations occur every year. The climate of Japan is very similar to that in many parts of Australia. Temperature is the main limiting factor to development of the immature stages and activity of adults. Temperatures most favourable to development (>10^{o}C) and adult activity (>18^{o}C) of *A. honmai* (Yamaguchi *et al.* 2001) occur over much of Australia.
- Existing control programs (e.g. Cross 1997) would probably be effective for some but not all hosts. For example, *Eucalyptus* occurs across Australia, and control of *Adoxophyes* on this genus is not practical, considering the large pool of native hosts. Resistance to pesticides has also been recorded in *Adoxophyes* species (e.g. Funayama and Takahashi 1995).

Polyphagy, high fecundity and preadaptation to temperatures found in Australia and limited success of control measures for leafroller moths all support a risk rating for establishment of 'High'.

4.6.4 Probability of spread

The likelihood that leafroller moths will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the expansion of the geographic distribution of these pests, is: **HIGH**.

- The very large number and geographic ranges of host species in Australia such as *Eucalyptus*, pome and stone fruits, citrus fruits, grapes, ornamentals, tea, coffee, cereals and cotton (Carter 1984; Meijerman and Ulenberg 2000; CAB International 2004) would facilitate rapid spread of *Adoxophyes* species and *H. magnanima*. The extent and direction of spread will most likely vary depending on the moth species.
- Adults of *A. honmai* and *H. magnanima* can fly about 5 km per night (Shirai and Kosugi 1997, 2000).
- Adults and immature forms may also spread undetected via the movement of fruit or infested vegetative host material.
- The presence or absence of natural enemies in Australia is not known.
- As temperature increases, the reproductive rate and the number of generations also increases. *Adoxophyes* species and *H. magnanima* are likely to spread into the warmer, northern areas of Australia.
- Similar environmental conditions (especially temperature) occur in Japan and Australia.

Readily available hosts, including eucalypts, and strong, directional flight ability support a risk rating for spread of 'High'.

4.6.5 Probability of entry, establishment and spread

The likelihood that leafroller moths will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **LOW**.

4.6.6 Consequences

Assessment of the potential consequences (direct and indirect) of leafroller moths for Australia is: **MODERATE**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – minor significance at the national level *Adoxophyes* species and *H. magnanima* are not native to Australia and can cause direct harm to a very wide range of plant hosts. These include *Eucalyptus* species, which occur all over Australia, and other commercial crops such as pome and stone fruits, citrus fruits, grapes, tea, coffee, cereals and cotton (Carter 1984; Meijerman and Ulenberg 2000; CAB International 2004). Larvae feed on fruit, which would retard the ability of plants to reproduce. Light infestations are usually not harmful to plants, but more severe infestations will most likely result in leaf curl, holes in fruit, fruit drop, stunting of shoot growth, and delay in production of flowers and fruit, as well as a general decline in plant vigour.
Other aspects of the environment	**Impact score**: D – significant at the district level *Adoxophyes* species and *H. magnanima* introduced into a new environment may compete for resources with the native species. Their wide host range, including *Eucalyptus* species for *A. honmai* that occur throughout Australia, suggests that impacts on ecological communities and amenity plants are likely to occur.
Indirect	
Eradication, control etc.	**Impact score**: E – significant at the regional level Programs to minimise the impact of these moths on host plants are likely to be costly and include pesticide and pheromone applications, crop monitoring, and the possible introduction of biological control agents. Existing control programs may be effective for some but not all hosts (e.g. *Eucalyptus*, *Acacia* species).
Domestic trade	**Impact score**: D – significant at the district level The presence of these pests in commercial production areas may have a significant effect at the district and local level due to resulting interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets.
International trade	**Impact score**: D – significant at the district level The presence of these pests in commercial production areas, such as citrus growing areas, may have a significant effect at the district level due to limitations to access to overseas markets where these pests are absent.
Environmental and non-commercial	**Impact score**: B – minor at the local level Although additional pesticides may be required to control moths on susceptible crops, this is not considered to have significant consequences for the environment.

4.6.7 Unrestricted risk estimate

The unrestricted risk for *Adoxophyes dubia, A. honmai, A. orana fasciata* and *Homona magnanima* is: **LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for the leafroller moths of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.7 Bagworms

Eumeta japonica; Eumeta minuscula

4.7.1 Introduction

The larvae of bagworms (Psychidae) form a bag, a portable case made of bits of twigs and leaves, which they carry with them as they feed. Larvae feed on the leaves, twigs and the surface of fruit of hosts, including citrus (MAFF 1990). Males leave the bag after maturing, but females seldom emerge from their bags until oviposition is completed and death is near (Nishida 1983). Adult males have wings, but adult females are wingless and resemble larvae (Arnett 1997). The distributional range of *E. japonica* and *E. minuscula* is restricted to Japan.

The bagworms considered in this import risk assessment are *E. japonica* and *E. minuscula.* These species have been grouped together because of their related biology and taxonomy. In this assessment, the term 'bagworms' is used to refer to these species, unless otherwise specified.

4.7.2 Probability of entry

Probability of importation

The likelihood that bagworms will arrive in Australia with the importation of fresh unshu mandarin from the production area in Japan is: **VERY LOW**.

- Bagworms are known to occur on unshu mandarin in Japan. At the time of harvest, between October and December, bagworms will exist as late instar larvae, and some may have entered the overwintering phase (Nishida 1983). Overwintering larvae are unlikely to be found on the fruit (Nishida 1983). Actively feeding larvae may be on the surface of fresh unshu mandarin fruit at harvest.
- Infested unshu fruit may be detected during sorting, packing and inspection procedures. Late instar larvae are large (up to 25 mm) and feed on the fruit surface (Nishida 1983). Larval feeding damage to citrus fruit by the related Psychidae species, *Cryptothelea gloverii*, the orange bagworm, results in one to several holes being eaten into the rind (Villaneuva *et al*. 2005). Larvae, from the first instar onwards, are conspicuous due to the attached bags made of leaf litter (Nishida 1983).
- Bagworms overwinter as larvae under temperate climatic conditions in Japan. Therefore, larvae are likely to survive transportation of the fruit in climate controlled containers held at 4–6ºC.

Overwintering larvae are unlikely to be found on the fruit. The large, visible and conspicuous nature of all life stages of these two bagworm species make these moths easy to detect and support a risk rating for importation of 'Very low'.

Probability of distribution

The likelihood that bagworms will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan is: **LOW**.

- Unshu mandarin may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would be generated.
- Adult males have wings and are capable of flight, but adult females are flightless (Nishida 1983). First instar larvae disperse by 'ballooning' – spinning silk webs, which are caught by the wind (Funakoshi and Tanaka 2003). Late instar larvae are capable of dispersal by crawling (Funakoshi and Tanaka 2003).

Almost all life stages of bagworms are wingless, and their dispersal is wind dependent, which restrict their movement from the fruit and support a risk rating for distribution of 'Low'.

Probability of entry (importation × distribution)

The likelihood that bagworms will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan, is: **VERY LOW**.

4.7.3 Probability of establishment

The likelihood that bagworms will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to their survival and reproduction, is: **HIGH**.

- A wide range of plants commonly found in Australia can act as hosts for *Eumeta japonica* and *E. minuscula*, including commercially grown fruit trees (*Citrus* spp., *Averrhoa carambola* (star fruit), *Diospyros kaki* (persimmon) and *Pyrus* spp.), native tree species such as *Acacia mangium*, *Araucaria cunninghamii*, *Eucalyptus deglupta,* and ornamental shrubs such as *Abelia grandiflora* (Robinson *et al*. 2007).
- Female bagworms lay a high number of eggs (up to 4500 for *E. japonica*; up to 2400 for *E. minuscula*) (Nishida 1983), which would promote establishment.
- The Australian climate is expected to be conducive for the establishment of both bagworm species. Their distributional range in Japan suggests that both species could become established in Australia due to suitable climatic environments (CAB International 2007).
- Control programs would probably be effective for some but not all hosts (Nakayama *et al.* 1973), considering the large pool of native hosts, including eucalypts, acacias and araucarias (Robinson *et al*. 2007).

The polyphagy, high fecundity, limited success of control measures, and the likely adaptation of these moths to temperatures found in Australia all support a risk rating for establishment of 'High'.

4.7.4 Probability of spread

The likelihood that bagworms will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the expansion of the geographic distribution of these pests, is: **HIGH**.

- Natural physical barriers (e.g. deserts/arid areas) may prevent or slow long distance spread of these pests, though their host plant range is extensive and includes widely distributed native tree species (see *Establishment,* above). Larvae are capable of short distance dispersal by crawling or 'ballooning' (most likely to a nearby host plant) (Nishida 1983).

- Males are very active fliers. Females have high fecundity (see *Establishment,* above). In Japan, the major period of dispersal is during emergence of first instar larvae is during the summer months, during late June and early July (Nishida 1983).
- In Japan, bagworm larvae and pupae are susceptible to high levels of parasitism and predation, particularly by hymenopteran species (Nishida 1983).

Readily available commercial hosts, including widely dispersed native tree species and high fecundity support a risk rating for spread of 'High'.

4.7.5 Probability of entry, establishment and spread

The likelihood that bagworms will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **VERY LOW**.

4.7.6 Consequences

Assessment of the potential consequences (direct and indirect) of bagworms for Australia is: **MODERATE**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: E – significant at the regional level Bagworms cause direct damage to many host plant species, including crops such as *Citrus* and *Prunus* species, and *Eucalyptus*, *Araucaria* and *Acacia* species (Robinson *et al*. 2007). Bagworms are common defoliators and thereby induce reduced growth of their hosts. They also can damage young twigs, and fruit of a wide range of commercially grown fruit trees (Robinson *et al*. 2007).
Other aspects of the environment	**Impact score**: D – significant at the district level Introduced *E. japonica* or *E. minuscula* in a new environment are likely to compete for resources with the native species. Their host range includes native tree species such as *Araucaria cunninghamii*, *Acacia mangium* and *Eucalyptus deglupta* (Robinson *et al.* 2007).Their wide host range, including *Eucalyptus* species that occur throughout Australia, suggests that impacts on ecological communities and amenity plants are likely to occur.
Indirect	
Eradication, control etc.	**Impact score**: C – significant at the local level Additional programs to minimise the impact of these pests on host plants may be necessary. These impacts are likely to be significant at the local level.
Domestic trade	**Impact score**: C – significant at the local level The presence of these pests in commercial production areas of fruit and timber tree production and in nursery stock production would have a significant effect at the local level due to resulting interstate trade restrictions. Affected commodities could include fruit, nursery stock and timber tree products.
International trade	**Impact score**: B – minor at the local level The presence of these pests in commercial production areas of some commodities (e.g. *Citrus*, *Pyrus*) may have a minor effect at the local level. Most of the host commodities are exported in a form that is free of the pest.
Environmental and non-commercial	**Impact score**: B – minor at the local level Bagworm species introduced into a new environment will compete for resources with native species. Additional pesticide applications or other activities would be necessary to manage these pests on susceptible timber trees and crops. Any additional insecticide usage may affect the environment.

4.7.7 Unrestricted risk estimate

The unrestricted risk for *Eumeta japonica* and *E. minuscula* is: **VERY LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for the bagworms of 'very low' achieves Australia's ALOP. Therefore, specific risk management measures are not required for these pests.

4.8 Apple heliodinid

Stathmopoda auriferella

4.8.1 Introduction

Stathmopoda auriferella belongs to the family Oecophoridae. This lepidopteran family includes other pest species of fruit, such as *Stathmopoda masinissa*, the persimmon fruit moth. Overall, these moth species are relatively small, about one centimetre in size. Adults live for about one month (Park *et al.* 1994). While *S. auriferella* has been found on citrus, the biology of this species on citrus has not been reported in detail. Therefore available information of its biology on other fruits (e.g. kiwifruit) is used for the risk assessment.

4.8.2 Probability of entry

Probability of importation

The likelihood that *S. auriferella* will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **MODERATE**.

- There are two generations of *S. auriferella* per year on kiwifruit in Korea (Park *et al.* 1994). In Korea, adults occur from late May to mid-July and mid-August to early September, with peaks in early to mid June and late August. Larvae are commonly collected throughout July, whereas pupae start to appear in July, and are commonly collected in August (Park *et al.* 1994). Some residual eggs and larval development stages from the second generation of *S. auriferella* adults may be present on unshu mandarins when fruit is harvested in the designated export areas from the beginning of December. However, most of the egg hatch is likely to have occurred by the time of fruit harvest.
- Larvae feeding on unshu fruit may be detected during sorting, packing and inspection procedures, because 70% of the damage to kiwifruit caused by *S. auriferella* occurred on the fruit surface, and some (10%) at the fruit stalk (Park *et al.* 1994).
- Eggs are very small (0.10–0.13 mm) (Park *et al.* 1994), and they are unlikely to be detected on infested fruit, especially as they may be hidden in the surface texture of citrus fruit. Data obtained from the related species *Stathmopoda masinissa* (persimmon fruit moth) suggests that egg numbers laid per female are relatively small at about 25 eggs per female. Adults live for about one month, depending on suitable climatic conditions (Park *et al.* 2001). Removal of eggs from the fruit surface during routine washing procedures undertaken within the packing house.
- Adult moths are winged and they are good fliers. They are unlikely to stay on the fruit during picking, sorting and packing, in contrast to the egg and larval development stages.

The potential presence of eggs and larvae on fruit during the latter part of fruit development support a risk rating for importation of ‘Moderate’.

Probability of distribution

The likelihood that *S. auriferella* will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan, is: **HIGH**.

- The cold tolerance of *S. auriferella* is unknown, but the immature stages are likely to survive transportation. Mature larvae of a different species (*S. masinissa*) undergo diapause during winter (Shao *et al.* 1995), although earlier instar larvae may be more susceptible to cold temperatures.
- Fruit infested with eggs and larvae may be distributed throughout Australia for retail sale.
- *Stathmopoda auriferella* has a wide host range, including commercial fruit producing species such as citrus, mango, avocado, peach, grapes (Yamazaki and Sugiura 2003; CAB International 2007), and some weed (*Acacia nilotica*) and ornamental (*Albizia altiissima*) species (Robinson *et al.* 2007), facilitating its transfer to new areas.
- Adult moths are winged and good fliers.

Diapause and polyphagy support a risk rating for distribution of ‘High’.

Probability of entry (importation × distribution)

The likelihood that *S. auriferella* will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan, is: **MODERATE**.

4.8.3 Probability of establishment

The likelihood that *S. auriferella* will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to its survival and reproduction, is: **HIGH**.

- A wide range of plants commonly found in Australia (e.g. citrus, grapes, kiwifruit, avocado, mango) can act as hosts for this pest. Host plants occur across a wide climatic range.
- One study showed that the average number of eggs laid by females of a related species *(S. masinissa)* was 25 on persimmon (Park *et al.* 2001). Adult females of *S. auriferella* can most likely lay a similar number of eggs, which would promote establishment.
- Like other species of *Stathmopoda*, some stages of the life-cycle of *S. auriferella* (such as the mature larva and pupa), can probably undergo diapause during winter (see *Distribution*, above).
- Adults are capable of flight, and are therefore able to move directly from fruit into the environment to find a host. Host plants include species over a wide climatic range from temperate (e.g. peaches, grapes) to tropical species (e.g. mango, avocado, coffee) (Yamazaki and Sugiura 2003; CAB International 2007; Robinson *et al.* 2007).

Polyphagy and flight ability all support a risk rating for distribution of ‘High’.

4.8.4 Probability of spread

The likelihood that *S. auriferella* will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the expansion of the geographic distribution of the pest, is: **HIGH**.

- Natural physical barriers (e.g. deserts/arid areas) may prevent long distance spread of these pests unaided but adults are capable of flight and larvae may be spread in infested host material.
- Japan possesses a generally cooler climate than that of Australia. *Stathmopoda auriferella* could potentially reproduce and spread at a greater rate than in Japan if introduced into Australia.
- The absence or presence of natural enemies in Australia is not known.
- Although field and laboratory tests have shown that some species of *Stathmopoda* (e.g. *S. masinissa*) can be controlled with chemical pesticides (e.g. Tomomatsu *et al.* 1995; Matsuoka *et al.* 2001), such data is lacking for *S. auriferella*. However, other studies have shown that chemical control of *Stathmopoda* species has failed to prevent infestation (e.g. Tomkins 1992).

Directional flight ability, the potential for greater reproductive success in larger geographical areas with suitable climatic conditions in Australia and the failure to control infestations of *Stathmopoda* species all support a risk rating for spread of 'High'.

4.8.5 Probability of entry, establishment and spread

The overall likelihood that *S. auriferella* will be imported as a result of trade in fresh unshu mandarin from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **MODERATE**.

4.8.6 Consequences

Assessment of the potential consequences (direct and indirect) of *S. auriferella* for Australia is: **LOW**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: C – significant at the local level This pest causes direct damage to many host plant species, such as *Citrus*, *Mangifera*, *Vitis*, and *Prunus* spp. (Yamazuki and Sugiura 2003; CAB International 2007), and *Acacia* (Robinson *et al.* 2007). *Stathmopoda auriferella* larvae damage the leaves, buds and fruit of its hosts.
Other aspects of the environment	**Impact score**: B – minor at the local level Introduction of *S. auriferella* into a new environment would lead to competition for resources with other native lepidopteran species. However, this pest has a preference for commercial host species.
Indirect	
Eradication, control etc.	**Impact score**: C – significant at the local level Additional programs to minimise the impact of *S. auriferella* on host plants may be necessary, although the efficacy of pesticides and other control measures on this species is unknown.
Domestic trade	**Impact score**: D – significant at the district level The presence of this pest in commercial production areas may have a significant effect at the district level due to resulting interstate trade restrictions.

International trade	**Impact score**: D – significant at the district level The presence of *S. auriferella* in commercial production areas of a range of commodities (including *Citrus*, *Vitis*, *Prunus*, *Mangifera*) may have a significant effect at the district level due to additional phytosanitary requirements to access overseas markets where this pest is absent, e.g. the USA and New Zealand.
Environmental and non-commercial	**Impact score**: B – minor at the local level Although additional pesticide applications or other control activities would be required to control this pest on susceptible crops, these are not considered to impact on the environment. Additional pesticide applications or other activities would be necessary to manage these pests on susceptible fruit crops (see above) and some weed (*Acacia nilotica*) and ornamental (*Albizia altissima*) species (Robinson *et al.* 2007). Any additional insecticide usage may affect the environment.

4.8.7 Unrestricted risk estimate

The unrestricted risk for *S. auriferella* is: **LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for *S. auriferella* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.9 Thrips

*Chaetanaphothrips orchidii**, Frankliniella intonsa; Frankliniella occidentalis^; Thrips palmi#*

(*of regional quarantine concern to Western Australia; ^of regional quarantine concern to Northern Territory, Tasmania; #of regional quarantine concern to Northern Territory, South Australia, Tasmania, Western Australia)

4.9.1 Introduction

Some Thysanoptera (thrips) species are pests of commercial crops, due to damage caused by feeding on developing flowers, leaves and fruit (CAB International 2007). Their mouthparts are used to rupture and imbibe fluids from plant cells, causing scarring that can reduce crop yield, productivity and marketability (CSIRO 1991). They can also transmit tospoviruses while feeding (CAB International 2007). Thrips are opportunistic, well adapted to surviving difficult conditions, and capable of tolerating temperatures below freezing over extended periods (McDonald *et al.* 1997).

The thrips considered in this import risk assessment are: *Chaetanaphothrips orchidii, Frankliniella intonsa*, *Frankliniella occidentalis and Thrips palmi.* These species have been grouped together because of their related biology and taxonomy. They are predicted to pose a similar risk and require similar mitigation measures. In this assessment, the term 'thrips' is used to refer to these species, unless otherwise specified.

4.9.2 Probability of entry

Probability of importation

The likelihood that the thrips assessed will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **HIGH**.

- Thrips are cold tolerant and may survive low temperatures during storage and transport (CAB International 2007). For example, *T. palmi* is able to survive temperatures as low as -3°C to -7°C (Nagai and Tsumuki 1990).
- The lifespan of *F. intonsa* adults is up to 49 days (CAB International 2007) which exceeds the packing and transport period (refer to *Post-harvest*, Chapter 3).
- Adult thrips are only 1.3 mm long (Pernezny *et al.* 2003; QDPIF 2005). Eggs of *Frankliniella* spp. are small (about 200 µ long) and may be laid on, or under the peel of unshu mandarins (Nakazawa 1981; Tsuchiya *et al.* 1995).
- Damage may appear as scratches, bronzing or silvering to the fruit (CAB International 2007) which at low levels would be difficult to detect.

The cold tolerance, lifespan, small size and cryptic nature of thrips, and their association with fresh unshu mandarin fruit, all support a risk rating for importation of 'High'.

Probability of distribution

The likelihood that thrips will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan, is: **MODERATE**.

- Adult thrips may hide, feed and lay eggs on, or under the peel of fresh unshu mandarin fruit (Tsuchiya *et al.* 1995; Pernezny *et al.* 2003). Although adult thrips will most likely move off the fruit when disturbed, immature instars may remain with the fruit during distribution for wholesale or retail trade.
- Thrips are among the weakest flying insects but their finely fringed wings enable them to remain airborne and be easily dispersed by wind (Lewis 1973), and on clothing, hair, contaminated equipment and containers (EPPO 1997). Adult thrips are also able to run and jump (Jenser 1973; EPPO 1997; Pearsall 2002) further increasing their mobility.
- Thrips have a wide host range including crop plants and ornamental species, all of which are present in Australia (refer to Appendix B). *Chaetanaphothrips orchidii* is a polyphagous species attacking commercial fruit trees and vines, including citrus, papaw, passionfruit, tree and shrub species, such as *Banksia* and oleander, weeds, including lantana (APPD 2008). This thrips is also a major pest of anthuriums (CAB International 2007). *Frankliniella intonsa* can be found on capsicum, tomato, asparagus, strawberry, peach, nectarine, chrysanthemum, pea, soybean, lucerne, rice and cotton (CAB International 2007). Hosts of *F. occidentalis* include chrysanthemums, cucurbits, cotton, grapes, citrus and apple (CAB International 2007). *Thrips palmi* may be present on a range of plants in the families Curcurbitaceae and Solanaceae (Young and Zhang 1998; QDPIF 2005; CAB International 2007).
- The intended use of the proposed import of fresh unshu mandarin fruit from Japan is for human consumption. This end use would assist the potential distribution of these thrips species. Disposal of infested fruit or peel into the environment provides the potential for these pests to transfer to susceptible hosts in the vicinity.

The cryptic nature, high mobility and polyphagy of thrips, moderated by their weak flying ability, support a risk rating for distribution of 'Moderate'.

Probability of entry (importation × distribution)

The likelihood that thrips will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan, is: **MODERATE**.

4.9.3 Probability of establishment

The likelihood that thrips will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to their survival and reproduction, is: **HIGH**.

- Thrips species reproduce rapidly. For example, *F. intonsa* reproduced up to 22 generations during one year in laboratory experiments, with the egg, larval stage and pupal stage each lasting only 1–3 days (Tang 1976; Pernezny *et al.* 2003; CAB International 2007). Similar experiments have shown that *F. occidentalis* can produce up to 15 generations per year (Katayama 1997; McDonald *et al.* 1998; CAB International 2007) while *T. palmi* are capable of producing 25–26 generations per year with the entire egg to adult stage taking 10–19 days (Huang and Chen 2004). Adult females of this species lay up to 200 eggs during their lifespan (Wang *et al.* 1989). *Chaetanaphothrips orchidii* reproduces parthenogenetically and lays 80 to 100 eggs per female (Hara *et al.* 2002).
- Abiotic factors have a large influence on the abundance of thrips. *Frankliniella intonsa* and *T. palmi* develop at faster rates at warmer temperatures (CAB International 2007). Reproductive rates are also improved when temperatures exceed 20°C. The total life-cycle of *F. occidentalis* is between 15 days at 30°C and 45 days at 15°C (CAB International 2007). Temperatures in the range of 25–30°C are optimal for population growth of *T. palmi* (Huang and Chen 2004). *Chaetanaphothrips orchidii* completes its entire life cycle in about 28–32 days during the warm summer months in the USA (Hara *et al.* 2002). Much of Australia is subject to temperatures between 15°C and 30°C, providing opportunity for establishment. Adult *F. intonsa* are also more mobile when exposed to temperatures above 20°C (Jenser 1973; CAB International 2007).
- Natural enemies and pesticides have controlled populations of thrips with some degree of success (CAB International 2007). However, whilst insecticides have been widely used to suppress *F. intonsa* populations on plants such as cotton, the success of this treatment is limited (Atakan and Özgür 2001). Control of thrips for long periods is difficult because of their cryptic habit and their known ability to become resistant to pesticides (Herron *et al.* 1996; Datta *et al.* 1999; Herron and Cook 2002; CAB International 2007). In addition, differences in pesticide resistance profiles have been observed between *F. occidentalis* populations in Japan and Australia (Morishita 2001; Herron and James 2005; Zhang *et al*. 2008). Therefore existing pesticide control practices in Australia may be less effective against Japanese thrips species.
- *Frankliniella occidentalis* is already established in some parts of Australia including Queensland (Mound 2005), New South Wales (Bright *et al.* 2006), South Australia and Western Australia (NTDPIFM 2007). *Thrips palmi* occupies some parts of the Northern Territory and south-eastern Queensland. *Chaetanaphothrips orchidii* occurs in Queensland, New South Wales and South Australia (Mound 2001; APPD 2007). Control

measures are currently implemented on interstate transport of known host commodities (Young and Zhang 1998; QDIPF 2005; NTDPIFM 2006; DAFWA 2008c).

- *Thrips palmi* has a wide host range, including plants in the Curcurbitaceae and Solanaceae families (Young and Zhang 1998; QDPIF 2005; CAB International 2007; NTDPIFM 2006) which are widely distributed throughout Australia. Wide host plant distribution would support the spread of pest populations.

The high reproductive rate, pre-adaptation to temperature ranges found in Australia, and limited success of control measures for thrips all support a risk rating for establishment of 'High'.

4.9.4 Probability of spread

The likelihood that thrips will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the expansion of the geographic distribution of the pest, is: **HIGH**.

- *Frankliniella intonsa* originated in South-East Asia and is now found throughout Europe and Asia where it has established itself as an economically significant pest (CAB International 2007). *Frankliniella occidentalis* is a native to western North America, but since 1960, it has spread rapidly throughout much of North America, Europe, northern and southern Africa, parts of South America and Asia, Australia and New Zealand (Kirk and Terry 2003). Already present within parts of Australia (NT and Qld), *T. palmi* is able to spread very quickly (Young and Zhang 1998; CAB International 2007) and has rapidly become a major pest of cucurbits and solanaceous plants in many tropical regions of the world (Young and Zhang 1998; QDIPF 2005; CAB International 2007). Similarly, *C. orchidii* is present along the eastern seaboard of Australia and South Australia (Mound 2001; APPD 2008). Its polyphagous nature and ability to adapt to a wide climatic range (i.e. of tropical, subtropical and temperate distribution) all support the probability that it could spread to other areas of Australia.
- Thrips have a wide host range, including crop plants and ornamental species, all of which are present in Australia (refer to *Distribution*, above).
- Climatic factors, such as deserts, semi-arid and arid areas, can significantly slow the natural spread of these insect pests, due to their low tolerance to low humidity and high temperatures. However, they may be moved with fruit and other plant material.

The vast spread of the four thrips species in other countries over short periods of time, their polyphagy, and the wide distribution of susceptible hosts within Australia, all support a risk rating for spread of 'High'.

4.9.5 Probability of entry, establishment and spread

The likelihood that thrips will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **MODERATE**.

4.9.6 Consequences

Assessment of the potential consequences (direct and indirect) of thrips for Australia is: **LOW**.

Criterion	**Estimate and rationale**
Direct	
Plant life or health	**D** – significant at the district level Thrips may cause direct harm to a range of plant hosts. *Frankliniella intonsa* damages both crop and ornamental species, including capsicum, tomato, asparagus, strawberry, peach, nectarine, chrysanthemum, pea, soybean, lucerne, rice and cotton (CAB International 2007). *Frankliniella occidentalis* causes direct harm to a wide range of plant hosts, including chrysanthemums, cucurbits, cotton, grapes, citrus and apple (CAB International 2007), all of which are present in Australia. *Thrips palmi* causes damage to a wide range of hosts, including plants in the Curcurbitaceae and Solanaceae families (QDPIF 2005; NTDPIFM 2006). *Chaetanaphothrips orchidii* is polyphagous, causing damage to commercial fruit trees, ornamentals, shrubs and weeds (APPD 2008). Although light infestations of thrips are generally not harmful to plants, more severe infestations can result in damaged fruit, skin 'russeting', delay in production of flowers and fruit, stunting of shoot growth, distorted fruits and a general decline in plant vigour, diminished fruit set, fruit drop, and the occurrence of white swellings and spots caused by oviposition (EPPO 1997; CAB International 2007). A range of thrips can also act as a vector for a number of tospoviruses, many of which are not known to occur in Australia (Campbell *et al*. 2008). Viral symptoms vary considerably in different plants, ranging from wilting and collapse of lettuce plants, leaf mottling and distortions, to ring-spotting on tomato fruits, and can lead to the total loss of certain crops (CAB International 2007).
Other aspects of the environment	**B** – minor at the local level Thrips introduced into a new environment may compete for resources with the native species. There are no known consequences on other aspects of the environment.
Indirect	
Eradication, control etc.	**D** – significant at the district level Existing control programs using pesticides may be effective, though it is difficult to quantify the specific damage caused by thrips. Control programs with broad spectrum pesticide applications could be effective for some hosts, but would need to be supplemented by other methods shown to be effective, such as hygiene measures in glasshouses, as thrips quickly develop resistance to the same pesticide preparations (Herron *et al.* 1996; Datta *et al.* 1999; Herron and Cook 2002; CAB International 2007). Introduced thrips species from Japan may have different pesticide resistance profiles and thus existing control programs may be ineffective.
Domestic trade	**D** – significant at the district level The introduction of thrips species that are not present in Australia is likely to have a significant impact on interstate trade affecting a wide range of host commodities, with potential loss of markets and significant industry adjustment.
International trade	**D** – significant at the district level Presence of thrips in commercial production areas on a wide range of commodities (e.g. species of Fabaceae, Cucurbitaceae, Solanaceae, Rosaceae and Rutaceae) will impact trade as countries may impose measures that may limit access to overseas markets which lack these pests.
Environmental and non-commercial	**B** – minor at the local level Thrips species introduced into a new environment will compete for resources with native species. Additional pesticide applications or other activities would be necessary to manage these pests on susceptible hosts. Any additional insecticide usage may affect the environment.

4.9.7 Unrestricted risk estimate

The unrestricted risk estimate for *Chaetanaphothrips orchidii, Frankliniella intonsa*, *F. occidentalis and Thrips palmi* is: **LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for thrips of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.10 Japanese orange fly

Bactrocera tsuneonis

4.10.1 Introduction

Fruit flies are considered to be among the most damaging pests to horticulture (White and Elson-Harris 1994). Fruit flies in the genus *Bactrocera* are one of four fruit fly genera that are of most global concern. *Bactrocera* species are an economically important and diverse genus of fruit flies, having in excess of 400 recognised species (White and Elson-Harris 1994). They occur in many countries, can easily establish in new environments, rapidly increase in numbers and disperse successfully and therefore represent a significant threat to agriculture (Fletcher 1989a, b). *Bactrocera* spp. attack a wide range of fruit including tropical, subtropical and temperate fruit in South-East Asia, Oceania, the Subcontinent and parts of Africa.

Fruit flies are of concern because their larvae generally complete their feeding and development within the host fruit (Fletcher 1989a). Fruit with infestation normally show obvious signs of attack or tissue decay. However, infested fruit cannot always be distinguished from uninfested fruit (White and Elson-Harris 1994). The transportation of infested fruit is regarded as the major means of movement and dispersal of fruit flies (Baker *et al*. 2000; Iwaizumi 2004) and therefore deserves the most scrutiny in terms of pathways for introduction.

4.10.2 Probability of entry

Probability of importation

The likelihood that *B. tsuneonis* will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **LOW**.

- MAFF advised that in Japan *B. tsuneonis* occurs on Kyushu Island and on the Ryukyu Islands which are to the South of Honshu Island. This information is consistent with distribution records listed for Japan by White and Elson-Harris (1994). The unshu mandarin production area in the Shizuoka Prefecture is on Honshu Island and is apparently free of natural populations of *B. tsuneonis*.
- However, there are currently no restrictions on the movement of citrus fruit in Japan, and infected fruit could be present in the production area.
- *Bactrocera tsuneonis* is a serious pest of citrus, including cumquats, sweet and sour oranges and tangerines (White and Elson-Harris 1994). MAFF provided additional information that *B. tsuneonis* also infests other thin skinned citrus species such as unshu mandarin.

- Information provided by MAFF on the biology of *B. tsuneonis* shows that this species, in its distributional range, has one generation per year. Reproduction is by sexual means. Adults emerge during summer from early June to around mid July. Egg laying, that of 30-40 eggs during its lifetime, commences three to four weeks after emergence, i.e. from late July to early September and continues for over 20 days. Eggs are deposited into the host fruit with a long, extendable ovipositor. Generally there is one developing larva per fruit. All three larval stages feed inside the fruit before the third mature larval stage emerges from the fruit at the end of November. It buries itself into the soil and overwinters in the pupa stage until emerging as an adult in the following summer.
- *Bactrocera tsuneonis* is distributed throughout the subtropical and tropical islands of Kyushu Island and the Ryukyu Islands. MAFF informed that *B. tsuneonis* has never been reported from the Shizuoka Prefecture on temperate Honshu Island. Although there is no data on the cold tolerance of this species available, there neither is evidence of it being cold tolerant. Pupation under subtropical conditions prior to winter suggests that this species is unlikely to be cold tolerant.
- Male flies of *Bactrocera tsuneonis* are non lure responsive and trapping efficiency is therefore low. However, long term trapping data (since 2001) and the fruit fly's limited distributional range (see above) all provide confidence that *B. tsuneonis* has not been trapped and is not able to establish in the designated export areas.
- Infested fruit may show symptoms, e.g. punctures and solidified sugars associated with the egg depositing hole, but these symptoms may not be detected during the pre-export inspections. Eggs and larval stages may survive in harvested fruit and will not be visible.
- Also, routine washing procedures undertaken within the packing house would not remove the eggs or larvae from under the fruit surface.
- Adults of this species are unlikely to stay on the fruit during inspection and packing procedures.

The difficulty of detecting fruit fly eggs and larval stages internally in fruit and the lack of movement restrictions of fruit fly host commodities throughout Japan moderated by the fruit fly's natural distributional range in the subtropics/tropics and its reported absence supported by active trapping from the Shizuoka Prefecture support a risk rating for importation of 'Low'.

Probability of distribution

The likelihood that *B. tsuneonis* will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan is: **HIGH**.

- In the event that fruit infested with eggs and larvae would survive transport to Australia, fruit are likely to be distributed throughout the country for retail sale. Adults, larvae and eggs are likely to be associated with infested waste.
- Although damaged fruit are likely to be detected and removed from consignments because of quality concerns, fruit flies have the capacity to complete their development in discarded fruit. Although *B. tsuneonis* has a relatively narrow host range, hosts are widely distributed throughout Australia.
- Eggs can develop into larvae within stored fruit, at the point of sale or after purchase by consumers.

- Adults are strong fliers, and can move directly from infected fruit into the environment to search for mates and suitable hosts.

The ability to complete larval development on discarded fruit, their directional and strong flight ability and the wide distribution of suitable citrus hosts throughout Australia all support a risk rating for distribution of 'High'.

Probability of entry (importation x distribution)

The likelihood that *B. tsuneonis* will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin fruit from the production area in Japan is: **LOW**.

4.10.3 Probability of establishment

The likelihood that *B. tsuneonis* will establish within Australia, based on a comparison of factors in the source and destination areas considered pertinent to its survival and reproduction is: **HIGH**.

- Establishment will depend on surviving females successfully locating a mating partner. Previous exotic fruit fly incursions in Australia of other fruit fly species, which subsequently have been eradicated, indicate that establishment is possible. For example, *Bactrocera papayae* was detected around Cairns, northern Queensland in 1995. It was eradicated from Queensland by implementing an eradication program using male annihilation and protein bait spraying (SPC 2002). This example demonstrates that fruit fly species can establish in Australia.
- Although the host range of citrus species is relatively narrow, hosts species are widespread throughout Australia, both in commercial orchard districts and suburban areas.
- Suitable subtropical and tropical climatic ranges occur on the eastern and western seaboard of Australia and in northern Australia.
- The food source for adult fruit flies (honeydew excreted by aphids and other insects) is found throughout Australia, which would allow adults to colonise new areas.
- Control of *B. tsuneonis* is possible. Most species of *Bactrocera* can be monitored by traps baited with male lures; however, no chemical male lure is known to attract *B. tsuneonis* (White and Elson-Harris 1994). In China, control of *B. tsuneonis* in citrus orchards includes sterile male technique (Wang *et al*. 1990), and the pesticide trichlorphan (Zhang 1989). Both female and male *B. tsuneonis* flies can be monitored by protein bait traps (CAB International 2007).

Suitable climatic environments coupled with a wide distribution of citrus hosts throughout Australia and the lack of male lure responsiveness support a risk rating for establishment of 'High'.

4.10.4 Probability of spread

The likelihood that *B. tsuneonis* will spread within Australia, based on the comparison of those factors in source and destination areas considered pertinent to the expansion of the geographical distribution of the pest is: **HIGH**.

- The host range of *B. tsuneonis* is narrow, but hosts are densely distributed throughout populated parts of Australia.
- Information supplied by MAFF indicates that the adult life span of *B. tsuneonis* is normally 40–50 days. Fruit flies generally are strong fliers and are able to colonise new areas effectively. *Bactrocera tsuneonis'* large sized body, 11 mm in length, would support strong flight ability.
- The incidence of *B. papayae* in northern Australia in 1995 is indicative of the ability of introduced fruit fly species to spread. Initially, the infested area covered 4500km^2 (Allwood 1995), and was centred around Cairns. The declared pest quarantine area later expanded, including urban areas, farms, and areas along rivers and the coastline in northern Queensland (Cantrell *et al*. 2002). Although *B. tsuneonis* is likely to spread more slowly than *B. papayae* in Australia because of its narrower host range, the capacity to greatly increase its range is still present.

Strong, directional flight ability and the wide availability of hosts and suitable climatic conditions of extensive populated parts of Australia all support a risk rating for spread of 'High'.

4.10.5 Probability of entry, establishment and spread

The overall likelihood that *B. tsuneonis* will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia is: **LOW**.

4.10.6 Consequences

Assessment of the potential consequences (direct and indirect) of *B. tsuneonis* for Australia is: **HIGH**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**E** – significant at the regional level *Bactrocera tsuneonis* can cause direct harm to a wide range of plant hosts within the genus *Citrus*. The fruit fly is considered to threaten the economic viability of citrus production through a moderate decrease of saleable produce, specifically in the subtropical and tropical regions of Australia.
Other aspects of the environment	**C** – significant at the local level The introduction of *B. tsuneonis* into a new environment may lead to this fruit fly competing for resources with native species. There are no known consequences for other aspects of the environment.

Indirect	
Eradication, control etc.	**F** – significant at the national level A control program would add considerably to the cost of production of the host fruit. In 1995, the *B. papayae* (papaya fruit fly) eradication program using male annihilation and protein bait spraying cost AU$35 million (SPC 2002). Fruit flies are estimated to have significant consequences at the national level and highly significant consequences at the regional level. Recent research has highlighted the potential prevalence of insecticide resistance in *Bactrocera* species (Hsu *et al.* 2006; Skouras *et al.* 2007). Incursion of insecticide resistant populations of *Bactrocera* species would be more difficult to control or eradicate and add significantly to the costs of these programs. Males of *B. tsuneonis* are non-lure responsive. Population monitoring would require the labour intensive and costlier alternative of female protein baiting.
Domestic trade	**E** – significant at the regional level The presence of fruit flies in commercial production areas would have a significant effect at the regional level because of any resulting interstate trade restrictions on a wide range of citrus commodities.
International trade	**E** – significant at the regional level Fruit flies, including *B. tsuneonis*, are regarded as major destructive pests of horticultural crops in various parts of the world. Although *B. tsuneonis* can lead to considerable yield losses of citrus in orchards and urban backyards, they also have consequences for the Australian citrus industry on gaining and maintaining export markets. For example, when the papaya fruit fly outbreak occurred in northern Queensland, it affected Australia's trade. In the first two months of the papaya fruit fly eradication campaign, about $600,000 worth of exports were interrupted by Australian trade partners (Cantrell *et al.* 2002). Within a week of the papaya fruit fly outbreak being declared, Japan ceased imports of mangoes at a cost of about $570,000, New Zealand interrupted its $30,000 banana trade, and the Solomon Islands completely stopped importing fruit and vegetables from Queensland (Cantrell *et al.* 2002) until eradication was declared.
Environmental and non-commercial	**D** – significant at the district level Broad-scale chemical control of any fruit fly would have significant effects on fragile rainforest ecosystems (Cantrell *et al.* 2002).

4.10.7 Unrestricted risk estimate

The unrestricted risk for *B. tsuneonis* is: **MODERATE**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for *B. tsuneonis* of 'moderate' exceeds Australia's ALOP. Therefore, specific risk mitigation measures are required for this pest.

4.11 Citrus scab

Sphaceloma fawcettii

Citrus scab, caused by *S. fawcettii*, produces serious fruit blemishes that cost the citrus industry millions of dollars worldwide in reduced fruit value for the fresh market. Of the four recognised pathotypes (i.e. Florida broad host range, Florida narrow host range, lemon and Tryon's), the lemon and Tryon's pathotypes occur in Australia (Tan *et al.* 1996). These two pathotypes are established in coastal New South Wales, Queensland and the Northern Territory (Timmer *et al.* 1996a; APPD 2007).

While all pathotypes of *S. fawcettii* affect *C. jambhiri* (rough lemon) and *C. limon* (lemon), the lemon pathotype is known to only affect lemon while the Tryon's pathotype also attacks certain *C. reticulata* (mandarin) cultivars (Timmer *et al.* 1996a). In Japan, *S. fawcettii* is known to affect *Citrus unshiu* (MAFF 1990; JSCC 2008), *Citrus reticulata* Blanco (Ponkan mandarin) and *Citrus hassaku* (JSCC 2008). Tan *et al.* (1996, 1999) suggested that, because unidentified pathotypes may exist in localised areas, strict quarantine precautions should be taken to avoid moving the citrus scab fungi into Australia from other countries. In 2008, Japan advised that the pathogenic form of the species that is present in Japan is not known.

Citrus scab is known to occur in citrus production areas in the Shizuoka Prefecture, although the incidence of scab is low, as advised by MAFF officers during the 2007 Biosecurity Australia site visit. Regular monitoring for citrus scab is conducted within the Prefecture as part of the National Pest Outbreak Forecasting Program. The Shizuoka Department of Agriculture advises growers of spray applications for citrus scab, should these be required (refer to Chapter 3). However, adherence of growers to the recommended spray applications is not mandatory.

In previous policy developed for the importation of Tahitian limes from New Caledonia (BA 2006) exotic pathotypes of *Sphaceloma fawcettii* were assigned an unrestricted risk rating of **LOW**, which exceeds Australia's ALOP. This risk rating has been reviewed, and it has been concluded that it is valid for this risk analysis.

The unrestricted risk estimate for *Sphaceloma fawcettii* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.12 Citrus canker

Xanthomonas citri subsp. *citri*

4.12.1 Introduction

Citrus canker, caused by *Xanthomonas citri* subsp. *citri,* is a leaf-spotting and fruit rind blemishing disease. Canker lesions appear as corky eruptions surrounded by an oily or water-soaked margin on the surface of leaves, twigs and fruit (Timmer *et al.* 1991). Premature fruit abscission and deformed and blemished fruit with increasing disease severity cause major economic losses (Koizumi 1981, 1985; Stall and Seymour 1983; Schubert *et al.* 2001; Gottwald *et al.* 2002a; Das 2003).

As stated previously (refer to *Scope* in Section 1.2.2), the unrestricted risk for the identified quarantine pests, which include citrus canker, is assessed for the production area. The production area surrounds the four designated export areas to Australia and has no phytosanitary conditions in place. This is in contrast to the designated export areas from which unshu mandarins are currently exported to other countries, including the USA and New Zealand, and which are subject to phytosanitary conditions.

4.12.2 Probability of entry

Probability of importation

The likelihood that *X. citri* subsp. *citri* will arrive in Australia with the importation of fresh unshu mandarin fruit from the production area in Japan is: **LOW**.

Citrus canker status in the production area

- Citrus canker is present in the Shizuoka Prefecture, where it occurs on vegetative plant parts and fruit of mid-season mandarin varieties (Obata 1974; Kuhara 1978). Sampling and reporting procedures for the Shizuoka prefectural citrus canker monitoring program are outlined in Appendix F.
- MAFF provided information that there have been no reported visible symptoms of *X. citri* subsp. *citri* on unshu mandarin in the designated export areas since monitoring for citrus canker commenced in 1968 as part of the export protocol for unshu mandarins to the USA. Table 4.2 provides a summary of field monitoring records (1996–2005) for unshu mandarin export orchards near Fujieda City provided by MAFF. This data shows that no unshu mandarin export orchard registered for trade to the USA or New Zealand was rejected for citrus canker.

  While Japan has advised that citrus canker has never been reported in the designated export areas from which fruit is sourced for export to the USA and New Zealand, no supporting data demonstrating the absence of visible symptoms of *X. citri* subsp. *citri* from the production area, excluding the designated export areas, was provided.

Table 4.2 Summary of field inspection records for unshu mandarin export orchards in the Shizuoka Prefecture near Fujieda City

After petal fall inspection

Year	No. of orchards	Area (ha)	No. of trees	No. of orchards passed	No. of orchards rejected for citrus canker	No. of orchards rejected, including reason
1996	164	24.02	30 184	163	0	1 – citrus mealybug
1997	157	23.22	28 802	156	0	1 – poor management
1998	156	23.16	28 589	156	0	0
1999	161	24.28	27 505	161	0	0
2000	157	23.61	26 164	157	0	0
2001	159	23.75	24 781	159	0	0
2002	161	24.33	23 786	158	0	3 – poor management
2003	156	24.01	23 045	153	0	3 – poor management
2004	153	23.07	21 720	153	0	0
2005	148	22.40	20 588	146	0	2 – not stated

Pre-harvest inspection

Year	No. of orchards	Area (ha)	No. of trees	No. of orchards passed	No. of orchards rejected for citrus canker	No. of orchards rejected, including reason
1996	163	23.97	30 149	161	0	2 – poor management
1997	156	23.19	28 781	156	0	0
1998	156	23.15	28 589	150	0	6 – poor management & arrowhead scale
1999	161	24.28	27 505	159	0	2 – arrowhead scale
2000	157	23.61	26 164	156	0	1 – arrowhead scale
2001	159	23.75	24 781	159	0	0
2002	161	24.33	23 786	157	0	4 – poor management & arrowhead scale
2003	156	24.01	23 045	151	0	5 – poor management & arrowhead scale
2004	153	23.07	21 687	148	0	5 – poor management & arrowhead scale
2005	148	22.4	20 588	145	0	3 – not stated

- MAFF informed Biosecurity Australia in 2007 that there are no other citrus canker hosts in the designated export areas other than unshu mandarins, but citrus canker hosts may be present in the production area outside the four designated export areas. However, the number of host plants would be low, because horticultural production within the production area predominately consists of tea, unshu mandarin and bamboo plantations nestled amongst *Cryptomeria* forest (refer to Section 3.2).

- Due to above reasons, the production area is considered as an area of low pest prevalence (ALPP) for citrus canker.
- While the mountainous terrain that surrounds the production area acts as a natural wind break (Kuhara 1978), there is still concern that *X. citri* subsp. *citri* may be introduced to the production area during typhoons (Chapter 3).

Resistance of unshu mandarin to citrus canker

- Resistance to citrus canker varies between citrus species and cultivars (Matsumoto and Okudai 1990; Koizumi and Kuhara 1982; Canteros 1992, 2004). Citrus species such as grapefruit, limes and trifoliata rootstock are of low resistance to *X. citri* subsp. *citri* infection. Unshu mandarin rates amongst the most resistant citrus species to this bacterium (Kuhara 1978; Danos *et al.* 1981; Koizumi and Kuhara 1982; Serizawa and Inoue 1983; Leite and Mohan 1984). Unshu mandarin fruit rarely show signs of infection (Kuhara 1978; Canteros 2004), although fruit infection does occur (Koizumi 1972; Serizawa *et al.* 1985). Goto (2005) provides an image of fruit infection of unshu mandarin.
- Research on the inheritance of resistance to citrus canker was studied by Matsumoto and Okudai (1990). They showed that unshu mandarin is homozygous for a single dominant allele that confers resistance to citrus canker. These authors and Koizumi and Kuhara (1982) consistently found that unshu mandarin is moderately resistant to citrus canker. In this pest risk assessment, unshu mandarin is considered to be moderately resistant to citrus canker and this terminology is used in the report unless other terminology was used in the original source.
- The moderate resistance of unshu mandarin fruit to citrus canker was supported by a 10 year (1995–2004) field research project in Argentina (Canteros 2004). Fruit of unshu mandarin exhibited the lowest citrus canker disease intensity of all tested species (i.e. grapefruit, lemon, Valencia orange and Murcott tangor). In fact, no fruit infection was recorded for unshu mandarin on all 25 observation dates over the length of the study, unlike the results for all the other species. Disease incidence for vegetative plant parts was slightly higher than for fruit, but unshu mandarin was again consistently the least susceptible species to citrus canker for each of the given 25 observation dates (Canteros 2004). Field research conducted on satsuma mandarin (*C. unshiu*) in Brazil provided similar results as fruit of this species was the least susceptible to *X. citri* subsp. *citri* infection compared with that of a wide range of citrus species/cultivars (i.e. mandarin, grapefruit, pummelo, natsudaidai, calamondin) (Leite and Mohan 1984).

Suitability of climate

- Climatic information from the field research site in Argentina (Canteros 2004) and the production area in Japan is summarised in Table 4.3. Argentinian records were obtained from the closest weather station at Corrientes using data from Servicio Meteorologico Nacional (2008) and from Canteros (2004). Equally, the summers are warm and moist at the research site in Argentina, and at the production area in Japan, although the total rainfall in summer is lower in Argentina. Despite this, conditions for the expression of citrus canker symptoms are more conducive throughout the year in Argentina, as the monthly rainfall pattern is more even and average minimum temperatures above 14ºC occur for seven months, compared to four months in Japan (refer to Table 3.3). Proliferation of cells of *X. citri* subsp. *citri* commences at above 14ºC (Koizumi 1976, 1977, 1985).

- Reports provided by MAFF indicate that leaf and fruit damage of unshu mandarin due to wind/weather events that would promote infection are not known to occur in the designated export areas. Unshu mandarin trees are thornless and are grown on the lower slopes in hilly terrain. This reduces the incidence of wounds as potential entry sites to citrus canker bacteria. The export orchards are well established and the mature unshu mandarin trees flush once per year during spring/early summer. This is the stage when leaf tissues are most susceptible to infection with citrus canker. However, leaf flush occurs prior to flowering and in most years prior to the commencement of the typhoon season in Japan.

Table 4.3 Comparison of meteorological data relevant to the designated export areas in Japan and to research in Argentina

Japan				Argentina						
Month	Avg. min (ºC)	Avg. max (ºC)	Avg. rain (mm)	Month	Avg. min (ºC)	Avg. max (ºC)	Avg. rain (mm) 1981-1990	Avg. rain (mm) 1991/1992	Avg. rain (mm) 1997/1998	Avg. rain (mm) 2002/2003
Jan	–2.7	17.9	86.3	Jul	10.6	20.9	48.5	n/a	n/a	n/a
Feb	–1.5	20.2	97.7	Aug	11.8	23.1	60.3	n/a	n/a	n/a
Mar	–0.6	22.4	183.0	Sep	12.5	23.9	83.0	n/a	n/a	n/a
Apr	5.7	29.1	175.3	Oct	15.7	28.0	129.7	105.9	267.3	244.0
May	10.5	29.8	210.1	Nov	18.4	29.7	174.8	169.6	162.0	212.0
Jun	14.9	33.2	298.3	Dec	19.7	32.1	118.8	190.0	265.3	329.0
Jul	20.2	35.6	373.9	Jan	21.3	33.5	166.1	107.5	259.9	110.2
Aug	20.3	36.0	335.9	Feb	20.8	32.1	156.9	187.7	206.7	146.8
Sep	16.3	33.5	212.7	Mar	19.2	30.6	205.9	252.7	371.4	247.5
Oct	9.6	30.0	342.1	Apr	16.9	26.2	284.6	427.7	394.8	158.0
Nov	4.8	24.4	132.9	May	13.5	23.5	125.2	123.7	44.9	12.0
Dec	–1.0	20.4	77.4	Jun	10.7	20.1	91.8	n/a	n/a	n/a

Timing for infection in the orchard

- Developing leaves, between 50% and 75% of their final size, are the most susceptible stage for citrus canker infection (Ohta 1967; Canteros 1992). The first disease symptoms of citrus canker usually become visible on new leaves and shoots of unshu mandarin during the growing season (Goto 1962; Koizumi 1977).
- The appearance of lesions on twigs and fruit in the disease cycle generally occurs only after a certain inoculum level has been reached on leaves (Schubert *et al.* 2001). A reduction of the pathogen level on leaves reduces the occurrence of the pathogen on fruit (Kuhara 1978; Stall *et al.* 1982; Goto 1992; Canteros 2004).
- Koizumi (1972) observed that citrus canker infection is highly dependent on host receptivity. *Xanthomonas citri* subsp. *citri* bacteria die relatively quickly in lesions of early infected fruit, as the formation of a phellogen layer acts as a barrier between infected and non-infected tissue suppressing further bacterial infection. In late infections, a combination of physiological changes associated with the ripening of fruit and the drop in temperatures during the autumn and winter period, effectively arrest bacterial development in infected tissue.

- The time interval for fruit to become naturally infected with the bacterium is limited, as resistance of fruit to citrus canker increases with fruit maturity (Koizumi 1972; Canteros 1992; Graham *et al.* 1992b). Natural (stomatal) citrus canker infection of unshu mandarin is most severe during the early stages (first two months) of fruit development when fruit is less than 30 mm in size (Goto 1962; Koizumi 1972). Biosecurity Australia officers who visited the designated export areas in 2007 observed that fruit reached this size in mid summer (July). Unshu mandarin fruit become increasingly resistant to infections when they reach 45–50% of their final size (Koizumi 1972; Canteros 1992). In comparison, fruit of less resistant citrus species become resistant at a later growth stage. For example, *Citrus natsudaidai* (natsudaidai mandarin) becomes resistant when fruit reaches 50 mm in size (Goto 1962), *Citrus sinensis* cv. Washington Navel (sweet orange) at 68% and *Citrus paradisi* cv. Duncan (grapefruit) at 85% of their final size (Canteros 1992).
- For fruit infection to occur, several conditions are required to coincide: the host tissue needs to be in a receptive stage, climatic conditions suitable to release and transfer bacteria need to occur, and sufficient inoculum needs to be available.
- The minimum inoculum load of *X. citri* subsp. *citri* bacteria to cause stomatal infection is about 100 000 cells/ml and for wound infection is about 100 to1000 cells/ml (Goto 1962).
- Lesions less than a fortnight old contain about 10 000 000 viable *X. citri* subsp. *citri* cells per lesion. Lesions more than one month old contained less than 1000 viable *X. citri* subsp. *citri* cells per lesion (Timmer *et al.* 1991).
- Population levels of *X. citri* subsp. *citri* on symptomless fruit of grapefruit, lemon, orange and tangerine ranged from undetectable levels from sprayed low disease orange and lemon plots to between 0 to 1 000 000 *X. citri* subsp. *citri* cells per fruit from highly infected, unsprayed grapefruit, lemon and orange plots (Rybak and Canteros 2001). The fruit of all citrus cultivars used in this study were of higher susceptibility to citrus canker than *C. unshiu* (Koizumi 1976, 1985; Koizumi and Kuhara 1982). Symptomless *C. unshiu* fruit may be expected to have very low population levels of *X. citri* subsp. *citri* in comparison to the citrus cultivars tested by Rybak and Canteros (2001).

Conditions limiting fruit infection in the production area

- Shizuoka Prefecture is affected by typhoons generally from July to October annually (refer to Table 3.4). Strong winds, during these typhoons, could carry citrus canker bacteria from infected areas along the coastal lowlands inland to the production area.
- Warm and wet weather, together with wind-driven rain and wind speeds exceeding 8.7 m/s, greatly increase the likelihood of infection (Serizawa *et al*. 1969).
- Infection other than through young leaves and young fruit requires wounded tissue, such as caused by mechanical damage or citrus leafminer damage (Goto 1962; Serizawa *et al.* 1969; Koizumi 1981; Koizumi and Kuhara 1982; Chagas *et al.* 2001). Pruning of trees in the export areas occurs about March in early spring prior to leaf flush, flowering and fruit set (refer to Chapter 3).
- Unwounded fully expanded leaves and unshu fruit larger than half of their final size are less prone to infection due to the presence of a waxy cuticle (Canteros 1992; Goto 1992). Although fruit infection can occur (Koizumi 1972; Serizawa *et al.* 1985; Goto 2005), this generally happens in instances of high inoculum pressure with severe bacterial infection of the tree canopy (Serizawa *et al.* 1985; Goto 1992).

Existing commercial control program

- MAFF's unshu mandarin spray calendar (Table 3.5) recommends the use of chemicals to control citrus canker and citrus leafminer. Citrus canker sprays are timed to protect suceptible leaves and small fruit, and citrus leafminer control is timed to coincide with the emergence of larvae feeding on leaves. The use of chemicals would reduce the incidence of both pests in orchards. Chemical usage is not mandatory in the production area.
- Copper sprays are a standard control measure that reduce the level of citrus canker (Stall *et al.* 1980; Das 2003; Graham *et al.* 2004). Copper sprays decrease the number of viable cells of *X. citri* subsp. *citri* found on infected plants (Stall *et al*. 1980). Behlau *et al*. (2007) and Leite *et al*. (1987) reported copper treatments reduced the incidence of citrus canker by 43.5% and 90%, respectively. The number of sprays necessary to control citrus canker depends on the susceptibility of the citrus cultivar and on climatic conditions (Kuhara 1978; Leite and Mohan 1990).

Conditions for transport

- In 2008, MAFF informed Biosecurity Australia that the transport temperatures for fruit shipped from Japan to New Zealand and the USA are 4ºC and 6ºC, respectively. The voyage to these countries takes about two and four weeks, respectively. Bacterial multiplication occurs only above 14ºC (Koizumi 1976, 1985) and transport temperatures are therefore not conducive to the proliferation of citrus canker bacteria. However, citrus canker bacteria survive below zero temperatures during winter in Japan's most northern citrus growing areas (refer to Table 3.3), which suggests that bacteria are likely to survive transportation at these temperatures.

Volume of trade

- The expected import volume of unshu mandarin from Japan is estimated to be small, as the total area of the designated export areas (Areas 1–4) consists of only about 25 hectares. Export volumes of fresh unshu mandarin fruit to the USA from these designated export areas averaged a total of 230 tonnes per annum between 1995 and 2005 (APHIS 2006).

The unknown status of citrus canker and its hosts in the production area outside the designated export areas, moderated by the protected position of orchards, and the moderate resistance of unshu mandarin to citrus canker and the expected low volume of imports, support a risk rating for importation of 'Low'.

Probability of distribution

The likelihood that *X. citri* subsp. *citri* will be distributed within Australia in a viable state, as a result of the processing, sale or disposal of fresh unshu mandarin fruit from the production area in Japan, is: **VERY LOW**.

- Unshu mandarins would be distributed throughout Australia via wholesale and retail sale. The intended use of the commodity is for human consumption and waste material would be generated.
- Successful transfer of citrus canker bacteria from infected peel to a host is likely to be limited, considering the following events need to coincide:
    1. *Infected fruit peel would need to be discarded in close proximity to a susceptible host*

       Most fruit waste, including peel, would be disposed of by municipal garbage collection and therefore would be unavailable as a potential infection source. Some waste, of which the majority will be peel, may be discarded in compost bins or heaps. Fruit peel may also be discarded in gardens, along roadsides or within parks and other public places.

Citrus canker hosts, especially species of *Citrus*, are commonly grown in gardens and some as potted plants throughout Australia. However, citrus cultivation in built-up areas is limited to home gardens, as citrus is rarely used as an amenity plant.

2. *Viable inoculum would need to be present*

Citrus canker bacteria can survive on a variety of surfaces including plastics, cloth, wood and metal for up to 48 hours under sun and 72 hours under shade conditions (Graham *et al.* 2000).

In soil, populations of citrus canker bacteria rapidly decline unless there is replenishment of bacteria from infected inoculum sources (Graham *et al.* 1989). Hence, there is limited potential for citrus canker bacteria to remain viable away from fruit or a host.

Exposure of infected fruit peel to antagonistic and predatory microorganisms, such as those associated with compost or soil, greatly accelerates bacterial cell death (Koizumi 1972; Goto *et al.* 1975b). Above-ground, the desiccation of citrus canker bacteria is accelerated by exposure to direct sunlight (Goto 1962, 1992; Graham *et al.* 2000). Epiphytic bacterial proliferation is epidemiologically insignificant (Timmer *et al*. 1996b). The available inoculum in or on infected fruit peel diminishes once fruit has been detached from the tree (see point 3, below).

The survival of *X. citri* subsp. *citri* bacteria in fruit peel of unshu mandarins was studied in the field during the cool and wet winter period in Japan. Results on the survival of *X. citri* subsp. *citri* bacteria were as follows: less than 2 months for specimens buried or left on the ground, 2.5 months for specimens left outdoors but not in contact with the ground, and about 5 months for specimens kept indoors (Koizumi 1972). This suggests a potential for the bacteria to persist in the environment if associated with infected fruit. However, Graham *et al.* (1989) report that in a study in Florida, USA, citrus canker populations rapidly declined in lesions on fruit on the ground or in infested soil. The proposed import of unshu mandarins into Australia coincides with summer, when climatic conditions would speed up the rate of decomposition.

Fresh citrus canker lesions are the primary source of inoculum, as the rate and number of bacterial cells exuding from infected tissue is higher from fresh than from older lesions (Timmer *et al.* 1991). Population levels of *X. citri* subsp. *citri* in visible lesions are higher than the levels associated with asymptomatic occurrences of bacteria on leaves and fruit (Rybak and Canteros 2001). Therefore, the possible inoculum levels on asymptomatic unshu fruit may be too low to initiate infections.

Xanthomonas citri subsp. *citri* bacteria die relatively quickly in lesions of early infected unshu fruit due to the formation of suberised tissue (phellogen), which forms a barrier between infected and non-infected tissue to inhibit further bacterial growth and spread (Koizumi 1972). Koizumi also observed that in late infections a combination of physiological changes associated with the ripening of fruit and the drop in temperatures during the autumn and winter period, effectively arrest the development of infected tissue (Koizumi 1972).

3. *Free water is necessary to enable the release of viable bacteria from infected tissue*

Bacteria need to actively ooze from the infected tissues to become available for transfer. This requires the infected tissue (in this instance the peel) to be wet for a minimum of 15 minutes (Goto 1962).

Bacterial proliferation depends on warm (>20ºC) and moist (>1000 mm/annum rainfall during the growing season) growing conditions (Koizumi 1976, 1985; Kuhara 1978). The multiplication of citrus canker bacteria occurs mostly in the margins of expanding lesions on leaves and fruit. Lesions are associated with visible symptom development. Asymptomatic fruit has not yet developed lesions and therefore is unlikely to release bacterial ooze. Multiplication of citrus canker bacteria ceases with abscission of leaves and fruit and with the onset of decomposition (Koizumi 1972; Graham *et al.* 1989; Goto 1992). There is no evidence that epiphytic bacteria on the surface of fruit persist in adequate numbers to provide sufficient inoculum to cause infection (Timmer *et al*. 1996b). Neither are there reports in the literature that fruit without visible symptoms at harvest would develop lesions after harvest (Graham *et al.* 2004).

4. *Free water is necessary to enable the transfer of bacteria from peel to a host*

   The transfer of bacteria is facilitated by rain splash (Gottwald *et al.* 1989, 1992). *Xanthomonas* bacteria, due to their mucilaginous coat, suspend easily in water and disperse in droplets. Wind speeds of more than 8.7 m/s are required to cause stomatal infection, as lower wind speeds rarely result in new infections (Serizawa *et al.* 1969). However, fresh wounds, such as those caused by the citrus leafminer, remain suitable infection sites without the requirement of pressurised water soaking (Chagas *et al.* 2001).

5. *Orientation of fruit peel*

   Fruit peel would have to have to face upwards to enable bacterial release during a wind driven rain event in the direction of an infection court. Bacteria in discarded fruit waste on the ground are less likely to be dispersed by wind or rain than bacteria on trees, because the waste is partly sheltered on the ground.

While host plants are common in commercial and domestic environments in Australia, the following events have to coincide for distribution of the bacterium to occur: warm weather, wind-driven rain, and sufficient citrus canker inoculum. These factors combined support the risk rating for distribution of 'Very low'.

Probability of entry (importation × distribution)

The likelihood that *X. citri* subsp. *citri* will enter Australia and be transferred in a viable state to a susceptible host, as a result of trade in fresh unshu mandarin from the production area in Japan, is: **VERY LOW**.

4.12.3 Probability of establishment

The likelihood that *X. citri* subsp. *citri* will establish in Australia, based on a comparison of factors in the source and destination areas considered pertinent to its survival and reproduction, is: **HIGH**.

- Australia's diverse citrus industry would be susceptible to citrus canker, specifically the production of highly susceptible citrus such as *Citrus sinensis* cv. Navel (sweet orange), *C. paradisi* (grapefruit), *C. limon* (lemon) and *C. aurantifolia* (lime).
- Existing pest management practices are unlikely to have an effect on the establishment of of citrus canker. Chemical control is difficult, as copper fungicides only give limited control, and importance is placed on the prevention of primary infection (Kuhara 1978; Serizawa and Inoue 1983).

- However, the natural infection period of hosts is limited, as infection is primarily associated with expanding plant tissues such as leaf flushes and early fruit development (90–120 days after flowering) (Koizumi 1981; Gottwald and Graham 1992; Graham *et al.* 1992b). Resistance of fruit and leaves to citrus canker increases with the development of a waxy cuticula (Canteros 1992; Goto 1992). Alternatively, the pathogen requires wounds as entry sites.
- Wet, warm weather simultaneously with wind speeds exceeding 8.7 m/s, such as experienced during rain storms, aid in the release of bacteria from infected tissue and their transfer and penetration through stomata or wounds (Serizawa *et al.* 1969; Gottwald and Graham 1992; Graham *et al.* 1992a). Intercellular spaces of plant tissues are generally filled with air, but under certain conditions (i.e. wind-driven rain, rainstorms etc) become filled with water. Such water congestion favours infection with bacterial pathogens (Gottwald and Graham 1992). It is recognised that fresh wounds remain suitable infection sites without the requirement of pressurised water soaking (Chagas *et al.* 2001).
- Citrus leafminer (*Phyllocnistis citrella*), which through its leafmining damage aids in the establishment of the pathogen (Gottwald *et al.* 1997; Chagas *et al.* 2001), is widely distributed throughout Australia (Herbison-Evans and Crossley 2004).
- Citrus canker can survive in diseased plant tissues, as long as cells in the vicinity of the lesion remain viable. Overwintering lesions are the most important source of inoculum for the following season (Koizumi 1977).
- Citrus canker is primarily known to occur in tropical and subtropical climates where high temperatures and rainfall occur at the same time such as in South-east Asia, Pacific and Indian Ocean islands, and South America. It is also reported from drier, more temperate areas in South-west Asia and the Middle East (CAB International 2007).
- In Australia, an outbreak of citrus canker occurred in the Northern Territory in 1991 and in 1993; official eradication was declared in 1995. A more recent outbreak occurred in Emerald, central Queensland, in late 2004, demonstrating that suitable environments for citrus canker occur in Australia, especially in the northern Australian production areas. This outbreak occurred in an isolated area and eradication was officially announced on 23 January 2009 (IPPC 2009).
- Broadbent (1992) assessed the potential of citrus canker to cause infection under Australian conditions, evaluating the climatic parameters and leaf flushes at the major citrus growing regions within Australia. Conditions in the tropical (Torres Strait and Darwin) and subtropical (Central Burnett) region in southern Queensland and central New South Wales (Kulnura) citrus growing regions would be suitable for disease development. In the tropics a major growth flush occurs in October, which coincides with the onset of the wet season during summer. Citrus in the Burnett region and around Kulnura flushes in early November when temperature and rainfall are increasing. Conditions may also be suitable at Carnarvon where citrus is grown under irrigation and suitable temperature regimes occur for most of the year.

Past outbreaks of citrus canker in areas of northern Australia, a wide distribution of citrus host plants throughout Australia, and the ability for citrus canker to survive in diseased plant tissues all support a risk rating for establishment of ‘High’.

4.12.4 Probability of spread

The likelihood that *X. citri* subsp. *citri* will spread within Australia, based on a comparison of those factors in source and destination areas considered pertinent to the geographic distribution of the pest, is: **HIGH**.

- Citrus canker is mostly found on *Citrus* species and citrus relatives, including *Fortunella* and *Poncirus* (PHA 2004a). Cultivated citrus species are widespread in Australia. Native hosts, such as *C. glauca*, occur widely throughout arid and semi-arid inland eastern Australia from northern Queensland and southern New South Wales to the Flinders Ranges in the west (Mabberley 1998; QDPIF 2006b; APNI 2008). *Citrus glauca* may provide a host in irrigated inland areas west of the Great Dividing Range (QDPIF 2006b).
- An infected host plant is rarely killed by citrus canker and infected host tissue can provide an inoculum source contributing to the spread of the pathogen for many years (Gottwald *et al.* 2001; Schubert *et al.* 2001).
- *Xanthomonas* bacteria, due to their mucilaginous coat, suspend easily in water and disperse in droplets. The bacterium can spread over short distances by rain, irrigation, wind and contaminated harvesting and packing boxes and other equipment (Pruvost *et al.* 1999; Graham *et al.* 2000; Gottwald and Graham 2000). Weather events such as thunderstorms, tornadoes, tropical storms and hurricanes contribute to medium to long distance spread from the original source of infection (Gottwald *et al.* 2000, 2001, 2002b; Gottwald and Irey 2007). Overhead and spray irrigation contribute to in-field spread of the pathogen (Pruvost *et al.* 1999).
- A study of the spread of citrus canker bacteria under typhoon conditions was carried out in Japan (Serizawa *et al.* 1969). Satsuma seedlings (*C. unshiu*) at a distance of 5.7 m from a highly infected, young citrus tree showed signs of infection when a typhoon incurred precipitation of about 70 mm of rain/day and wind speeds between 12.0 and 17.3 m/s for about 4 hours to the study area. The disease generally developed in wounds or injuries caused by leafminer (*Phyllocnistis citrella*). Lower wind speeds (i.e. that of 8.7 m/s) rarely resulted in new infections (Serizawa *et al.* 1969).
- In Florida in the USA, eradication of all citrus canker hosts within 1900 ft (579 m) from an infection source was not sufficient to contain the spread of the pathogen in areas affected by hurricanes. This subsequently led to the abandonment of the citrus canker eradication campaign in Florida (USDA 2006). The 1900 ft rule was based on research that indicated that in most instances inoculum forms infection foci that would be contained within this distance (Gottwald *et al.* 2000). Extrapolations on the spread of the pathogen by hurricane storm fronts in the Florida region indicate that the pathogen may have spread under such conditions as far as 17.9 km from the infection source (Gottwald *et al.* 2000, 2001, 2002b).
- Experience from Argentina has shown that citrus canker spreads swiftly under subtropical conditions and was known to occur in all areas of north-eastern Argentina within about 10 years of its first detection. This included infection of even isolated citrus trees in urban areas (Canteros 2000).
- The tropical and subtropical environments in Australian citrus production areas would favour the spread of citrus canker (Broadbent 1992).
- An industry contingency plan for citrus canker incursions has been developed. However, monitoring for citrus canker would only commence from the time of detection. Hence the bacterium may have already spread widely.

Suitable climatic conditions, specifically in northern Australia, the wide distribution of citrus host plants throughout Australia and the fact that infected plants are not naturally killed and could provide an inoculum source for many years, all support a risk rating for spread of 'High'.

4.12.5 Probability of entry, establishment and spread

The likelihood that *X. citri* subsp. *citri* will be imported as a result of trade in fresh unshu mandarin fruit from the production area in Japan, be distributed in a viable state to a susceptible host, establish and spread within Australia, is: **VERY LOW**.

4.12.6 Consequences

Assessment of the potential consequences (direct and indirect) of *X. citri* subsp. *citri* for Australia is: **HIGH**.

Criterion	Estimate and rationale
Direct	
Plant life or health	**Impact score**: F – significant at the national level Citrus canker decreases the marketability of fresh table fruit by causing skin blemishes and can drastically decrease yields by causing premature fruit drop and severe defoliation (Kuhara 1978). It is one of the most economically damaging diseases of citrus worldwide (PHA 2004a). Once the pathogen has caused infection of a host, it cannot be eliminated from the tree by chemical or other treatments (Stall *et al.* 1987). Eradication of infected and exposed host plants is general practice. After establishment, the pathogen disperses rapidly by wind-driven rain, flooding, overhead irrigation, water run-off, contaminated tools, machinery, hands, shoes or clothing. The spread of the disease is rapid. Citrus canker spread swiftly throughout north-eastern Argentina within 10 years from its first detection. This included isolated citrus trees in urban areas (Canteros 2000). The disease would cause most damage in tropical and subtropical regions of Australia where favourable conditions for the establishment and spread of citrus canker occur year round. An outbreak of citrus canker in the larger production areas in south-eastern Australia could lead to the complete loss of production for a number of years. Replanting and full fruit production could only be re-achieved, assuming that eradication would be successful. Citrus relatives are widely distributed in Australia and some of these species have been shown to be susceptible to citrus canker when inoculated under field and laboratory/greenhouse conditions (Peltier and Frederich 1920, 1924; Reinking 1921). However, extensive surveillance in the recent citrus canker outbreak area at Emerald in Australia did not detect citrus canker on the native species *Citrus glauca* that occurred in areas where infection levels were high (QDPIF 2007a).
Other aspects of the environment	**Impact score**: A – indiscernible at the national level There are no known direct effects on the environment.

Indirect	
Eradication, control etc.	**Impact score**: E – significant at the regional level Monitoring and surveillance will result in extra costs to citrus growers and eradication is an expensive option. Expenditure on the citrus canker eradication campaign in Emerald, central Queensland, which commenced in July 2004, was estimated to be about $A20 million (QDPIF 2007b). More than 500,000 citrus trees and other hosts were removed (QDPIF 2006a, 2007b). Citrus canker was declared eradicated from the Emerald region on 23 January 2009 (IPPC 2009). As of this date, Australia is free from citrus canker. The USA government spent US$100 million on an attempted eradication of citrus canker from 1996–1999 in Florida. In 2000, the program was broadened to US$145 million (Schubert *et al.* 2001) before the United States Department of Agriculture stopped funding in early 2006, declaring citrus canker in Florida ineradicable (DOACS 2006). In areas where citrus canker has become established, highly susceptible citrus varieties, such as grapefruit (*C. paradisi*), lemons (*C. limon*) and sweet oranges (*C. sinensis*), particularly Navel oranges, will have reduced economic viability due to the requirement for multiple bacterial sprays per year to maintain yields and quality (Gottwald *et al.* 2001; Schubert *et al.* 2001). A change in production systems is also likely to be required such as the introduction of drip irrigation, increased orchard hygiene, regular sanitation of workers, machinery and tools and the likely establishment of windbreaks (Schubert *et al.* 2001).
Domestic trade	**Impact score**: E – significant at the regional level The presence of *X. citri* subsp. *citri* in commercial production areas would have a significant effect on interstate trade due to the increased needs for surveillance, certification and disinfestation. Restrictions to trade are likely to significantly impact domestic markets. Furthermore, the removal of commercial citrus trees would lead to the complete loss of production in some regions for some years until replanting and full fruit production would be re-achieved. The presence of citrus canker would prevent plant nurseries from selling or moving citrus canker host plants to regions free from the pathogen. The citrus industry is Australia's largest horticultural industry. The industry had a farm gate value of more than A$400 million per year over the past decade; 60% of the overall farm gate value derives from domestic sales (ACG 2006, 2007). Whilst the direct costs associated with the citrus canker eradication campaign in Emerald were about $A20 million (QDPIF 2007b), the indirect costs to the industry, associated industries, marketers and to the public (consumers) as a whole were much larger, but no specific data is available.
International trade	**Impact score**: E – significant at the regional level The presence of *X. citri* subsp. *citri* in commercial production areas of citrus commodities would have a significant effect on international trade due to limited access to overseas markets where this pest is absent. Australia currently exports 20% of fresh citrus commodities to markets that are free from citrus canker (PHA 2004a). Australia's citrus industry consists of a number of discrete production areas. Experience from the citrus canker outbreak in Emerald in 2004 has shown that a number of trading partners prohibited the import of citrus fruit or demanded additional assurances for trade to resume. Citrus exports generated over A$150 million dollars for the 2004/05 financial year, which is about 40% of the gross farm gate value (ACG 2006). Export trade of about A$30 million dollars could be affected in an event of a citrus canker outbreak. Whilst the direct costs associated with the citrus canker eradication campaign in Emerald was about $A20 million (QDPIF 2007b), the indirect costs to the industry and associated industries and marketers involved in international trade exceeded the direct costs, but no specific data is available.
Environmental and non-commercial	**Impact score**: C – significant at the local level Additional control activities would be required to control citrus canker on native host plants, which include species within *Citrus* and other genera (QDPIF 2006b). Experience from the citrus canker eradication campaign in Emerald showed that control of suspected native hosts (such as *Citrus glauca*) was labour intensive. The impact on the environment is likely to be significant at the local level and of minor significance at the district level.

4.12.7 Unrestricted risk estimate

The unrestricted risk for *X. citri* subsp. *citri* is: **LOW**.

Unrestricted risk is the result of combining the probability of entry, establishment and spread with the outcome of overall consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for *X. citri* subsp. *citri* of 'low' exceeds Australia's ALOP. Therefore, specific risk management measures are required for this pest.

4.13 Pest risk assessment conclusion

The unrestricted risk posed by pink citrus rust mite, mealybugs (four species), leafroller moths (four species), thrips (four species), apple heliodinid, Japanese orange fly, citrus canker and exotic pathotypes of citrus scab have been determined to exceed Australia's ALOP. Therefore, risk management measures for these pests are required to reduce the risks to a level consistent with Australia's ALOP. The unrestricted risk of the other pests assessed achieves Australia's ALOP and therefore risk management measures are not required. The results of these risk estimates are summarised in Table 4.4. The rationale for each value of the pest risk assessment, summarised in this table, is described in the relevant sections above.

Table 4.4: Summary of risk assessments for quarantine pests for fresh unshu mandarin fruit from the production area

Pest name	Probability of					Overall probability of entry, establishment and spread	Consequences	Unrestricted risk
	Entry			Establish-ment	Spread			
	Importation	Distribution	Overall (importation x distribution)					
Eriophyid mites [Acarina: Eriophyidae]								
Aculops pelekassi	High	Low	Low	Moderate	Moderate	Low	Moderate	Low
Spider mites [Acarina: Tetranychidae]								
Panonychus citri (WA, NSW)	High	Low	Low	Moderate	Moderate	Low	Low	Very Low
Armoured scales [Hemiptera: Diaspididae]								
Howardia biclavis (WA, SA) *Ischnaspis longirostris* (WA) *Lepidosaphes gloverii* (SA) *Lepidosaphes pinnaeformis* (WA) *Lopholeucaspis japonica* *Morganella longispina* (WA, SA) *Parlatoria cinerea* *Parlatoria pergandii* (WA, SA) *Parlatoria theae* *Parlatoria ziziphi* *Pseudaonidia duplex* *Pseudaonidia trilobitiformis* (WA, SA) *Unaspis euonymi* *Unaspis yanonensis*	High	Low	Low	High	Moderate	Low	Low	Very Low

Pest name	Probability of					Overall probability of entry, establishment and spread	Consequences	Unrestricted risk
	Entry			Establish-ment	Spread			
	Importation	Distribution	Overall (importation x distribution)					
Mealybugs [Hemiptera: Pseudococcidae]								
Planococcus kraunhiae *Planococcus lilacinus* *Pseudococcus comstocki* *Pseudococcus cryptus*	High	Moderate	Moderate	High	High	Moderate	Low	Low
Leafroller moths [Lepidoptera: Tortricidae]								
Adoxophyes dubia *Adoxophyes honmai* *Adoxophyes orana fasciata* *Homona magnanima*	Low	Moderate	Low	High	High	Low	Moderate	Low
Bagworms [Lepidoptera: Psychidae]								
Eumeta japonica *Eumeta minuscula*	Very Low	Low	Very Low	High	High	Very Low	Moderate	Very Low
Apple heliodinid [Lepidoptera: Oecophoridae]								
Stathmopoda auriferella	Moderate	High	Moderate	High	High	Moderate	Low	Low
Thrips [Thysanoptera: Thripidae]								
Chaetanaphothrips orchidii (WA) *Frankliniella intonsa* *Frankliniella occidentalis* (NT, Tas.) *Thrips palmi* (NT, WA, SA, Tas.)	High	Moderate	Moderate	High	High	Moderate	Low	Low

Pest name	Probability of					Overall probability of entry, establishment and spread	Consequences	Unrestricted risk
	Entry			Establish-ment	Spread			
	Importation	Distribution	Overall (importation x distribution)					
Fruit flies [Diptera: Tephritidae]								
Bactrocera tsuneonis	Low	High	Low	High	High	Low	High	Moderate
Fungi [Miriangiales: Elsinoaceae]								
Sphaceloma fawcettii	High	Low	Low	Moderate	Moderate	Low	Moderate	Low
Bacteria [Xanthomonadales: Xanthomonadaceae]								
Xanthomonas citri subsp. *citri*	Low	Very Low	Very Low	High	High	Very Low	High	Low

The relevant state or territory for pests of regional concern are shown in parentheses.

5 Pest risk management

5.1 Pest risk management measures and phytosanitary procedures

In addition to Japan's existing commercial production practices for the production of fresh unshu mandarin fruit and minimum border procedures in Australia, specific pest risk management measures, including operational systems, are recommended to achieve Australia's ALOP.

Japan proposed the following systems approach for the management of citrus canker based on export systems for existing export markets for production of fresh unshu mandarin for export to Australia:

- MAFF to register and manage unshu mandarin production areas that are free from citrus canker. These areas would consist of an export zone and a buffer zone of a certain distance.
- Publicly administered inspections for citrus canker, etc. to be conducted by MAFF phytosanitary officers, as employees of national phytosanitary bodies, and inspection assistants who would be commissioned by MAFF and who have specialist knowledge of pests and diseases.
- Planting of citrus fruits that are markedly susceptible to citrus canker in the buffer zones would be restricted.
- Pathological assays of fruit for *X. citri* subsp. *citri* using bacteriophages.
- Joint inspections of orchards by Japanese and Australian phytosanitary officers (before harvest) and of export fruit at packing.
- Surface disinfection of fruit.

Biosecurity Australia has considered the components of this systems approach in developing the following pest risk management measures for citrus canker in this report.

The pest risk management measures are based on the mandatory requirement for Japan to adhere to existing commercial practices (refer to Chapter 3), unless deviations from these requirements are approved by AQIS.

The recommended pest risk management measures will apply to the four designated export areas (Areas 1–4) near Fujieda City and registered packing houses.

The specific pest risk management measures and operational system recommended for fresh unshu mandarin fruit from four designated export areas (Areas 1–4) near Fujieda City and registered packing houses are summarised in Table 5.1.

Table 5.1: Phytosanitary measures recommended for quarantine pests for fresh unshu mandarin fruit from the designated export areas

Pest	Common name	Measures
Arthropods		
Eriophyid mites [Acarina: Eriophyidae] *Aculops pelekassi*	pink citrus rust mite	Inspection and, if required, remedial action
Mealybugs [Hemiptera: Pseudococcidae] *Planococcus kraunhiae* *Planococcus lilacinus* *Pseudococcus comstocki* *Pseudococcus cryptus*	Japanese mealybug coffee mealybug Comstock mealybug citrus mealybug	
Leafroller moths [Lepidoptera: Tortricidae] *Adoxophyes dubia* *Adoxophyes honmai* *Adoxophyes orana fasciata* *Homona magnanima*	leafroller moths	
Thrips [Thysanoptera: Thripidae] *Chaetanaphothrips orchidii* (WA) *Frankliniella intonsa* *Frankliniella occidentalis* (NT, Tas.) *Thrips palmi* (NT, SA, Tas., WA)	citrus rust thrips intonsa flower thrips western flower thrips melon thrips	
Heliodinids [Lepidoptera: Oecophoridae] *Stathmopoda auriferilla*	apple heliodinid	
Fruit flies [Diptera: Tephritidae] *Bactrocera tsuneonis*	Japanese orange fly	Continuation with the existing surveillance program to verify area freedom

Pest	**Common name**	**Measures**
Pathogens		
Sphaceloma fawcettii	citrus scab (exotic pathotypes)	Orchard inspection, orchard control and orchard freedom from symptoms at inspection
Xanthomonas citri subsp. *citri*	citrus canker	Unshu mandarin fruit for export to Australia to be sourced only from registered orchards within the four designated export areas in Japan (Areas 1–4) Freedom from symptoms of citrus canker in the designated export areas for a minimum of two years prior to registration of orchards each year for export to Australia Freedom from symptoms of citrus canker during the growing season based on monitoring of the registered export orchards after petal fall and prior to harvest An additional survey of the export areas if a typhoon should be recorded at the meteorological station in Shizuoka City before the end of August Mandatory copper sprays in accordance with the unshu mandarin spray calendar for Japan in the registered export orchards Mandatory control for citrus leafminer (*Phyllocnistis citrella*) in accordance with the unshu mandarin spray calendar for Japan in the registered export orchards Restrictions on movement of host material into the export areas Post-harvest chemical treatment.

Australian regional quarantine pests with regions concerned in parentheses

5.1.1 Management for *Aculops pelekassi*, *Stathmopoda auriferella*, the mealybugs *Planococcus kraunhiae* and *Pl. lilacinus*, *Pseudococcus comstocki* and *Ps. cryptus*, the leafroller moths *Adoxophyes dubia, A. honmai, A. orana fasciata* and *Homona magnanima*, and the thrips *Chaetanaphothrips orchidii, Frankliniella intonsa, F. occidentalis* and *Thrips palmi*

Pink citrus rust mite (*A. pelekassi*), the apple heliodinid (*S. auriferella*), four species of mealybug, four species of leafroller moth and four thrips have been assessed to have an unrestricted risk estimate of 'low' (Table 5.1) and measures are therefore required to manage these risks.

Pre-export inspection by MAFF and pre-clearance inspection by AQIS are recommended as the pest risk management measures for these pests. Consignments for pre-clearance are inspected by appropriately trained AQIS officers using the standard AQIS inspection protocol, which includes optical enhancement where necessary and inspection under fruit sepals.

The requirement is that each lot for inspection be free of quarantine pests based on finding no quarantine pests in a sample of 600 units (one unit equals a single unshu mandarin fruit) from each lot, whereby a lot is defined as all unshu mandarin fruit packed for export to Australia each day by a registered packing house. Freedom from pests by inspection of 600 units achieves a confidence level of 95% that no more than 0.5% of units in the lot are infested.

If quarantine pests and/or regulated articles (including soil, animal and plant debris) are detected during inspections, remedial action is to be taken. Remedial action may include one or more of the following:

- treatment and re-inspection of the lot to ensure no viable quarantine pests or other regulated articles are present
- removal of the lot from the export pathway to Australia.

Biosecurity Australia considers that these measures will reduce the likelihood of importation for these pests to at least 'very low'. The restricted risk for all of these pests would then be reduced to at least 'very low', which would achieve Australia's ALOP.

5.1.2 Management for *Bactrocera tsuneonis*

Japanese orange fly (*B. tsuneonis*) does not occur on Honshu Island and has never been reported in the Shizuoka Prefecture (Appendix D). An existing monitoring program for the detection of *B. tsuneonis* and for any other fruit flies is in place in the unshu mandarin production area near Fujieda City. Traps consist of cuelure, methyl eugenol and protein baited lures (Appendix D). MAFF provided the results of fortnightly monitoring data for the detection of *B. tsuneonis* in the production area near Fujieda City, for the years 2001–2007. All trap results were negative for *B. tsuneonis*.

It is recommended that absence of *B. tsuneonis* in unshu orchards registered for export to Australia be confirmed by continuation of the existing surveillance program for *B. tsuneonis* to verify area freedom for the designated export areas.

The finding of any live or dead *B. tsuneonis* associated with unshu manadrin consignments would indicate non-compliance with the pest free area status. Therefore, if any live or dead *B. tsuneonis* are detected at inspections, the export program to Australia will be suspended until Biosecurity

Australia and MAFF are satisfied that appropriate corrective action has been taken to re-instate the pest free area status for *B. tsuneonis* or an alternative risk management measure has been developed and approved as an alternative.

Biosecurity Australia considers that these measures will reduce the likelihood of importation of *B. tsuneonis* to 'extremely low'. The restricted risk would then be reduced to 'very low', which would achieve Australia's ALOP.

5.1.3 Management for *Sphaceloma fawcettii*

Exotic pathotypes of citrus scab (*S. fawcettii*) have been assessed to have an unrestricted risk estimate of 'low' and measures are therefore required to manage this risk.

Visual inspection of fruit on its own is not considered to be an appropriate risk management option, as external signs of infection may not be present. If infected fruit was not detected at inspection, citrus scab may enter, establish and spread in Australia.

It is recommended that the risk of citrus scab in unshu orchards registered for export to Australia be managed by a mandatory fungicidal spray program to prevent infection by *S. fawcettii*. MAFF approved effective fungicide applications are to be integrated into the pesticide spray program and applied at critical infection periods.

It is recommended that MAFF manages the adherence of growers to the MAFF approved orchard control program for citrus scab. Information on the application of the control program must be made available by MAFF, on request by AQIS.

The detection of citrus scab during the pre-export phytosanitary inspections will result in removal of the source orchard from the export program for the remainder of the shipping season.

Biosecurity Australia considers that these measures will reduce the likelihood of importation of *S. fawcettii* to at least 'low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

5.1.4 Management for *Xanthomonas citri* subsp. *citri*

Citrus canker (*Xanthomonas citri* subsp. *citri*) has been assessed to have an unrestricted risk estimate of 'low' and measures are therefore required to manage this risk.

Visual inspection of fruit on its own is not considered to be an appropriate risk management measure, considering the closeness of hosts in the production area relative to the designated export areas, the unavailability of survey data for citrus canker in the production area (excluding the four designated export areas) and the biology of the pathogen.

It is recognised that citrus canker has not been reported from the designated export areas for the past 40 years during regular surveys that are timed to coincide with the period of optimal symptom expression during the production season. However, as the four designated export areas are located within the production area where there is the potential for low pest prevalence, measures are required.

Biosecurity Australia recommends a systems approach for citrus canker, requiring the following mandatory measures for the importation of unshu mandarin fruit from Japan:

- unshu mandarin fruit for export to Australia to be sourced only from registered orchards within the four designated export areas in Japan (Areas 1–4)

- freedom from symptoms of citrus canker in the designated export areas for a minimum of two years prior to registration of orchards for export to Australia each season
- freedom from symptoms of citrus canker during the growing season based on monitoring in the registered export orchards after petal fall and prior to harvest
- an additional survey of the export areas if a typhoon should be recorded at the meteorological station in Shizuoka City before the end of August
- copper sprays in accordance with the unshu mandarin spray calendar for Japan in the registered export orchards
- control of citrus leafminer in accordance with the unshu mandarin spray calendar for Japan in the registered export orchards
- restrictions on movement of host material into the export areas
- post-harvest chemical treatment.

Registration of orchards in the designated export areas in Japan (Areas 1–4)

It is recommended that only orchards located within the designated export areas (Areas 1–4) are permitted for export to Australia. The minimum requirement for registration of orchards for export to Australia is their location within the designated export areas. This requirement is contingent upon the absence of symptoms of the disease determined by regular surveys.

For the first two years of trade, the inspection records for citrus canker that are currently collected in the designated export areas, as part of the existing export protocols for unshu mandarins to the USA and New Zealand, can be used to meet the requirements for registration of the designated export areas (Areas 1–4) to Australia.

Freedom from symptoms of citrus canker for registration of orchards

It is recommended that freedom from symptoms of citrus canker for a period of two years prior to export be required for the annual registration of orchards for export to Australia.

A sampling regime of 600 randomly selected unshu mandarin trees across the whole of each of the designated export areas is recommended. This sampling regime is based on finding no symptoms of citrus canker on all above-ground plant parts, including fruit and rootstock shoots. Freedom from symptoms of citrus canker in the inspection of 600 trees achieves a confidence level of 95% that no more than 0.5% of trees in each of the designated export areas have symptoms of citrus canker. MAFF would need to provide the results of these surveys to AQIS.

Freedom from symptoms of citrus canker during the growing season

It is recommended that field surveillance for symptoms of the disease be carried out in the registered export orchards at two sampling times; following petal fall during early fruit development and immediately prior to harvest[5]. AQIS officers would have significant involvement in the pre-harvest orchard inspection (refer to *Requirement for pre-clearance*, below). The ongoing need for joint orchard inspection may be re-assessed after a period of significant trade.

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[5] The timing of in-field inspections has taken into consideration that young fruit, up to about 50% of its final size, is the most susceptible development stage to infection by *X. citri* subsp. *citri* (refer to Section 4.12.2). An inspection immediately prior to harvest provides the longest time frame for symptoms to become visible during a given production season.

A sampling regime of 600 randomly selected unshu mandarin trees for registered orchards in each of the designated export areas at each of the two sampling times, is recommended. This sampling regime is based on finding no symptoms of citrus canker on all above-ground plant parts, including fruit and rootstock shoots. Freedom from symptoms of citrus canker in the inspection of 600 trees achieves a confidence level of 95% that no more than 0.5% of trees in registered orchards in each of the designated export areas have symptoms of citrus canker.

It is recommended that the detection of citrus canker at any time in the designated export areas leads to suspension of the entire export program. Suspension of the entire export program is considered justified, given the close proximity and small size of the individual export orchards, and possible effects of wind in the introduction and spread of the pathogen to the area. This measure will remain in place until such time as AQIS and MAFF are satisfied that appropriate corrective action has been taken to allow reinstatement. Applications for resumption of export to Australia can be made after a minimum of two years, ascertained by the absence from symptoms of citrus canker from the designated export areas (Areas 1–4).

Additional survey of the designated export areas after typhoons

Mid to late summer coincides with early fruit development when fruit is most susceptible to citrus canker.

It is recommended that if a typhoon is registered at the meteorological bureau at Shizuoka City between the after petal fall inspection and the end of August, then an additional survey for symptoms of citrus canker, will be required for the designated export areas 60 days after the last typhoon recorded by the end of August.

A sampling regime of 600 randomly selected unshu mandarin trees across the whole of each of the designated export areas is recommended. This sampling regime is based on finding no symptoms of citrus canker on all above-ground plant parts, including fruit and rootstock shoots. Freedom from symptoms of citrus canker in the inspection of 600 trees achieves a confidence level of 95% that no more than 0.5% of trees in each of the designated export areas have symptoms of citrus canker. Data from orchard inspections following typhoons is to be made available to AQIS in a routine manner[6].

Mandatory copper sprays in accordance with the unshu mandarin spray calendar for Japan

It is recommended that mandatory copper sprays be applied in the registered export orchards at the times set out in the unshu mandarin spray calendar for Japan (refer to Table 3.5).

Mandatory control for citrus leafminer in accordance with the unshu mandarin spray calendar for Japan

It is recommended that mandatory insecticide sprays be applied for the control for citrus leafminer (*Phyllocnistis citrella*) in the registered export orchards at the times set out in the unshu mandarin spray calendar for Japan (refer to Table 3.5).

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[6] An inspection after typhoon events that may have occurred by the end of August allows sufficient time for citrus canker infections to become visible. The typhoon season, which is a coastal event, may commence as early as May each year and generally ceases by October (refer to Section 3.3). The inspection prior to harvest is designed to detect symptoms that have developed through the whole of the production season, as it provides the longest time for symptoms to become visible during a given production season.

Movement restrictions for citrus canker host material

It is recommended that the following movement restrictions into the designated export areas (Areas 1–4) apply:

- Staff working in orchards infected with citrus canker, and vehicles and equipment used in citrus canker infected orchards, are not to be allowed entry into the designated export areas without following appropriate decontamination procedures.
- Fruit harvested for export is to be placed in clean bins and transported to the designated packing house under quarantine security if the conveyance has to pass through a non-quarantine area. Vehicles must be appropriately decontaminated if they have been used to transport citrus canker infected material.
- Only unshu mandarin plants, and no other rutaceous hosts (neither vegetative plant parts nor fruit), are to be grown or carried into the designated export areas (Areas 1–4). Compliance with these movement requirements are subject to audit by AQIS.

These movement restrictions into the designated export areas are recommended to be implemented by MAFF notification. Copies of this notification and procedures to monitor the movement restrictions are to be made available to AQIS prior to the initial registration of export orchards in the designated export areas (Areas 1–4) near Fujieda City.

Post-harvest chemical treatment for citrus canker

Disinfection treatment of fresh unshu mandarins in a registered packing house is recommended as a mandatory requirement. The operational procedures, below, are currently based on soaking fruit in solutions of chlorine or sodium ortho-phenylphenate tetrahydrate (SOPP tetrahydrate). In the event that other agents are to be used, these should be of an equivalent efficacy. MAFF would need to submit supporting documentation on the efficacy against *X. citri* subsp. *citri* and maintenance of active concentrations for other agents for approval by AQIS.

It is recommended that all fresh unshu fruit for export to Australia has been subjected to complete immersion in a water solution containing:

- a minimum of 200 parts per million (ppm) available chlorine for a minimum of two minutes, with the pH maintained between 6.0 and 7.5

  or
- between 1.86% and 2% of a registered product that contains 95% sodium ortho-phenylphenate tetrahydrate (SOPP tetrahydrate) for at least one minute, with the pH of the solution maintained between 11.7 and 12.0.

It is recommended that registered packing houses have a documented system, approved by MAFF and AQIS, for measuring the available active constituents and pH levels in the water to ensure that they do not fall below the minimum recommended rates.

The level of available chlorine or SOPP tetrahydrate in the water is to be maintained at or above the required level. The available chlorine or SOPP tetrahydrate must be monitored and adjusted as required at the start of packing each day and every 30 minutes thereafter throughout the packing process.

Records of all chlorine or SOPP tetrahydrate monitoring, as listed above, are to be maintained and made available for audit by AQIS on request.

It is recommended that registered packing houses have an approved system in place to limit the build-up in the treatment tank of extraneous organic matter, including leaves, twigs, grass, weed, soil, slime or any other material that would interfere with the treatment.

Biosecurity Australia considers that these measures will reduce the likelihood of importation of *X. citri* subsp. *citri* to ‘extremely low’. The restricted risk would then be reduced to at least ’very low’, which would achieve Australia’s ALOP.

5.1.5 Operational system for the maintenance and verification of phytosanitary status

A system of operational procedures is necessary to maintain and verify the phytosanitary status of fresh unshu mandarin fruit from the four designated export areas (Areas 1–4) near Fujieda City in Japan. This is to ensure that the recommended risk management measures have been met and are maintained.

It is recommended that Japan’s NPPO, or other relevant agency nominated by the NPPO, prepare a documented work plan for approval by AQIS that describes the phytosanitary procedures for the pests of quarantine concern for Australia and the various responsibilities of all parties involved in meeting this requirement.

Recognition of the competent authority

Japan’s Ministry of Agriculture, Forestry and Fisheries (MAFF) is the designated NPPO under the International Plant Protection Convention (IPPC).

The objectives of the NPPO are to ensure that:

- recommended service and certification standards, and recommended work plan procedures, are met by all relevant agencies participating in this program
- recommended administrative processes are established that provide assurance that the recommended requirements of the program are being met.

Audit and verification

The objectives of the recommended requirement for audit and verification are to ensure that:

- an effective approved documented system for the orchard, the packing house and during transport is in operation.

The phytosanitary system for unshu export production, certification of export orchards, pre-clearance inspection and certification is subject to audit by AQIS. Audits may be conducted at the discretion of AQIS during the entire production cycle and as a component of any pre-clearance arrangement.

AQIS orchard audits will measure compliance with orchard registration and identification, pest/disease management including maintenance of a spray diary/monitoring, record management, freedom of the designated export areas from symptoms of citrus canker, provision of typhoon data, and accreditation requirements, including accredited personnel for the recognition of all identified quarantine pests.

AQIS packing house audits of participants involved in pre-clearance arrangements will include the verification of compliance with packing house responsibilities, traceability, labelling, segregation and product security, MAFF/agency certification processes, and the use of accredited personnel for the above tasks.

Requirement for pre-clearance

The objectives of the recommended mandatory requirement for pre-clearance are to ensure that:

- the recommended quarantine measures, including orchard surveys and required pesticide applications, product identification, AQIS inspection requirements, product security and documentation are met.

Under pre-clearance arrangements, AQIS officers would be involved in orchard inspections for pests of quarantine concern to Australia, in the direct verification of packing house procedures, and in fruit inspection. It would further include their involvement in auditing of other arrangements including registration procedures, existing commercial practices, traceability, handling of export fruit in a secure manner, movement controls etc.

Annual registration of export orchards

The objectives of this recommended procedure are to ensure that:

- unshu mandarin fruit is sourced from MAFF registered export orchards producing export quality fruit, as the pest risk assessments are based on existing commercial production practices
- export orchards from which unshu mandarin fruit is sourced can be identified so investigation and corrective action can be targeted rather than applying it to all contributing export orchards in the event that live pests are regularly intercepted during pre-clearance inspection
- export orchards adhere to specific requirements for citrus canker as outlined above
- registration of orchards for export to Australia are to be completed in winter before the start of each unshu mandarin season to allow pest control programs (including pesticide applications for citrus leafminer, scab and citrus canker) and inspection protocols for the identified quarantine pests to take place.

Registration of packing houses and auditing of procedures

The objectives of this recommended procedure are to ensure that:

- unshu mandarin fruit is processed and packaged at MAFF registered packing houses, processing export quality fruit, as the pest risk assessments are based on existing commercial packing activities
- reference to the registered packing house and the source orchard, by name or a number code, are clearly stated on cartons destined for export of fresh unshu mandarin fruit to Australia for trace back and auditing purposes.

It is recommended that MAFF registers the packing houses before the commencement of each harvest season.

Pre-export phytosanitary inspection and certification by MAFF

The objectives of this recommended procedure are to ensure that:

- all lots are inspected by MAFF in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a standard 600 unit sampling rate per lot whereby one unit is one unshu mandarin fruit (refer to Section 5.1.1)

- a phytosanitary certificate (PC) is issued for each consignment upon completion of pre-export inspection and treatment to verify that the relevant measures have been undertaken offshore
- each PC includes:

  a description of the consignment (including grower number and packing house details)

  and

  an additional declaration that '*The fruit in this consignment has been produced in Japan in accordance with the conditions governing entry of fresh unshu mandarin fruit to Australia and inspected and found free of quarantine pests'*.

Pre-clearance phytosanitary inspection by AQIS

The objectives of this recommended procedure are to ensure that:

- all lots are inspected by AQIS in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a standard 600 unit sampling rate per lot whereby one unit is one unshu mandarin fruit (refer to Section 5.1.1).
- The detection of dead or alive *B. tsuneonis,* for which area freedom is a prerequisite for export to Australia, would incur the suspension of the entire export program pending an investigation by MAFF and AQIS.
- The detection of symptoms of citrus scab would incur the suspension of the source orchard from the export program for the remainder of the export season.
- The detection of other quarantine pests would incur the rejection of the inspected lot and remedial action which includes the option for treatment.
- The detection of symptoms of citrus canker would incur the suspension of the entire export program pending an investigation by MAFF and AQIS.

Packaging and labelling

The objectives of this recommended procedure are to ensure that:

- unshu mandarin fruit proposed for export to Australia is not contaminated by quarantine pests or regulated articles (e.g. trash, soil and weed seeds)
- unprocessed packing material (which may vector pests not identified as being on the pathway) is not imported with fresh unshu mandarin fruit
- all wood material used in packaging of the commodity complies with AQIS conditions (see AQIS publication 'Cargo Containers: Quarantine aspects and procedures)
- secure packaging is used if consignments are not transported in sealed containers directly to Australia
- the packaged unshu mandarin fruit is labelled with the orchard registration number for the purposes of trace back to registered orchards
- the pre-cleared status of unshu mandarin fruit is clearly identified.

Specific conditions for storage and transport of produce

The objectives of this recommended procedure are to ensure that:

- product for export to Australia is secure by segregation from non-precleared product and to prevent mixing or cross-contamination with produce destined elsewhere
- the quarantine integrity of the commodity during storage and movement is maintained.

Remedial action(s) for non-compliance – on-arrival verification

The objectives of the recommended requirements for remedial action(s) for non-compliance during on-arrival verification are to ensure that:

- any quarantine risk is addressed by remedial action, as appropriate, for consignments that do not comply with import requirements.

5.1.6 Uncategorised pests

If an organism is detected on fresh unshu mandarin fruit during the pre-clearance inspection, that has not been categorised, it will require assessment by Biosecurity Australia to determine its quarantine status and if phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis may result in remedial action, as appropriate.

5.2 Review of policy

Australia reserves the right to review and amend the import policy if circumstances change.

Australia is prepared to review the policy after a substantial volume of trade has occurred.

The NPPO, or other relevant agency nominated by the NPPO, must inform AQIS immediately of any change in the distribution of Japanese orange fly, citrus greening or the Asian citrus psyllid in Japan or the detection of any new pests of unshu mandarin that are of potential quarantine concern to Australia.

Appendices

Appendix A: Initiation and pest categorisation

Appendix A 1: Pest categorisation for fresh unshu mandarin fruit from Japan —Presence/absence in Australia and pathway association for arthropods and pathogens[7, 8, 9, 10, 11, 12]

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
INVERTEBRATA					
ACARI (mites)					
Aculops pelekassi (Keifer, 1959) [Eriophyidae]	Pink citrus rust mite	Yes (MAFF 1990)	No (Smith *et al.* 1997)	Yes – Feeds on green stems, leaves and fruits of citrus (McCoy 1996; Futch *et al.* 2001; Childers *et al.* 2004).	Yes
Brevipalpus californicus (Banks, 1904) [Tenuipalpidae]	Citrus flat mite	Yes (Mito and Uesugi 2004)	Yes (Smith *et al.* 1997; DAFWA 2008a)		No

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[7] This pest categorisation table does not represent a comprehensive list of all pests associated with the entire plant of an imported commodity. Reference to soilborne nematodes (as listed in the technical issues paper in 2002), soilborne pathogens (such as *Rhizobium radiobacter*), wood borer pests (such as *Anoplophora chinensis*), root pests or pathogens (such as *Paracardiophorus pullatus),* and secondary pests (such as *Aschersonia aleyrodis*) have not been listed, or have been deleted from the table, as they are not directly related to the export pathway of fresh unshu mandarin fruit and would be addressed by Australia's current approach to contaminating pests.

[8] Organisms are listed by their current taxonomic name; where stakeholders have referred to previous names, these have been included as synonyms in the table.

[9] Strain, pathovar, subspecies or pesticide resistance profiles are considered only in instances where these are scientifically recognised in the literature.

[10] The inclusion/exclusion of pests for which the host is stated as *Citrus* sp., rather than *C. unshiu,* has been made by expert judgement that has considered the relevant literature.

[11] Pests that were proposed by stakeholders for consideration in this IRA and for which no evidence of their presence exists for JApan have been excluded from pest categorisation (e.g. *Pseudococcus odermatti*, *Selanaspidus articulatus*)

[12] *Cacoecimorpha pronubana* (Hubner, 1800) [Tortricidae] - carnation tortrix, has been deleted from the pest categorisation table, as it is absent from Japan (MAFF 2009).

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Brevipalpus lewisi McGregor, 1949 [Tenuipalpidae]	Citrus flat mite	Yes (MAFF 1990)	Yes (Halliday 1998)		No
Brevipalpus obovatus Donnadieu, 1875 [Tenuipalpidae]	Privet mite	Yes (MAFF 1990)	Yes (Halliday 1998). Not present in WA (DAWA 2003a).	No – Feeds on leaves, stems and petioles (Jeppson *et al*. 1975).	No
Brevipalpus phoenicis (Geijskes, 1939) [Tenuipalpidae]	False spider mite	Yes (CIE 1970a)	Yes (Halliday 2000; DAFWA 2008a)		No
Bryobia rubrioculus (Scheuten, 1857) [Tetranychidae]	Bryobia mite	Yes (MAFNZ 2000)	Yes (Halliday 1998)		No
Eotetranychus kankitus Ehara, 1955 [Tetranychidae]	Citrus yellow mite	Yes (MAFF 1990)	No (Halliday 1998)	No – Attacks citrus trees, withering branches and causing leaves, flowers and fruit to fall (Chen 1999). This pest can attack leaves, flowers, shoots and fruitlets, with young leaves receiving the most damage (Yang 1998).	No
Eotetranychus sexmaculatus (Riley, 1890) [Syn.: *Eotetranychus asiaticus* Ehara, 1966] [Tetranychidae]	Six-spotted spider mite	Yes (MAFF 1990)	Yes (Halliday 1998) including WA (Fisher and Learmonth 2006)		No
Eutetranychus orientalis (Klein, 1936) [Tetranychidae]	Citrus brown mite	Yes (Mito and Uesugi 2004)	Yes (Walter *et al.* 1995; DAFWA 2008a)		No

Pest	**Common name**	**Present in Japan**	**Present in Australia**	**Presence on fresh unshu mandarin fruit**	**Consider further**
Panonychus citri (McGregor, 1916) [Tetranychidae]	Citrus red mite	Yes (MAFF 1990)	Yes (Halliday 1998). Under quarantine control in NSW (Smith *et al.* 1997). Not present in WA (DAWA 2003a).	Yes – Feeds on fruit, leaves and green twigs of citrus. Can cause pale stippling of rind, fruit may appear dull (Smith *et al.* 1997). Mites can develop and mature on ripe orange fruit in California (Jeppson *et al.* 1975).	Yes (for WA, NSW)
Panonychus ulmi (Koch, 1835) [Tetranychidae]	European red spider mite	Yes (MAFF 2003)	Yes (Halliday 1998)		No
Phyllocoptruta oleivora (Ashmead, 1879) [Eriophyidae]	Citrus rust mite	Yes (CIE 1970b)	Yes (Smith *et al.* 1997; DAFWA 2008b)		No
Polyphagotarsonemus latus (Banks, 1904) [Tarsonemidae]	Broad mite	Yes (MAFF 1990)	Yes (Halliday 1998)		No
Tetranychus cinnabarinus (Boisduval, 1867) [Tetranychidae]	Carmine spider mite	Yes (MAFF 1990)	Yes (Halliday 1998)	No – Associated with leaves on citrus, cotton and tomato (MAFF 1990; CAB International 2004).	No
Tetranychus kanzawai Kishida, 1927 [Tetranychidae]	Kanzawa spider mite	Yes (MAFF 1990)	Yes (Halliday 1998). Not present in WA (DAWA 2003a).	No – Associated with leaves and stems on citrus (MAFF 1990; CAB International 2004).	No
Tetranychus urticae Koch, 1836 [Tetranychidae]	Two spotted mite	Yes (MAFNZ 2000)	Yes (Halliday 1998)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
INSECTA (insects)					
Coleoptera (beetles)					
Actenicerus orientalis (Candèze, 1899) [Elateridae]	Click beetle	Yes (MAFF 2003)	No (Calder 1996; 1998)	No – Adults gather on flowers of unshu. Larvae are saprophagous (MAFF 2003).	No
Adoretus sinicus Burmeister, 1855 [Scarabaeidae]	Chinese rose beetle, Flower beetle, Scarab	Yes (MAFF 1990; Furuno 1993)	No (Cassis *et al.* 1992, 2002)	No – Affects the flowers and leaves of citrus in Korea. Larvae feed on roots (MAFF 1990; USDA 2002).	No
Adoretus tenuimaculatus Waterhouse, 1875 [Scarabaeidae]	Brown chestnut chafer, Flower beetle, Scarab	Yes (MAFF 1990; Furuno 1993)	No (Cassis *et al.* 1992, 2002)	No – Affects the flowers and leaves of citrus in Korea. Larvae feed on roots (MAFF 1990; USDA 2002).	No
Agrilus alesi Oben, 1935 [Buprestidae]	Ales' flatheaded citrus borer	Yes (MAFF 1990)	No (Bellamy 2001)	No – Adults bore into cambium of branches or trunks of citrus and are also associated with leaves (MAFF 1990).	No
Agrilus auriventris Saunders, 1873 [Buprestidae]	Citrus flatheaded borer	Yes (MAFF 1990)	No (Bellamy 2001)	No – Adults bore into cambium of branches or trunks of citrus and are also associated with leaves (MAFF 1990).	No
Agrypnus binodulus binodulus (Motschulsky, 1860) [Syn.: *Lacon binodulus* Motschulsky, 1860] [Elateridae]	Wireworm	Yes (MAFF 2003)	No (Calder 1996, 1998)	No – Sprouting seeds and below ground portions of young seedlings suffer feeding damage (MAFF 2003).	No
Amystax satanus Nakane, 1963 [Curculionidae]	Weevil	Yes (MAFF 1990)	No (No records found)	No – Associated with leaves of citrus (MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Anomala albopilosa albopilosa Hope, 1839 [Scarabaeidae]	Cane white grubs	Yes (MAFF 2003)	No (Cassis *et al.* 2002)	No – Pest of strawberries, grapes, persimmons and podocarps (MAFF 2003). Pest of sugarcane in Japan (Hokyo and Nagamine 1978) and also found feeding on leaves of kanaf (*Hibiscus cannabinus*) (Hiramatsu *et al.* 2001). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Anomala cuprea (Hope, 1839) [Scarabaeidae]	Cupreous chafer	Yes (MAFF 1990)	No (Cassis *et al.* 2002)	No – Adults feed on leaves of citrus and larvae feed on roots (MAFF 1990; USDA 1995).	No
Anomala orientalis (Waterhouse, 1875) [Scarabaeidae]	Chafer	Yes (Togashi 1980)	No (Cassis *et al.* 2002)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Anomala rufocuprea Motschulsky, 1860 [Scarabaeidae]	Chafer	Yes (Yokoyama *et al.* 1998)	No (Cassis *et al.* 2002)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002). Adults feed on leaves of alder, Sakhalin knotweed, kanaf (*Hibiscus cannabinus*) and are found on flowers of other plants (Hiramatsu *et al.* 2001; IKIP 2002).	No
Anthrenus verbasci (Linnaeus, 1767) [Dermestidae]	Variegated carpet beetle	Yes (Kuwahara and Nakamura 1985)	Yes (CSIRO 1991)		No
Aphotistus notabilis Candèze, 1873 [Elateridae]		Yes (MAFF 2003)	No (Calder 1996; 1998)	No – Elaterid larvae feed in soil on plant material or other soil insects. Adults occasionally come to flowers to feed (Calder 1996). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Aplotes roelofsi Chevrolat, 1885 [Syn.: *Sphenophorus carinicollis* Roelofs, 1875] Current preferred name inferred from the MOKUROKU database (Tadauchi and Inoue 2007) [Curculionidae]		Yes (MAFF 2003)	No (Zimmerman 1993)	No – Feeds on the stem of the Asiatic dayflower (*Commelina communis*) in Japan (Morimoto 1978). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Araecerus coffeae (Fabricius, 1801) [identified as *A. fasciculatus* in MAFF, 1990] There is debate on the synonymy of *A. coffeae* and *A fasciculatus* (Zimmerman 1994; Valentine 2005). In this IRA these two species are considered synonymous. [Anthribidae]	Coffee bean weevil	Yes (MAFF 1990)	Yes (Zimmerman 1994)		No
Athemus suturellus suturellus (Motschulsky, 1860) [Cantharidae]	Leather winged beetle	Yes (MAFF 2003)	No (Calder 1998)	No – Cantharid adults are predacious (MAFF 2003) but also feed on pollen, nectar and fresh foliage. Larvae are general predators on small arthropods in the soil and leaf litter (Lawrence and Britton 1994). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Athemus vitellinus (Kiesenwetter, 1874) [Cantharidae]		Yes (MAFF 2003)	No (Calder 1998)	No – Cantharid adults are predacious (MAFF 2003) but also feed on pollen, nectar and fresh foliage. Larvae are general predators on small arthropods in the soil and leaf litter (Lawrence and Britton 1994). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Aulacophora femoralis (Motschulsky, 1857) [Chrysomelidae]	Cucurbit leaf beetle	Yes (Whalon *et al.* 2003)	No (Wilcox 1972)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Aulacophora nigripennis Motschulsky, 1857 [Chrysomelidae]	Pumpkin beetle	Yes (MAFF 1990)	No (Wilcox 1972)	No – Larvae and adults feed on leaves of citrus (MAFF 1990).	No
Blitopertha orientalis Reitter, 1903 [Scarabaeidae]	Oriental beetle	Yes (MAFF 1990; CABI and EPPO 1997a)	No (Cassis *et al.* 1992)	No – Larvae feed on the roots and adults feed on the leaves and flowers of citrus (Davidson and Peairs 1966; MAFF 1990, 2003).	No
Cassida obtusata Boheman, 1854 [Chrysomelidae]	Flea beetle	Yes (MAFF 1990)	No (Borowiec and Świętojańska 2004)	No – Associated with flowers and leaves of citrus (MAFF 1990).	No
Chlorophorus annularis (Fabricius, 1787) [Cerambycidae]	Bamboo longhorn beetle	Yes (MAFF 2003)	Yes (McKeown 1947; APHIS 2000)		No
Corymbitodes gratus (Lewis, 1894) [Elateridae]		Yes (MAFF 2003)	No (Calder 1996, 1998)	No – Gathers on new foliage of broad leaf trees in early spring, and also commonly gathers on flowers (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Ectinohoplia obducta (Motschulsky, 1857) [Scarabaeidae]	Scarab	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Associated with flowers of citrus (MAFF 1990).	No
Ectinus sericeus sericeus (Candèze, 1878) [Elateridae]	Wheat wireworm	Yes (MAFF 2003)	No (Calder 1996, 1998)	No – Pest of barley, sweet corn, potatoes, sweet potatoes, Chinese radish, Chinese cabbage and cabbage (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Epuraea domina (Reitter, 1873) [Nitidulidae]	Sap beetle	Yes (MAFF 1990)	No (No records found)	No – Associated with flowers of citrus (MAFF 1990) and decayed fruit (Hayashi 1978).	No
Epuraea japonica (Motschulsky, 1860) [Nitidulidae]	Sap beetle	Yes (MAFF 1990)	No (No records found)	No – Associated with flowers of citrus (MAFF 1990) and decayed fruit (Hayashi 1978).	No
Eucetonia pilifera (Motschulsky, 1860) [Scarabaeidae]	Flower beetle	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults feed on the pollen and nectar of citrus flowers (MAFF 1990, 2003).	No
Eucetonia roelofsi (Harold, 1880) [Scarabaeidae]	Flower beetle	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults feed on flowers of citrus (MAFF 1990; IKIP 2002).	No
Glycyphana fulvistemma (Motschulsky, 1860) [Scarabaeidae]	Scarab beetle	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults are associated with flowers of citrus (MAFF 1990).	No
Haptoncurina paulula Reitter, 1873 [Nitidulidae]	Sap beetle	Yes (MAFF 1990)	No (no records found)	No – Associated with flowers of citrus (MAFF 1990) and decayed fruit (Hayashi 1978).	No
Holotrichia kiotonensis (Brenske, 1894) [Scarabaeidae]	Black chafer	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults feed on leaves of citrus and larvae feed on roots (MAFF 1990). Melolonthine larvae are root feeders damaging pastures and crops; adults are chafers often causing defoliation of trees during outbreaks; adults when disturbed will often fall to the ground or take flight (Booth *et al.* 1990).	No
Holotrichia picea (Motschulsky, 1857) [Scarabaeidae]	Chafer	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Melolonthine larvae are root feeders damaging pastures and crops; adults are chafers often causing defoliation of trees during outbreaks; adults when disturbed will often fall to the ground or take flight (Booth *et al.* 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Hoplia communis Waterhouse, 1875 [Scarabaeidae]		Yes (MAFF 2003)	No (Cassis *et al.* 1992)	No – Pest of pulse pastures, lawn grass, azaleas and rhododendrons (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Hypomeces squamosus (Fabricius, 1792) [Curculionidae]	Gold-dust weevil	Yes (Cab International 2007)	No (No records found)	No – Larvae feed on roots, adults feed on leaves. Citrus is recorded as a host (Cab International 2007).	No
Luperodes moorii (Baly, 1874) [Chrysomelidae]		Yes (MAFF 2003)	No (No records found)	No – Gathers on nettle and alder trees (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Luperomorpha funesta (Baly, 1874) [Chrysomelidae]	Mulberry flea beetle	Yes (MAFF 1990)	No (No records found)	No – Associated with leaves, roots or young fruits of citrus (Iba and Inoue 1977; MAFF 1990).	No
Maladera japonica (Motschulsky, 1857) [Scarabaeidae]	Velvety chafer	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Feed on leaves and roots of citrus (MAFF 1990).	No
Maladera orientalis (Motschulsky, 1857) [Scarabaeidae]	Smaller velvety chafer	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults feed on the leaves and larvae feed on the roots of citrus (MAFF 1990).	No
Melanotus fortnumi (Candèze, 1878) [Elateridae]	Sweet potato wireworm	Yes (MAFF 1990)	No (Calder 1996, 1998)	No – Adults feed on leaves and larvae feed on roots of citrus (MAFF 1990; Matsui and Ueda 1992).	No
Melanotus legatus Candèze, 1860 [Elateridae]	Pectinate-horned click beetle	Yes (Kohno 1992)	No (Calder 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Mesalcidodes trifidus (Pascoe, 1870) [Curculionidae]	Weevil	Yes (MAFF 1990)	No (Klima 1934)	No – Adults are associated with leaves and lay eggs on stems of citrus (MAFF 1990, 2003). Associated with the leaves of kudzu plants (Frye *et al.* 2007). Not likely to be on the unshu fruit pathway (USDA 2002).	No
Mimela flavilabris Waterhouse, 1875 [Scarabaeidae]	Chafer beetle	Yes (MAFF 2003)	No (Cassis *et al.* 1992)	No – Feeds on flowers and alder leaves. Other *Mimela* spp. feed on roots (Fernando 1971; Chakravarthy *et al.* 1989; Mitsuhashi 1989; IKIP 2002).	No
Mimela testaceipes (Motschulsky, 1860) [Scarabaeidae]	Striated chafer	Yes (Torikura 1991)	No (Cassis *et al.* 2002)	No – Affects the leaves and roots of citrus in Korea (USDA 2002).	No
Nipponovalgus angusticollis (Waterhouse, 1875) [Scarabaeidae]	Flattened flower chafer	Yes (Tanaka 1986)	No (Cassis *et al.* 2002)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Oxycetonia jucunda (Falderman, 1835) [Scarabaeidae]	Citrus flower chafer	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults are associated with flowers, leaves, stems and larvae are associated with roots of citrus (MAFF 1990).	No
Pantomorus cervinus (Boheman, 1840) [Curculionidae]	Fuller's rose weevil	Yes (Mito and Uesugi 2004; CAB International 2007)	Yes (APPD 2008; DAFWA 2008a)		No
Phloeobius gigas Fabricius, 1775 [Anthribidae]		Yes (MAFF 2003)	Yes (Zimmerman 1994)		No
Phyllopertha irregularis (Waterhouse, 1875) [Scarabaeidae]		Yes (MAFF 2003)	No (Cassis *et al.* 1992)	No – Adults not associated with fruit, and larvae feed on roots.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Poecilophilides rusticola (Burmeister, 1842) [Scarabaeidae]		Yes (ME 2002)	No (Cassis *et al.* 2002)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Protaetia brevitarsis Lewis, 1879 [Scarabaeidae]	White spotted flower chafer	Yes (MAFF 2003)	No (Cassis *et al.* 1992)	No – Gathers on tree sap of unshu mandarin trees (MAFF 2003).	No
Protaetia orientalis Gory and Percheron, 1833 [Scarabaeidae]	May beetle	Yes (MAFF 1990)	No (Cassis *et al.* 1992)	No – Adults are associated with flowers, leaves, stems, and larvae feed on roots of citrus (MAFF 1990).	No
Psammoecus triguttatus Reitter, 1874 [Silvanidae]	Beetle	Yes (MAFF 1990)	No (Chûjô and Lee 1993)	No – Adults only feed on young citrus fruit (MAFF 1990).	No
Pseudocneorhinus bifasciatus Roelofs, 1880 [Curculionidae]	Gooseberry weevil	Yes (MAFF 1990)	No (Schenkling and Marshall 1931)	No – Larvae and adults feed on leaves of citrus (Maier 1983, 1986).	No
Pterolophia zonata (Bates, 1873) [Cerambycidae]	White-caudate longicorn	Yes (Iwata 1998)	No (Breuning 1961)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Scepticus griseus (Roelofs, 1873) [Curculionidae]	Rusty gourd-shaped weevil	Yes (MAFF 2003)	No (Günther and Zumpt 1933)	No – Pest infests young shoots and leaves of unshu (MAFF 2003).	No
Scepticus insularis Roelofs, 1873 [Curculionidae]	Striped gourd-shaped weevil	Yes (MAFF 1990)	No (Günther and Zumpt 1933)	No – Adults feed on leaves and larvae feed on roots of citrus (MAFF 1990).	No
Xanthochroa waterhousei Harold, 1875 [Oedemeridae]		Yes (MAFF 2003)	No (Schenkling 1915)	No – Larvae mainly live in rotten conifers. Adults gather on citrus flowers and are thought to feed on nectar and pollen (MAFF 2003).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Diptera (true flies; mosquitoes)					
Atherigona orientalis Schiner, 1868 [Muscidae]	Pepper fruit fly	Yes (Pont 1992)	Yes (Pont 1992; Poole 2006)		No
Bactrocera tsuneonis (Miyake, 1919) [Syn.: *Dacus cheni* Chao 1987] [Tephritidae]	Japanese orange fly	Yes (MAFF 1990)	No (Evenhuis 1999)	Yes – The pest is associated with citrus fruit in Japan (MAFF 1990; White and Elson-Harris 1994).	Yes
Contarinia okadai (Miyoshi, 1980) [Cecidomyiidae]	Japanese citrus flower-bud midge	Yes (MAFF 1990)	No (Evenhuis 1999)	No – Larvae feed on flower buds of citrus (Harris and Yukawa 1980; MAFF 1990).	No
Drosophila simulans Sturtevant, 1919 [Drosophilidae]		Yes (Mito and Uesugi 2004)	Yes (APPD 2008; DAFWA 2008b)		No
Limonia amatrix (Alexander, 1922) [Tipulidae]	Citrus crane fly	Yes (MAFF 1990)	No (Evenhuis 1999)	Yes – MAFF advised that this species has been recorded feeding on mandarin and other citrus fruit and that this pest does not occur in commercial citrus growing areas in Japan. Larvae of *Limonia* spp. require moist environments and are mostly associated with fungi, muddy earth, decaying wood and living roots. Eggs are laid in similar environments (Alexander 1920; CAB International 2007).	Yes
Hemiptera (aphids; leafhoppers; mealybugs; phyllids; scales; true bugs; whiteflies)					
Alcimocoris japonensis (Scott, 1880) [Pentatomidae]	Shield bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs suck the sap of citrus (MAFF 1990).	No
Aleurocanthus spiniferus (Quaintance, 1903) [Aleyrodidae]	Citrus spiny whitefly	Yes (MAFF 1990)	Yes (Martin 1999). Not present in WA (DAWA 2003a).	No – Associated with leaves of citrus (MAFF 1990). Mostly infests the underside of young leaves (Smith *et al.* 1997). *Citrus* species are a major host. Eggs are laid and crawlers feed on the underside of leaves. Affects the leaves and stems (CAB International 2007).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Aleuroclava aucubae (Kuwana, 1911) [Aleyrodidae]	Aucuba whitefly	Yes (MAFF 1990)	No (Martin 1999)	No – Associated with leaves of citrus (MAFF 1990). Not associated with unshu fruit (USDA 1995).	No
Aleurolobus marlatti (Quaintance, 1903) [Aleyrodidae]	Marlatt whitefly	Yes (MAFF 1990)	Yes (Martin 1999). Not present in WA (DAWA 2003a).	No – Associated with leaves of citrus (MAFF 1990; USDA 2002).	No
Aleurothrixus floccosus (Maskell, 1895) [Aleyrodidae]	Woolly whitefly	Yes (Kanmiya and Sonobe 2002)	No (Smith *et al.* 1997)	No – Generally associated with leaves of citrus (Kerns *et al.* 2004), and affects the leaves of unshu in Japan (MAFF 2009). Distributed in Okinawa region of southern Japan (MAFF 2009)	No
Anacanthocoris concoloratus (Uhler) [Coreidae]	Adzuki bean bug	Yes (MAFF 2003)	No (Cassis and Gross 2002)	No – Pest of pulses (MAFF 2003). Not associated with unshu fruit (USDA 1995).	No
Anacanthocoris striicornis (Scott, 1874) [Coreidae]	Larger squash bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults can suck the sap from citrus plants (MAFF 1990). Not associated with unshu fruit (USDA 1995).	No
Andaspis hawaiiensis (Maskell, 1895) [Syn. *Lepidosaphes moorsi* Doane and Ferris, 1916] [Diaspididae]	Armoured scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – This scale has been recorded damaging the leaves and fruit of citrus in Western Samoa (Williams and Watson 1988).	Yes
Antonina crawii Cockerell, 1900 [Pseudococcidae]	Bamboo scale	Yes (Ben-Dov *et al.* 2005)	Yes (Ben-Dov *et al.* 2005). Not present in WA (DAFWA 2008b).	No – Associated with leaves of citrus in Korea (USDA 2002). Unshu is not a host for this species in Japan (MAFF2009).	No
Aonidiella aurantii (Maskell, 1879) [Diaspididae]	Red scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Aonidiella citrina (Coquillett, 1891) [Diaspididae]	Yellow scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997), including WA (Watson 2005)		No
Aonidiella comperei McKenzie, 1937 [Diaspididae]		Yes (Inoue *et al*. 2006; Ben-Dov *et al.* 2008)	Yes (APPD 2008; DAFWA 2008a)		No
Aonidiella inornata McKenzie, 1938 [Diaspididae]		Yes (Inoue *et al*. 2006; Ben-Dov *et al.* 2008)	Yes (APPD 2008; DAFWA 2008a)		No
Apheliona ferruginea (Matsumura, 1931) [Cicadellidae]	Citrus leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994; Fletcher 2002)	No – Although this species is associated with citrus fruit (MAFF 1990) whereby adults and nymphs feed by inserting their stylets into plant tissues (leaves and maturing citrus fruit) for short periods of time, adults fly off and nymphs hop/walk from fruit once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No
Aphis craccivora (Koch, 1854) [Aphididae]	Cowpea aphid	Yes (MAFF 1990)	Yes (Berlandier and Sweetingham 2003)		No
Aphis fabae Scopoli, 1763 [Aphididae]	Black bean aphid	Yes (Cab International 2007; Sugimoto 2008)	No (No records found)	No – Mainly a pest of beans, citrus is a minor host. Aphids are sap sucking and are found on stems and on the underside of leaves (CAB International 2007). Unshu is not a host for this species in Japan (MAFF 2009).	No
Aphis gossypii Glover, 1877 [Aphididae]	Cotton aphid	Yes (MAFF 1990)	Yes (Smith *et al.* 1997)		No
Aphis spiraecola (Patch, 1914) [Aphididae]	Spiraea aphid	Yes (MAFF 1990)	Yes (Blackman and Eastop 2000)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Aphrophora intermedia Uhler, 1896 [Aphrophoridae]	Common spittlebug	Yes (MAFF 1990)	No (Fletcher 2006; Fletcher and Larivière 2006)	No– Associated with leaves and young shoots of citrus (MAFF 1990).	No
Aphrophora stictica (Matsumura, 1903) [Aphrophoridae]	Spittlebug	Yes (MAFF 1990)	No (Fletcher 2006; Fletcher and Larivière 2006)	No – Adults are associated with leaves of citrus (MAFF 1990). Pest of soybeans, citrus and pasture grasses (MAFF 2003).	No
Aspidiotus destructor Signoret, 1869 [Diaspididae]	Coconut scale	Yes (MAFF 2003)	Yes (Ben-Dov *et al.* 2005; APPD 2007)		No
Aspidiotus excisus Green, 1896 [Diaspididae]		Yes (Mito and Uesugi 2004; Inoue *et al*. 2006)	No (Ben-Dov *et al*. 2008)	No – Citrus is listed as a host (Williams and Watson 1988; Watson 2005). Associated with leaves and stems (Watson 2005).	No
Asterococcus muratae Kuwana, 1907 [Cerococcidae]		Yes (MAFF 2009)	No (Ben-Dov *et al*. 2008)	Unshu mandarin is not a host (MAFF 2009).	No
Aulacaspis tubercularis (Newstead, 1906) [Diaspididae]	White mango scale	Yes (Mito and Uesugi 2004)	Yes (APPD 2008; DAFWA 2008a)		No
Aulacorthum magnoliae (Essig and Kuwana, 1918) [Aphididae]	Aphid	Yes (MAFF 1990)	No (Blackman and Eastop 2000)	No – Feeds on young leaves and buds of citrus (MAFF 1990).	No
Aulacorthum solani (Kaltenbach, 1843) [Aphididae]	Foxglove aphid	Yes (MAFF 1990)	Yes (Berlandier 1997)		No
Bemisia giffardi (Kotinsky, 1907) [Aleyrodidae]	Giffard whitefly	Yes (MAFF 1990)	Yes (Martin 1999). Not present in WA (DAWA 2003a).	No - All species of whitefly feed on leaves of plants (Arnett 1997).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Bothrogonia japonica (Ishihara) [Cicadellidae]	Black-tipped leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994; Fletcher and Larivière 2006)	No – Associated with leaves of unshu in Japan (MAFF 1990).	No
Carbula humerigera (Uhler, 1860) [Pentatomidae]	Shieldbug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs suck sap, associated with leaves of citrus (MAFF 1990)	No
Ceroplastes ceriferus (Fabricius, 1798) [Coccidae]	Indian wax scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Ceroplastes floridensis Comstock, 1881 [Coccidae]	Florida wax scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005). Not present in WA (DAWA 2003a).	No – Associated with leaves and twigs of citrus (Smith *et al.* 1997).	No
Ceroplastes japonicus Green, 1921 [Coccidae]	Japanese wax scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs and branches of citrus (MAFF 1990).	No
Ceroplastes pseudoceriferus Green, 1935 [Coccidae]	Green scale	Yes (Ben-Dov *et al.* 2005)	No (Ben-Dov *et al.* 2005)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Ceroplastes rubens Maskell, 1893 [Coccidae]	Red wax scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005)		No
Chrysomphalus bifasciculatus Ferris, 1938 [Diaspididae]	False Florida red scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves and branches of citrus (MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Chrysomphalus aonidum (Linnaeus, 1758) [Syn.: *Chrysomphalus ficus* Ashmead, 1880] [Diaspididae]	Circular black scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; DAFWA 2008a)		No
Chrysomphalus dictyospermi (Morgan, 1889) [Diaspididae]	Spanish red scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005; APPD 2008; DAFWA 2008a).		No
Cletus punctiger (Dallas, 1852) [Coreidae]	Squash bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Sucks sap from leaves of citrus (MAFF 1990).	No
Coccus discrepans (Green, 1904) [Coccidae]	Soft scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs and branches of citrus (MAFF 1990; Ben-Dov *et al.* 2005).	No
Coccus hesperidum Linnaeus, 1758 [Coccidae]	Brown soft scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005)		No
Coccus longulus (Douglas, 1887) [Syn.: *Coccus elongatus* (Signoret, 1873)] [Coccidae]	Long brown scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005)		No
Coccus pseudomagnoliarum (Kuwana, 1914) [Coccidae]	Citricola scale	Yes (MAFF 1990)	Yes (Zhang and Wu 2002)		No
Coccus viridis (Green, 1889) [Coccidae]	Green coffee scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005), including WA (DAFWA 2008a)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Cryptotympana facialis (Walker, 1858) [Cicadidae]	Cicada	Yes (MAFF 1990)	No (Moulds 1990; Moulds and Cowan 2004)	No – Adults feed on trunks, branches and twigs of citrus. Nymphs feed on roots (Aizu *et al.* 1984; MAFF 1990).	No
Dialeurodes citri (Ashmead, 1885) [Aleyrodidae]	Citrus whitefly	Yes (MAFF 1990)	No (Martin 1999)	No – Associated with leaves of *Citrus* species; fruit is not directly affected (Jeppson 1989; Kim *et al*. 2000). Eggs, larvae, nymphs and adults are found on the underside of citrus leaves (Fasulo and Weems 2007).	No
Dialeurodes citrifolii (Morgan, 1893) [Aleyrodidae]	Cloudy winged whitefly	Yes (Cab International 2007)	No (Smith *et al*., 1997)	No – *Citrus* sp are major hosts. Eggs, nymphs and adults are found on citrus leaves (Nguyen *et al.* 2001).	No
Diaphorina citri (Kuwayama, 1908) [Psyllidae]	Asian citrus psyllid	Yes (MAFF 1990) However, this pest is not present in the export areas (MAFF 2003)	No (Hollis 2002; Bellis *et al.* 2005)	No – Feeds on leaves and stems of citrus in Florida (Halbert 2006). Found on leaves and stems of citrus in India (Pande 1971). The psyllid is a vector of the quarantinable pathogen *Candidatus* Liberibacter asiaticum (citrus greening). However, the psyllid does not occur on Honshu Island (Appendix E)	No
Diaspidiotus perniciosus (Comstock, 1881) [Diaspididae]	San Jose scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Diaspis boisduvalii Signoret, 1869 [Diaspididae]		Yes (Mito and Uesugi 2004; Inoue *et al.* 2006)	Yes (APPD 2008; Ben-Dov *et al*. 2008) Not present in WA (DAFWA 2008b)	No – Affects the leaves and twigs of hosts and citrus is a host (Watson 2005).	No
Drosicha corpulenta (Kuwana, 1902) [Margarodidae]	Giant mealybug	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs, buds and branches of citrus (MAFF 1990; Qu *et al.* 1996; USDA 2002).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Drosicha howardi (Kuwana, 1922) [Margarodidae]	Margarodid scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs, buds and branches of citrus (MAFF 1990; Qu *et al.* 1996).	No
Duplaspidiotus claviger (Cockerell, 1901) [Diaspididae]		Yes (Murakami 1970; Ben-Dov *et al.* 2008)	Yes (AICN 2008, APPD 2008; Ben-Dov *et al.* 2008). Not present in WA (DAFWA 2008a).	No – Polyphagous species and citrus is a host. Affects the branches and twigs of hosts (Watson 2005). Not recorded as affecting citrus in Japan (Murakami 1970).	No
Dysmicoccus brevipes (Cockerell, 1893) [Pseudococcidae]	Pineapple mealybug	Yes (Mito and Uesugi 2004; Inoue *et al.* 2006)	Yes (APPD 2008; DAFWA 2008a)		No
Edwardsiana flavescens (Fabricius, 1794) [Cicadellidae]	Small green leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994; Fletcher and Larivière 2007b)	No – Although this species is associated with citrus fruit (MAFF 1990), whereby adults and nymphs feed by inserting their stylets into plant tissues (leaves and maturing citrus fruit) for short periods of time, adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No
Empoasca arborescens Vilbaste, 1968 [Cicadellidae]	Leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994; Fletcher and Larivière 2007a)	No – Although this species is associated with citrus fruit (MAFF 1990), whereby adults and nymphs feed by inserting their stylets into plant tissues (leaves and maturing citrus fruit) for short periods of time, adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Empoasca onukii Matsuda, 1952 [Cicadellidae]	Tea green leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994; Fletcher and Larivière 2007a)	No – Although this species is associated with citrus fruit (MAFF 1990), whereby adults and nymphs feed by inserting their stylets into plant tissues (leaves and maturing citrus fruit) for short periods of time, adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No
Empoasca sakaii (Dworakowska, 1971) [Cicadellidae]		Yes (MAFF 2003)	No (Day and Fletcher 1994; Fletcher and Larivière 2007a)	No – Pest attacks leaves of lucerne and clover (Naito 1977). Inhabits citrus orchards (MAFF 2003).	No
Epiacanthus stramineus (Motschulsky, 1861) [Cicadellidae]	Grape leafhopper	Yes (MAFF 1990)	No (Fletcher and Larivière 2006)	No – Associated with leaves (MAFF 1990); not on unshu fruit pathway (USDA 1995).	No
Eucalymnatus tessellatus (Signoret 1873) [Coccidae]		Yes (Mito and Uesugi 2004)	Yes (APPD 2008; DAFWA 2008a)		No
Eucorysses grandis (Thunberg, 1783) [Pentatomidae]	Shield bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and juveniles suck sap from citrus trees (MAFF 1990). Adults of this stinkbug lay eggs on leaves or branches. Recently hatched immatures congregate before dispersing to find other host plants (TFRI 2004).	No
Ferrisia virgata (Cockerell, 1893) [Pseudococcidae]	Striped mealybug	Yes (Inoue *et al.* 2006; Ben-Dov *et al.* 2008)	Yes (Ben-Dov *et al.* 2008; DAFWA 2008a)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Fiorinia fioriniae (Targioni Tozzetti, 1867) [Diaspididae]		Yes (Mito and Uesugi 2004; Ben-Dov *et al.* 2008)	Yes (AICN 2008; Ben-Dov *et al*. 2008) Currently not known in WA (DAFWA 2008a,b)	No – Polyphagous species and citrus is a host. Affects the leaves of hosts (Watson 2005). Not recorded as affecting citrus in Japan (Murakami 1970) and unshu is not a host for this species in Japan (MAFF 2009).	No
Fiorinia proboscidaria Green, 1900 [Diaspididae]	Armoured scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves and young shoots of citrus (MAFF 1990).	No
Fiorinia randiae Takahashi, 1934 [Diaspididae]		Yes (Ben-Dov *et al.* 2008)	No (Ben-Dov *et al.* 2008)	No – *Citrus* sp. are listed as host for this species (Ben-Dov *et al*. 2008), but unshu is not a host in Japan (MAFF 2009).	No
Fiorinia theae Green, 1900 [Diaspididae]	Camellia scale	Yes (MAFF 2003)	No (Ben-Dov *et al.* 2005)	No – Found on leaves, twigs and branches of unshu mandarin (Miller 2001; MAFF 2003).	No
Gargara genistae (Fabricius, 1775) [Membracidae]		Yes (MAFF 2003)	No (Day 1999; Fletcher and Larivière 2005a)	No – Pest of wisteria (MAFF 2003). Feeds on foliage of scotch broom (Syrett *et al.* 1999). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Geisha distinctissima (Walker, 1858) [Flatidae]	Green flatid planthopper	Yes (MAFF 1990)	No (Fletcher and Larivière 2004; Fletcher and Watson 2006)	No – Associated with leaves and twigs of citrus (MAFF 1990).	No
Geocoris varius (Uhler, 1860) [Syn.: *Piocoris varius*] [Lygaeidae]	Anthocorid bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – This species feeds on the sap of citrus trees (MAFF 1990). It has been reported to feed on unshu plants, but is unlikely to be associated with the fruit (Hirose *et al.* 1999).	No
Gergithus variabilis (Butler, 1875) [Issidae]		Yes (MAFF 2003)	No (Fletcher and Larivière 2005b)	No – Pest of mulberry and paper mulberry (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Glaucias subpunctatus (Walker, 1867) [Pentatomidae]	Polished green stink bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Will not remain with the fruit during harvest or packing (USDA 2002).	No
Graptopsaltria nigrofuscata (Motschulsky, 1866) [Cicadidae]	Large brown cicada	Yes (MAFF 1990)	No (Moulds 1990; Moulds and Cowan 2004)	No – Adults associated with trunks, branches or twigs of citrus. Nymphs are associated with roots (MAFF 1990).	No
Halyomorpha halys Stål, 1855 [Syn.: *Halyomorpha mista* (Uhler, 1860] [Pentatomidae]	Brown marmorated stink bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Although this species is associated with citrus fruit and sucks on fruits of many species, including mandarin, persimmon, plum, pome, pear and peach (Kawada and Kitamura 1983; Funayama 1996; MAFF 2003), adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No
Hemiberlesia lataniae (Signoret, 1869) [Diaspididae]	Palm scale	Yes (Ben-Dov *et al.* 2005)	Yes (Ben-Dov *et al.* 2005)		No
Hemiberlesia rapax (Comstock, 1881) [Diaspididae]	Greedy scale	Yes (MAFF 1990)	Yes (Donaldson and Tsang 2006)		No
Hishimonus sellatus (Uhler, 1896) [Cicadellidae]	Rhombic-marked leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994)	No – Adults are associated with leaves of citrus (MAFF 1990). Pest attacks shoots of *Morus alba, Humulus japonica* and *Ziziphus jujuba* in Korea (Kim and Kim 1993). It is a vector of mulberry dwarf mycoplasma and jujube witches broom virus (Kim *et al.* 1985).	No
Homalogonia obtusa (Walker, 1868) [Pentatomidae]	Four spotted stink bug	Yes (Funayama 2002)	No (Cassis and Gross 2002)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Homoeocerus unipunctatus (Thunberg, 1783) [Coreidae]	Coreid bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs suck sap of citrus trees (MAFF 1990).	No
Howardia biclavis (Comstock, 1883) [Diaspididae]	Mining scale	Yes (MAFF 1990)	Yes (Donaldson and Tsang 2006). Not present in WA (DAWA 2003a). Not present in SA (PIRSA 2008).	Yes – All parts of citrus plant are affected including the roots (MAFF 1990).	Yes (for WA, SA)
Hygia opaca (Uhler, 1869) [Coreidae]	Coreid bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs suck sap of citrus trees (MAFF 1990).	No
Icerya aegyptiaca (Douglas, 1890) [Margarodidae]	Egyptian fluted scale	Yes (Ben-Dov *et al*. 2008)	Yes (APPD 2008; DAFWA 2008a)		No
Icerya purchasi Maskell, 1879 [Margarodidae]	Cottony cushion scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997)		No
Icerya seychellarum (Westwood, 1855) [Margarodidae]	Yellow cottony cushion scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; DAFWA 2008a).		No
Ischnaspis longirostris (Signoret, 1882) [Diaspididae]	Black thread scale	Yes (Mito and Uesugi 2004; Inoue *et al.* 2006).	Yes (APPD 2008; Ben-Dov *et al.* 2008). Not present in WA (DAFWA 2008a).	Yes – *Citrus* spp. are hosts for this species which usually feeds on leaves but is occasionally found on bark and fruit (Watson 2005).	Yes (for WA)

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Ishidaella albomarginata (Signoret, 1853) [Cicadellidae]		Yes (MAFF 2003)	Yes (Fletcher and Larivière 2006). Not present in WA (DAFWA 2008b).	No – Affects leaves and shoots of unshu in Japan (MAFF 2009)	No
Jacobiasca formosana (Paoli, 1936) [Cicadellidae]	Castor leaf hopper	Yes (MAFF 2003)	No (Fletcher and Larivière 2006)	No – Inhabits citrus orchards (MAFF 2003). Young and adult leaf hoppers feed on the sap from the lower surface of leaves of the castor oil plant (*Ricinus communis*) (Suddhiyam and Chuakittisak 2004). It is a major pest of tea, causing the shoots to wilt and drop off (Anon 2004a).	No
Kilifia acuminata (Signoret, 1873) [Coccidae]	Acuminate scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with branches, twigs and leaves of citrus (MAFF 1990). Associated with leaves of mango in Egypt (Salama and Saleh 1971).	No
Kolla atramentaria (Motschulsky, 1859) [Cicadellidae]	Leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994)	No – Associated with leaves of citrus (MAFF 1990).	No
Ledra auditura Walker, 1858 [Cicadellidae]	Auricled leafhopper	Yes (MAFF 2003)	No (Fletcher 2002)	No – Pest of rice plants, apples, Chinese parasol tree, and oaks (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Lepidosaphes beckii (Newman, 1869) [Diaspididae]	Purple scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; DAFWA 2007)		No
Lepidosaphes camelliae Hoke, 1921 [Diaspididae]	Camellia oystershell scale	Yes (MAFF 2003)	No (Ben-Dov *et al.* 2005)	No – Infests leaves of camellias including Sasanqua (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Lepidosaphes conchiformis (Gmelin, 1789) [Diaspididae]	Fig scale	Yes (Murakami 1970)	No (Ben-Dov *et al*. 2008)	No – This species has been recorded as infesting citrus in Pakistan (Ahmad and Ghani 1971). However, unshu is not a host in Japan (MAFF 2009).	No
Lepidosaphes gloverii (Packard, 1869) [Diaspididae]	Glover scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997), including WA (DAFWA 2008a). Not present in SA (PIRSA 2008).	Yes – Associated with fruit, leaves, twigs and branches of citrus (Smith *et al.* 1997). Crawlers settle in sheltered sites, in older leaves and beneath fruit calyx lobes (Smith *et al.* 1997).	Yes (for SA)
Lepidosaphes pinnaeformis Bouché, 1851 [Diaspididae]	Cymbidium scale	Yes (MAFF 2009)	Yes (APPD 2008). Not in WA (DAFWA 2008a)	Yes – Affects leaf, stem and fruit (MAFF 2009).	Yes (for WA)
Lepidosaphes tokionis (Kuwana, 1902) [Diaspididae]	Croton scale	Yes (Watson 2005; Ben-Dov *et al* 2008)	Yes (AICN 2008; APPD 2008). Not present in WA (DAFWA 2008b).	No – Associated with *Citrus maxima* in Fiji (Williams and Watson 1988). Found on the leaves of hosts (Watson 2005). Unshu is not a host for this species in Japan (MAFF 2009).	No
Lepidosaphes ulmi (Linnaeus, 1758) [Diaspididae]	Oystershell scale	Yes (MAFF 2003)	Yes (Ben-Dov *et al.* 2005).		No
Leptocorisa acuta (Thunberg, 1783) [Alydidae]	Rice bug	Yes (MAFF 1990)	Yes (Cassis and Gross 2002). Not present in WA (DAWA 2003a)	No – Associated with leaves and seeds of rice and cereals (citrus not listed as a host) (CAB International 2004). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Leptocorisa chinensis (Dallas, 1852) [Alydidae]	Rice bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Pest of rice in Japan (Yokosuka *et al.* 1991). Although this pest is listed on the MAFF (1990) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Lopholeucaspis cockerelli (Grandpre and Charmoy, 1899) [Diaspididae]	Armoured scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005), but not in WA (DAFWA 2008b).	No – Associated with citrus leaves and shoots in Japan (MAFF 1990).	No
Lopholeucaspis japonica (Cockerell, 1897) [Diaspididae]	Pear white scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005, CAB International 2007)	Yes – Associated with citrus fruit in Japan (Murakami 1970).	Yes
Machaerotypus sibiricus (Lethierry, 1876) [Membracidae]		Yes (MAFF 2003)	No (Fletcher and Larivière 2005a)	No – Pest of plum, persimmon, chestnut, mulberry, and paper mulberry (MAFF 2003). Associated with leaves of unshu (USDA 2002).	No
Maconellicoccus hirsutus (Green, 1908) [Pseudococcidae]	Pink hibiscus mealybug	Yes (Inoue *et al*. 2006; Ben-Dov *et al.* 2008)	Yes (Gullan 2000; APPD 2008; DAFWA 2008a)		No
Macrosiphum euphorbiae (Thomas, 1878) [Aphididae]	Potato aphid	Yes (MAFF 2003)	Yes (Berlandier 1997)		No
Megacopta punctatissimum (Montandon, 1894) [Plataspidae]	Bean pentatomid	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs feed on the sap of citrus trees (MAFF 1990). Nymphs feed on young branches of the weed *Pueraria lobata* in Japan (Tayutivutikul and Yano 1990).	No
Meimuna opalifera (Walker, 1850) [Cicadidae]	Cicada	Yes (MAFF 1990)	No (Moulds 1990; Moulds and Cowan 2004)	No – Adults are associated with trunks, branches and twigs of citrus trees. Nymphs are on roots (MAFF 1990).	No
Melanaspis sulcata Ferris, 1943 [Diaspididae]		Yes (Deitz and Davidson 1986)	No (no records found)	No – *Melanaspis* sp. occurs on trunks, branches, stems and leaves of hosts (Deitz and Davidson 1986).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Mesepora onukii (Matsumura, 1905) [Tropiduchidae]		Yes (MAFF 2003)	No (Fletcher and Watson 2006; Fletcher and Larivière 2007b)	No – Infests *Crinum* spp. (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Milviscutulus mangiferae (Green, 1889) [Coccidae]	Mango shield scale	Yes (Mito and Uesugi 2004)	Yes (Grimshaw and Donaldson 2007; DAFWA 2008b)		No
Morganella longispina (Morgan, 1889) [Diaspididae]	Plumose scale	Yes (MAFF 1990)	Yes (Donaldson and Tsang 2006). Not present in WA (Naumann 1993; DAFWA 2008a). Not present in SA (PIRSA 2008).	Yes – (Hamon 1981)	Yes for WA, SA)
Myzus persicae (Sulzer, 1776) [Aphididae]	Green peach aphid	Yes (MAFF 1990)	Yes (Wilson *et al.* 2002)		No
Nephotettix cincticeps Uhler, 1896 [Cicadellidae]	Rice green leafhopper	Yes (Guy *et al.* 1992)	No (Fletcher and Watson 2006)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Nezara antennata Scott, 1874 [Pentatomidae]	Green stink bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Nezara species lay their eggs on the under surface of leaves (Kobayashi 1959). Adults and nymphs suck the sap from citrus trees (MAFF 1990); both of these life stages would dislodge from feeding sites when disturbed.	No
Nezara viridula (Linnaeus, 1758) [Pentatomidae]	Southern green stink bug	Yes (MAFF 1990)	Yes (Clarke 1992; Smith *et al.* 1997)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Nipaecoccus viridis (Newstead, 1894) [Syn.: *Nipaecoccus vastator* (Maskell, 1895)] [Pseudococcidae]	Spherical mealybug	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005)		No
Nisia atrovenosa (Lethierry, 1888) [Flatidae]	Striated planthopper	Yes (Catendig 2004)	No (Fletcher and Watson 2006)	No – Affects the leaves of citrus in Korea (USDA 2002).	No
Nysius plebejus Distant, 1883 [Lygaeidae]	Seed bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Seed feeder (Hong 1986; Kim *et al.* 1994). Unshu mandarin fruit is seedless (Chapter 3).	No
Oceanaspidiotus spinosus (Comstock 1883) [Diaspididae]		Yes (Takagi 1984)	No (Ben-Dov *et al,* 2008)	No – Found on citrus twigs in North America (Takagi 1984).	No
Octaspidiotus stauntoniae (Takahashi, 1933) [Diaspididae]	Armoured scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves and young shoots of citrus. Not recorded on citrus on mainland Japan (MAFF 1990). Lives on leaves of host plants (Ben-Dov *et al.* 2005).	No
Oliarus quadricinctus Matsumura, 1914 [Cixiidae]		Yes (MAFF 2003)	No (Fletcher and Watson 2006)	No – Adult cixiids feed on phloem fluid of stems and do not feed on fruit. They may feed on larger veins of leaves too. The nymphs are more cryptic, feeding on roots in cracked soil (M Fletcher, pers. comm. 24 November 2004).	No
Oliarus subnubila (Uhler, 1896) [Cixiidae]		Yes (MAFF 2003)	No (Fletcher and Watson 2006)	No – Adult cixiids feed on phloem fluid of stems and do not feed on fruit. They may feed on larger veins of leaves too. The nymphs are more cryptic, feeding on roots in cracked soil (M Fletcher, pers. comm. 24 November 2004). *Albizia julibrissin* Durazz. is a host (MAFF 2003)	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Orchamoplatus mammaeferus (Quaintance and Baker, 1917) [Aleyrodidae]	Croton whitefly	Yes (USDA 1995)	Yes (Martin and Gillespie 2001; DAFWA 2008a)		No
Orientus ishidae (Matsumura, 1902 [Cicadellidae]	Japanese leafhopper	Yes (MAFF 2003)	No (Fletcher 2002)	No – Damages apple and other fruit trees of Rosaceae (MAFF 2003). Feeds on leaflets of *Gleditsia* (Valley and Wheeler 1985). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Orosanga japonicus (Melichar, 1898) [Ricaniidae]	Ricaniid planthopper	Yes (MAFF 1990)	No (Fletcher and Watson 2006)	No – Associated with leaves and twigs of citrus (MAFF 1990).	No
Orthobelus flavipes (Uhler, 1896) [Membracidae]	Sharpshooter bug	Yes (MAFF 2003)	No (Fletcher and Larivière 2005a)	No – Not likely to follow the unshu fruit pathway (USDA 2002). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Parabemisia myricae (Kuwana, 1927) [Aleyrodidae]	Myrica whitefly	Yes (MAFF 1990)	No (Martin 1999)	No – Associated with leaves and stems. May be associated with young fruit and fruitlets of citrus (MAFF 1990; CAB International 2004).	No
Paradasynus spinosus (Hsiao, 1963) [Coreidae]	Coreid bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs suck sap of citrus trees (MAFF 1990).	No
Parasaissetia nigra (Nietner, 1861) [Coccidae]	Nigra scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Parlatoria camelliae Comstock, 1883 [Diaspididae]		Yes (Murakami 1970; Ben-Dov *et al.* 2008)	Yes (Ben-Dov *et al.* 2008) Not present in WA (DAFWA 2008b)	No – Affects the leaves of *Citrus* sp. (Watson 2005). *Citrus* sp. are not recorded as hosts for this species in Japan (Murakami 1970).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Parlatoria cinerea Hadden in Doane and Hadden, 1909 [Diaspididae]	Armoured scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – Associated with fruit, leaves, stems and branches of citrus (Williams and Watson 1988).	Yes
Parlatoria pergandii Comstock, 1881 [Diaspididae]	Chaff scale	Yes (MAFF 1990)	Yes (Smith *et al.* 1997). Not present in WA (APPD 2007; DAFWA 2008a). Not present in SA (PIRSA 2008).	Yes – Associated with trunk, branches, twigs, leaves and fruit of citrus. Mostly present on fruit under the calyces (Miller 1997; Smith *et al.* 1997).	Yes (for WA, SA)
Parlatoria proteus (Curtis, 1843) [Diaspididae]	Cattleya scale, orchid scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Parlatoria theae Cockerell, 1896 [Diaspididae]	Tea parlatoria scale	Yes (MAFF 2003)	No (Ben-Dov *et al.* 2005)	Yes – Polyphagous pest, which hosts include citrus. Found on all aerial plant parts, especially twigs (Watson 2005). Affects the leaves and fruit of citrus in Korea (USDA 2002). Infests branches and trunks of rose, plum, *Zathoxylum piperitum*, and tea, but also infests leaf surface of Japanese aucuba, and *Viburnum awabuki* (MAFF 2003).	Yes
Parlatoria ziziphi (Lucas, 1853) [Diaspididae]	Black parlatoria scale	Yes (MAFF 1990)	No (CAB International 2007; DAFWA 2008a)	Yes – Infests citrus fruit and leaves, eggs laid on fruit (Jeppson 1989; Fasulo and Brooks 2004).	Yes
Parthenolecanium corni (Bouché, 1844) [Coccidae]		Yes (Ben-Dov *et al.* 2005)	No (Ben-Dov *et al.* 2005)	No – Affects the leaves of citrus in Korea (USDA 2002).	No
Penthimia nitida (Distant, 1912) [Cicadellidae]	Leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994)	No – Associated with leaves of citrus (MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Petalocephala discolor (Uhler, 1896a) [Cicadellidae]		Yes (MAFF 2003)	No (Fletcher 2002)	No – Inhabits sawtooth oak (*Quercus acutissima* Carruthers) (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Phenacoccus pergandei Cockerell, 1896 [Pseudococcidae]		Yes (Ben-Dov *et al.* 2005)	No (Ben-Dov *et al.* 2005)	No – Affects the leaves of citrus (USDA 2002). Also associated with leaves and stems of *Mallotus japonicus* (Hashimoto *et al.* 1980).	No
Physopelta cincticollis (Stål, 1863) [Largidae]	Largid bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs suck sap from citrus trees (MAFF 1990).	No
Physopelta gutta (Burmeister, 1874) [Largidae]	Largid bug	Yes (MAFF 1990)	Yes (Cassis and Gross 2002). Not present in WA (DAFWA 2008b).	No – Adults and nymphs suck sap from citrus trees (MAFF 1990).	No
Pinnaspis aspidistrae (Signoret, 1869) [Diaspididae]	Fern scale	Yes (MAFF 1990)	Yes (Williams and Watson 1988). Not present in WA (DAWA 2003a).	No – Associated with leaves of citrus (MAFF 1990).	No
Pinnaspis buxi (Bouche, 1851) [Diaspididae]		Yes (Inoue *et al.* 2006; Ben-Dov *et al.* 2008)	Yes (APPD 2008; DAFWA 2008a)		No
Pinnaspis strachani (Cooley, 1898) [Diaspididae]	Hibiscus snow scale	Yes (MAFNZ 2000)	Yes (Ben-Dov *et al.* 2005)		No
Planococcus citri (Risso, 1813) [Pseudococcidae]	Citrus mealybug	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Ben-Dov *et al.* 2005)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Planococcus kraunhiae (Kuwana, 1902) [Pseudococcidae]	Japanese mealybug	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – Associated with fruit, leaves and twigs of citrus (MAFF 1990).	Yes
Planococcus lilacinus (Cockerell, 1905) [Pseudococcidae]	Coffee mealybug	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – Associated with fruit, leaves and twigs of citrus (MAFF 1990).	Yes
Platypleura kaempferi (Fabricius, 1794) [Cicadidae]	Kaempfer cicada	Yes (MAFF 1990)	No (Moulds 1990; Moulds and Cowan 2004)	No – Adults associated with trunks, branches and twigs of citrus trees. Nymphs are on roots (MAFF 1990).	No
Plautia stali Scott, 1874 [Pentatomidae]	Brownwinged greenbug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Although this species sucks on citrus fruit (MAFF 1990; Moriya 1996), adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No
Protopulvinaria pyriformis (Cockerell, 1894) [Coccidae]	Pyriform scale	Yes (MAFF 1990)	No (Smith *et al.* 1997)	No – Associated with leaves and twigs of citrus (MAFF 1990).	No
Pseudaonidia duplex (Cockerell, 1896) [Diaspididae]	Camphor scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – Attacks all parts of *Citrus* species, including leaves, branches and fruit (Jeppson 1989; Kim *et al*. 2000). Mainly associated with twigs and branches but can be found on fruit and leaves (Watson 2005). *Citrus unshiu* is recorded as a host (Murakami 1970).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Pseudaonidia trilobitiformis (Green, 1896) [Diaspididae]	Trilobite scale	Yes (MAFF 1990)	Yes (Williams and Watson 1988). Not present in WA (DAWA 2003a). Not present in SA (PIRSA 2008).	Yes – Associated with fruit and leaves of citrus (MAFF 1990; Miller 1997).	Yes (for WA, SA)
Pseudaulacaspis pentagona (Targioni Tozzetti, 1886) [Diaspididae]	White peach scale	Yes (Ben-Dov *et al.* 2005)	Yes (Ben-Dov *et al.* 2005); APPD 2008). Not present in WA (DAFWA 2008a).	No – Associated with the leaves of unshu mandarin in Korea (USDA 2002). In Japan, this species is not recorded on citrus, but is found on twigs, branches and trunks of other hosts (Murakami 1970). Unshu is not a host for this species in Japan (MAFF 2009).	No
Pseudococcus comstocki (Kuwana, 1902) [Pseudococcidae]	Comstock mealybug	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – Associated with fruit and branches of citrus (Musaev and Bushkov 1977; Grafton-Cardwell *et al.* 2003).	Yes
Pseudococcus cryptus Hempel, 1918 [Pseudococcidae]	Citrus mealybug	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	Yes – Associated with fruit, leaves and twigs of citrus (MAFF 1990; Ben-Dov *et al.* 2005).	Yes
Pseudococcus longispinus (Targioni Tozzetti, 1867) [Pseudococcidae]	Longtailed mealybug	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Psylla coccinea Kuwayama, 1908 [Psyliidae]		Yes (MAFF 2003)	No (Hollis 2002)	No – Found on *Akebia quinata*, *Stauntonia hexaphylla* and *Akebia trifoliata* (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Pulvinaria aurantii Cockerell, 1896 [Coccidae]	Cottony citrus scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs and branches of citrus (MAFF 1990; Cui *et al.* 1997).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Pulvinaria citricola Kuwana, 1914 [Coccidae]	Cottony citrus scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs and branches of citrus (MAFF 1990; Cui *et al.* 1997).	No
Pulvinaria okitsuensis Kuwana, 1914 [Coccidae]	Cottony citrus scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves and twigs of citrus (MAFF 1990).	No
Pulvinaria psidii (Maskell, 1893) [Coccidae]	Green shield scale	Yes (Mito and Uesugi 2004; Inoue *et al.* 2006)	Yes (Qin and Gullan 1992; DAFWA 2008a)		No
Pulvinaria polygonata Cockerell, 1905 [Coccidae]	Cottony citrus scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005). Not present in WA (DAWA 2003a).	No – Associated with leaves and twigs of citrus (Smith *et al.* 1997).	No
Pygomenida bengalensis (Westwood, 1837) [Pentatomidae]	Shield bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Adults and nymphs are phloem-feeders (MAFF 1990). It is a pest of rice in Sri Lanka (Bambaradeniya *et al.* 2004). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Recilia dorsalis (Motschulsky, 1859) [Cicadellidae]	Zig-zag striped leafhopper	Yes (Ishijima *et al.* 2004)	Yes (Chapman and Myers 1987; Fletcher and Watson 2006)		No
Rhopalosiphum maidis (Fitch, 1856) [Aphididae]	Green corn aphid	Yes (MAFF 2003)	Yes (Berlandier 1997)		No
Rhynchocoris humeralis (Thunberg, 1783) [Pentatomidae]	Citrus stink bug	Yes (JSAE 1987)	No (Cassis and Gross 2002)	No – Although this species sucks on citrus fruit (TDAIS 2005), adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit. Sucking is also likely to incur fruit drop (FFTC 2003).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Riptortus clavatus (Thunberg, 1783) [Alydidae]	Bean bug	Yes (MAFF 1990)	No (Cassis and Gross 2002)	No – Not a pest of citrus (CAB International 2004). Although this pest is listed on the MAFF (1990) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Saissetia citricola (Kuwana, 1909) [Coccidae]	Soft scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves, twigs and branches of citrus (MAFF 1990).	No
Saissetia coffeae (Walker, 1852) [Coccidae]	Hemispherical scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Saissetia oleae (Olivier, 1791) [Coccidae]	Black scale	Yes (MAFF 1990)	Yes (Ben-Dov *et al.* 2005)		No
Sarucallis kahawaluokalani (Kirkaldy, 1907) [Aphididae]	Crepe myrtle aphid	Yes (Patti 1984)	No (CAB International 2004)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Sinomegoura citricola (van der Goot, 1917) [Aphididae]	Aphid	Yes (MAFF 2003)	Yes (Blackman and Eastop 2000). Not present in WA (DAFWA 2008b).	No – Associated with leaves and branches of citrus in Japan (MAFF 2003).	No
Sogatella furcifera (Horvath, 1899) [Delphacidae]	White-beaked rice planthopper	Yes (Guy *et al.* 1992)	Yes (Fletcher and Watson 2006)		No
Takahashia japonica (Cockerell, 1896) [Coccidae]	String cottony scale	Yes (MAFF 1990)	No (Ben-Dov *et al.* 2005)	No – Associated with leaves and twigs of citrus (MAFF 1990; Ben-Dov *et al.* 2005).	No
Tartessus ferrugineus ferrugineus (Walker, 1851) [Cicadellidae]	Leafhopper	Yes (MAFF 2003)	No (Fletcher 2002)	No – associated with leaves (MAFF 2003).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Tinocallis zelkowae (Takahashi, 1919) [Aphididae]	Zelkova aphid	Yes (Blackman and Eastop 1994)	No (Blackman and Eastop 1994)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Toxoptera aurantii (Fonscolombe, 1841) [Aphididae]	Black citrus aphid	Yes (MAFF 1990)	Yes (Smith *et al.* 1997)		No
Toxoptera citricidus (Kirkaldy, 1907) [Aphididae]	Tropical citrus aphid	Yes (MAFF 1990)	Yes (Blackman and Eastop 2000)		No
Toxoptera odinae (van der Goot, 1917) [Syn.: *Longiunguis spathodeae* (van der Goot, 1918)] [Aphididae]	Udo aphid	Yes (MAFF 1990)	No (Blackman and Eastop 2000)	No – Associated with leaves and young shoots of citrus (MAFF 1990).	No
Unaspis euonymi (Comstock, 1881) [Diaspididae]	Euonymus scale	Yes (MAFF 2003)	No (Ben-Dov *et al.* 2005)	Yes – Attacks almost all parts of the host above ground in Missouri (Hollinger 1923). Affects the leaves, stems and fruit of citrus in Korea (USDA 2005). Pest recorded on *Citrus grandis* (Ben-Dov *et al.* 2005).	Yes
Unaspis yanonensis (Kuwana, 1923) [Diaspididae]	Arrowhead scale	Yes (MAFF 1990)	No (Smith *et al.*, 1997; CAB International 2007; EPPO 2007)	Yes – Present on branches and fruit of citrus (Jeppson 1989). Can settle on twigs, leaves, stems and fruit and feed on cell sap (Itioka *et al*. 1992, 1997).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Zyginella citri (Matsumura, 1909) [Cicadellidae]	Smaller citrus leafhopper	Yes (MAFF 1990)	No (Day and Fletcher 1994)	No – Although this species is associated with citrus fruit (MAFF 1990), whereby adults and nymphs feed by inserting their stylets into plant tissues (leaves and maturing citrus fruit) for short periods of time, adults fly off and nymphs hop/walk from fruit, once disturbed. Thus this species is likely to be removed from the pathway during harvesting and processing of fruit.	No
Hymenoptera (ants; bees; wasps)					
Formica japonica Motschoulsky, 1866 [Formicidae]	Wood ants	Yes (MAFF 2003)	No (Shattuck and Barnett 2001)	No – Pest of lawn grass. Preys on first instar larvae after hatching (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Lasius niger (Linnaeus, 1758) [Formicidae]	Common black ant	Yes (Kaneko 2002)	No (Shattuck and Barnett 2001)	No – Known to attend the brown citrus aphid (*Toxoptera citricidus*) and the cotton aphid (*Aphis gossypii*), on the tree stems of mandarin (Kaneko 2002, 2003).	No
Polyrhachis dives Smith, 1857 [Formicidae]		Yes (MAFF 2003)	Yes (Kohout 1988; Shattuck 1999). Not present in WA (DAFWA 2008a).	No – Builds nests on the lower branches of trees between leaves and twigs, bound with silk (Kohout 1988).	No
Polyrhachis lamellidens Smith, 1874 [Formicidae]	Black ant	Yes (MAFF 2003)	No (Shattuck and Barnett 2001)	No – Builds nests in hollow tree trunks or underground, or in rotten wood and bricks (JAID 2003; CAD 2008)	No
Lepidoptera (butterflies; moths)					
Acanthopsyche nigraplaga (Wileman, 1911) [Psychidae]	Bagworm moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990), and various other plant species (Robinson *et al.* 2007).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Adoxophyes dubia Yasuda, 1998 [Tortricidae]	Smaller tea tortrix	Yes (MAFF 1990) as *Adoxophyes* sp., which in Japan includes *Adoxophyes dubia* Yasuda (Yasuda 1998a).	No (Nielsen *et al.* 1996)	Yes – The species is difficult to discriminate from *Adoxophyes orana* and misidentifications are possible (Yasuda 1998a; Davis *et al.* 2006). Therefore, the pest is considered likely to be present on the importation pathway.	Yes
Adoxophyes honmai Yasuda 1988 [Tortricidae]	Smaller tea tortrix	Yes (MAFF 1990), as *Adoxophyes* sp., which in Japan includes *Adoxophyes honmai* Yasuda (Yasuda 1998a).	No (Nielsen *et al.* 1996)	Yes – This species occurs on many trees and shrubs (Yasuda 1998a) including citrus in the Shizuoka Prefecture in Japan (Yasuda 1998b). The larvae of *Adoxophyes* species in general are voracious feeders, causing considerable harm to foliage, blossoms and fruit (Yasuda 1998a).	Yes
Adoxophyes orana fasciata Walsingham, 1900 [Tortricidae]	Summer fruit tortrix	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	Yes – Has been reported on unshu (MAFF 2003). The larvae of *Adoxophyes* are polyphagous and important pests on various fruit crops. They are voracious feeders, causing considerable harm to foliage, blossoms and fruit (Yasuda 1998a).	Yes
Agrius convolvuli Linnaeus, 1758 [Sphingidae]	Sphingids	Yes (MAFF 2003)	Yes (Moulds 1981)		No
Agrotis ipsilon (Hüfnagel, 1766) [Noctuidae]		Yes (Mizukoshi 1999)	Yes (Nielsen *et al.* 1996)		No
Anomis flava (Fabricius, 1775) [Noctuidae]	Cotton leaf caterpillar	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Anomis mesogona (Walker, 1858) [Noctuidae]	Hibiscus looper	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990). This species is not likely to follow the import pathway (USDA 2002).	No
Apamea aquila oriens (Warren, 1911) [Syn.: *Perigea affinis* Draudt, 1950] [Noctuidae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – In Europe, pest feeds on Indian grass and other Graminae (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Apochima excavata (Dyar, 1905) [Geometridae]	Mulberry looper	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Apochima juglansiaria (Graeser, 1889) [Gepmetridae]	Mulberry spinerlooper	Yes (Inoue *et al.* 1982)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Aporia crataegi Linnaeus, 1758 [Pieridae]		Yes (Sato 1978)	No (Braby 2000)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Archips breviplicanus (Walsingham, 1900) [Tortricidae]	Asiatic leafroller	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves, buds and flowers of citrus (MAFF 1990). This pest is primarily associated with leaves, and is not likely to be on the unshu fruit pathway (USDA 1995, 2002).	No
Archips ingentanus (Christoph, 1881) [Torticidae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Eats into flower buds and also feeds on petals, leaves and young unshu fruit (MAFF 2003). This pest is primarily associated with leaves, and is not likely to be on the unshu fruit pathway (USDA 1995, 2002).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Archips podana Scopoli, 1763 [Torticidae]	Great brown twist moth	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Mainly a pest of apple and pear affecting the leaves and young fruit. Citrus not listed as a host (CAB International 2004). Associated with leaves and not likely to be on the unshu fruit pathway (USDA 1995).	No
Archips xylosteanus Linnaeus, 1758 [Torticidae]	Apple leafroller	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Associated with leaves on unshu (MAFF 2003), and not likely to be on the unshu fruit pathway (USDA 1995, 2002).	No
Artena dotata (Fabricius, 1794) [Noctuidae]	Fruit-piercing moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990). This species is not likely to follow the import pathway (USDA 2002).	No
Ascotis selenaria (Denis and Schiffermuller, 1775) [Geometridae]	Mugwort looper	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990; Robinson *et al.* 2007).	No
Attacus atlas (Linné, 1758) [Saturnidae]	Giant atlas moth	Yes (MAFF 2009)	No (Nielsen *et al.* 1996)	Unshu mandarin is not a host (MAFF 2009).	No
Autographa gamma Linnaeus, 1758 [Noctuidae]		Yes (Kaneko 1995)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990).	No
Bambalina spp. [Psychidae]	Mulberry bagworm	Yes (MAFF 1990)	No, there are no species of this genus in Australia (Nielsen *et al.* 1996)	No – Larvae feed on leaves and bark of citrus (MAFF 1990; Lee *et al.* 1992).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Biston robustus robustus (Butler, 1879) [Geometridae]	Giant geometrid	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Blenina senex Butler, 1878 [Nolidae]	Bark-like moth	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Larvae eat persimmon leaves and build a cocoon under the surface of leaves (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Cadra cautella Walker, 1863 [Pyralidae]		Yes (Kuwahara and Imura 1995)	Yes (Nielsen *et al.* 1996)		No
Calyptra lata Butler, 1881 [Noctuidae]	Larger orasia	Yes (Robinson *et al.* 2007)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990).	No
Chalioides kondonis (Kondo, 1822) [Psychidae]	Kondo white psychid	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No[1] – Larvae feed on leaves of citrus (Nakashima and Shimizu 1972; MAFF 1990).	No
Chariaspilates formosaria Eversmann, 1837 [Geometridae]	Looper moth	Yes (Robinson *et al.* 2007)	No (Nielsen *et al.* 1996)	No – Affects the leaves of citrus in Korea (USDA 2002).	No
Chrysodeixis eriosoma Doubleday, 1843 [Noctuidae]		Yes (Inomata *et al.* 2000)	Yes (Nielsen *et al.* 1996)		No
Cleora repulsaria (Walker, 1860) [Geometridae]	Looper	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Cnidocampa flavescens Walker, 1855 [Limacodidae]		Yes (Ishii *et al.* 1984)	No (Nielsen *et al.* 1996)	No – Affects the leaves of citrus in Korea (USDA 2002).	No
Conogethes punctiferalis (Guenée, 1854) [Pyralidae]	Yellow peach moth	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996)		No
Cusiara stipitaria (Oberthur, 1880) [Geometridae]	Looper caterpillar	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Dendrolimus spectabilis Butler, 1877 [Lasiocampidae]	Pine moth	Yes (Kamata 2002)	No (Nielsen *et al.* 1996)	No – Affects the leaves of citrus in Korea (USDA 2002).	No
Descoreba simplex (Butler, 1878) [Geometridae]	Geometrid moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Dictyoploca japonica (Moore, 1862) [Saturniidae]		Yes (Nagase and Masaki 1991)	No (Nielsen *et al.* 1996)	No – Affects the leaves of citrus in Korea (USDA 2002). Polyphagous pest of walnut and chestnut trees, adults lay egg masses on the trees and larvae feed on leaves (Iwakuma and Morimoto 1984).	No
Dysgonia arctotaenia (Guenée, 1852) [Noctuidae]		Yes (Robinson *et al.* 2007).	Yes (Nielsen *et al.* 1996) Not present in WA (DAFWA 2008b).	No – Affects the leaves of citrus in Korea (USDA 2002). Unshu is not a host for this species in Japan (MAFF 2009).	No
Ectropis bistortata Goeze, 1783 [Geometridae]	Geometrid moth	Yes (Sato 1979)	No (Nielsen *et al.* 1996)	No – Affects the leaves of citrus in Korea (USDA 2002).	No
Ascotis selenaria cretacea (Butler, 1879 [Geometridae]	Japanese giant looper	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Extremely polyphagous, feeding on citrus, pome fruit and pulses. Larvae feed on leaves of unshu (MAFF 2003). Serious pest of tea, affecting leaves, in Japan (Witjaksono *et al.* 1999)	No

Pest	**Common name**	**Present in Japan**	**Present in Australia**	**Presence on fresh unshu mandarin fruit**	**Consider further**
Ectropis excellens (Butler, 1884) [Geometridae]	Large brown-striped geometrid moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Endoclyta excrescens (Butler, 1877) [Hepialidae]		Yes (Kan *et al.* 2002)	No (Nielsen *et al.* 1996)	No – Affects the stem of citrus in Korea (USDA 2002).	No
Ercheia umbrosa (Butler, 1881) [Noctuidae]	Noctuid moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Reported to suck sap of citrus trees (MAFF 1990). Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990).	No
Eudocima fullonia (Clerck, 1764) [Noctuidae]	Fruit piercing moth	Yes (MAFF 2003)	Yes (Smith *et al.* 1997; CAB International 2004)		No
Eudocima salaminia (Cramer, 1777) [Noctuidae]	Fruit-piercing moth	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996; Smith *et al.* 1997). Not present in WA (DAWA 2003a).	No – Adult moths fly to orchards during the night to suck sap from ripening, overripe or fermenting fruit, including citrus fruit (Common 1990; Smith *et al.* 1997). Ripening pierced fruit tends to fall to the ground (Fay 2005). Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter.	No
Eudocima tyrannus (Guenée, 1852) [Noctuidae]	Noctuid moth	Yes (MAFF 1990, 2003)	No (Nielsen *et al.* 1996)	No – This pest feeds mostly on *Erythrina* trees (Holloway *et al.* 2001). Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990).	No
Eumeta japonica (Heylaerts, 1884) [Psychidae]	Giant bagworm	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	Yes – Larvae feed on leaves, twigs and surface of citrus fruits (MAFF 1990). Important pest of shade and ornamental trees and shrubs in western Japan (Nishida 1983).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Eumeta minuscula (Butler, 1881) [Psychidae]	Tea bagworm	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	Yes – Larvae feed on leaves, twigs and surface of citrus fruits (MAFF 1990). Important pest of shade and ornamental trees and shrubs in western Japan (Nishida 1983). The pest occurs in the Osaka region (Nishida 1983), but has been carried forward as there are no movement controls on fruit.	Yes
Eupithecia carearia Leech, 1897 [Geometridae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Larvae eat the flowers and other parts of *Rhododendron obtusum* var. *kaempferi, Abelia spathulata, Symplocos chinensis* var*. leucocarpa form pilosa, Euonymus alatus* f. *ciliato dentatus* (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Euproctis piperita Oberthür, 1880 [Lymantriidae]		Yes (Robinson *et al.* 2007)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Euproctis pseudoconspersa Strand, 1923 [Lymantriidae]	Tea tussock moth	Yes (Arakaki *et al.* 1997)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Euproctis pulverea Leech, 1888 [Lymantriidae]	Black-dotted yellow tussock moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Not associated with unshu fruit (USDA 1995); affects leaves of citrus (USDA 2002).	No
Euproctis similis (Fuessly, 1775) [Lymantridae]	Gold-tail moth	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Affects leaves of citrus (USDA 2002), apple and persimmon (MAFF 2003).	No
Glyphodes pyloalis Walker, 1859 [Pyralidae]		Yes (Honda *et al.* 1990)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Helicoverpa armigera (Hübner, 1805) [Noctuidae]	African cotton bollworm	Yes (MAFF 2003)	Yes (Nielsen *et al.* 1996)		No
Helicoverpa assulta assulta Guenée, 1852 [Noctuidae]		Yes (Itagaki *et al.* 1983)	Yes (Nielsen *et al.* 1996)		No
Hemithea aestivaria Hübner, 1789 [Geometridae]	Common emerald	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of unshu. Larvae over-winter on tree, and weave leaves together to pupate (MAFF 2003).	No
Homona coffearia Nietner, 1861 [Tortricidae]	Avocado leaf roller	Yes (MAFF 2003)	Yes (Pinese and Brown 1986)		No
Homona magnanima Diakonoff, 1948 [Tortricidae]	Large tea tortrix	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Associated with leaves and shoots of citrus (MAFF 1990; Kim *et al*. 2000). Intercepted on unshu fruit for export to the USA and New Zealand (MAFF 2009).	Yes
Hydraecia amurensis (Staudinger, 1892) [Noctuidae]	Fruit piercing moth	Yes (USDA 1995)	No (Nielsen *et al.* 1996)	No – Adults feed on unshu fruit, but would not be expected to remain with the fruit during processing (USDA 1995). Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990).	No
Hyphantria cunea Drury, 1770 [Arctiidae]	Fall webworm	Yes (Gomi *et al.* 2004)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Lemyra imparilis (Butler, 1877) [Arctiidae]	Mulberry tiger moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves and buds of citrus (MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Lymantria dispar japonica (Motschulsky, 1861) [Lymantriidae]	Asian gypsy moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (Schaefer *et al.* 1986; MAFF 1990).	No
Mahasena aurea (Butler, 1881) [Psychidae]	Case moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990) and on buds and leaves of *Ginkgo biloba* (Lee *et al.* 1997).	No
Mamestra brassicae (Linnaeus, 1758) [Noctuidae]	Cabbage armyworm	Yes (MAFF 1990)	No (CAB International 2004)	No – Larvae feed on leaves, normally vegetable leaves (MAFF 1990). Larvae are found on wild and cultivated plants of cabbages and other *Brassica* species (Sannino and Espinosa 1999; Mazzei *et al.* 2004). Not associated with fruit pathway.	No
Megabiston plumosaria (Leech, 1891) [Geometridae]	Tea geometrid	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves and buds of citrus (MAFF 1990).	No
Monema flavescens Walker, 1855 [Limacodidae]	Oriental moth	Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Infests leaves and stems of citrus, apple, chestnut, persimmon, pear and *Prunus* (MAFF 2003).	No
Ophiusa coronata (Fabricius, 1775) [Noctuidae]	Fruit piercing moth	Yes (MAFF 2003)	Yes (Nielsen *et al.* 1996)		No
Ophiusa tirhaca Cramer, 1780 [Noctuidae]		Yes (Kita 1991)	Yes (Nielsen *et al.* 1996)		No
Ophthalmodes irrorataria Bremer and Grey 1853 [Geometridae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Larvae found on Rosaceae, including *Malus toringo*, apple, *Malus halliana*, *Pourthiaea villosa* var. *laevis*, and *Sorbus alnifolia* (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Oraesia emarginata (Fabricius, 1794) [Noctuidae]	Fruit-piercing moth	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996). Not present in WA (DAWA 2003a).	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990). Larvae overwinter in clusters of weeds and soil cracks around *Cocculus trilobus* in China (Liu *et al.* 2001). This species is not likely to follow the import pathway (USDA 2002).	No
Oraesia excavata (Butler, 1878) [Noctuidae]	Fruit-piercing moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990). Larvae overwinter in clusters of weeds and soil cracks around *Cocculus trilobus* in China (Liu *et al.* 2001). This species is not likely to follow the import pathway (USDA 2002).	No
Papilio bianor dehaanii (C. and R. Felder, 1864) [Papilionidae]	Bianor peacock	Yes (MAFF 2003)	No (Nielsen *et al.* 1996; Braby 2000)	No - Larvae feed on leaves of several Rutaceae, including species of citrus*, Orixa, Phellodendron, Poncirus, Skimmia* and *Zanthoxylum* (Robinson *et al.* 2007).	No
Papilio helenus nicconicolens (Butler, 1881) [Papilionidae]	Red Helen	Yes (MAFF 1990)	No (Nielsen *et al.* 1996; Braby 2000)	No – Larvae feed on leaves of citrus (MAFF 1990). Adults feed in flowers (Collins and Morris 1985).	No
Papilio maackii Ménétriés, 1859 [Papilionidae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996; Braby 2000)	No – Most common in lowland and montane mixed forests with *Phellodendron amurensis*, the host plant. In outbreak years, larvae may also feed on leaves of Rutaceae (Anon. 2004b).	No
Papilio memnon thunbergii (von Siebold, 1824) [Papilionidae]	Great mormon	Yes (MAFF 1990)	No (Nielsen *et al.* 1996; Braby 2000)	No – Larvae feed on leaves of citrus (MAFF 1990). Adults feed in flowers (Collins and Morris 1985).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Papilio polytes polycles (Fruhstorfer, 1902) [Papilionidae]	Black citrus swallowtail	Yes (JSAE 1987)	No (Braby 2000)	No – Early instar larvae feed openly on the upper surface of young leaves, including citrus; mature larvae rest on twigs among foliage away from their feeding areas (CAB International 2004). Adults feed on nectar from low growing flowers (Collins and Morris 1985; CAB International 2004).	No
Papilio polytes polytes Linnaeus, 1758 [Papilionidae]	Common mormon	Yes (MAFF 1990)	No (Nielsen *et al.* 1996; Braby 2000)	No – Larvae feed on leaves of citrus (MAFF 1990). Adults feed in flowers (Collins and Morris 1985).	No
Papilio protenor demetrius (Cramer, 1782) [Papilionidae]	Spangle	Yes (MAFF 1990)	No (Nielsen *et al.* 1996; Braby 2000)	No – Larvae feed on leaves of citrus (MAFF 1990). Adults feed in flowers (Collins and Morris 1985).	No
Papilio xuthus (Linnaeus, 1767) [Papilionidae]	Chinese yellow swallowtail	Yes (MAFF 1990)	No (Nielsen *et al.* 1996; Braby 2000)	No – Larvae feed on leaves of citrus (MAFF 1990). Adults feed in flowers (Collins and Morris 1985) and leaves (Lee *et al.* 1992) of citrus	No
Parallelia maturata (Walker, 1858) [Syn.: *Dysgonia maturata* (Walker, 1858)] [Noctuidae]	Purplish thick-legged moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990). This species is not likely to follow the import pathway (USDA 2002).	No
Paranerita inequalis inequalis (Rothschild, 1909)		Yes (MAFF 1990; 2003)	No (Nielsen *et al.* 1996)	No – Feeds on leaves of unshu. It is omniphagous and sometimes proliferates and strips leaves completely (MAFF 2003)	No
Parasa consocia Walker, 1865 [Limacodidae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Feeds on leaves of persimmon, pear, plum and cherry. Particularly prevalent in trees along streets (MAFF 2003). Associated with leaves of citrus (USDA 2002).	No
Parasa sinica Moore, 1877 [Limacodidae]		Yes (CAB International 2004)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Parnara guttata (Bremer and Grey, 1852) [Hesperiidae]	Rice skipper	Yes (CAB International 2004)	No (Braby 2000)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Peridroma saucia (Hubner, 1808) [Noctuidae]	Variegated cutworm; Pearly underwing moth	Yes (Inomata *et al.* 2002; CAB International 2007)	No (Nielsen *et al.* 1996)	No – Although this species has been recorded to damage leaves, stems and fruit of *Citrus* species in Korea (Kim *et al.* 2000), it is not a pest of unshu mandarin fruit in Japan (MAFF 2009).	No
Phalera assimilis (Bremer and Grey, 1852) [Notodontidae]		Yes (Robinson *et al.* 2007)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Phyllocnistis citrella (Stainton, 1856) [Gracillariidae]	Citrus leafminer	Yes (MAFF 1990)	Yes (Smith *et al.* 1997; Herbison-Evans and Crossley 2004)		No
Planociampa antipala (Prout, 1930) [Geometridae]	Looper moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Plusiodonta casta (Butler, 1878) [Noctuidae]	Noctuid moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Adults suck sap of citrus trees (MAFF 1990). Adults are primarily fruit-piercers and fly off from fruit, once disturbed. Larvae feed on *Stephanoa japonica* (Common 1990).	No
Plusiodonta coelonota (Kollar, 1844) [Noctuidae]	Noctuid moth	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996). Not present in WA (DAWA 2003a).	No – Feeds on leaves of several plants. No records on citrus (Robinson *et al.* 2007). Although this pest is listed on the MAFF (1990) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Psorosticha melanocrepida (Clarke, 1962) [Oecophoridae]	Citrus leafroller	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Associated with leaves of citrus (MAFF 1990). Not associated with unshu fruit (USDA 1995).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Pylargosceles steganioides (Butler, 1878) [Geometridae]	Two-wavy-lined geometrid	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Samia cynthia pryeri (Butler, 1978) [Saturniidae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Larvae eat leaves of many plants, including Amur cork tree, sawtooth oak, *Styrax japonica*, and camphor (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Sarcopolia illoba (Butler, 1878) [Noctuidae]	Mulberry caterpillar	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Adults suck sap of citrus trees (MAFF 1990).	No
Scythropiodes leucostola (Meyrick, 1921) [Lecithoceridae]	Tube caterpillar	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Serrodes campana (Guenée, 1852) [Noctuidae]	Fruit-piercing moth	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996). Not present in WA (DAWA 2003a).	No – Adults are attracted to fermenting fruits (Common 1990). Adults are primarily fruit-piercers of mandarins and other fruit (Bänziger 1982). Adults fly off from fruit, once disturbed.	No
Spilosoma lubricipeda (Linnaeus, 1758) [Arctiidae]	White ermine moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Larvae feed on leaves of citrus (MAFF 1990).	No
Spodoptera exigua Hübner, 1808 [Noctuidae]		Yes (CAB International 2004)	Yes (Nielsen *et al.* 1996)		No
Spodoptera litura (Fabricius, 1775) [Lepidoptera: Noctuidae]	Common cutworm	Yes (MAFF 1990)	Yes (Nielsen *et al.* 1996)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Stathmopoda auriferella (Walker, 1864) [Oecophoridae]	Apple heliodinid	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	Yes – Larvae feed on fruit, flowers and leaves of citrus (MAFF 1990). The pest occurs in the Osaka region (Yamazaki and Sugiura 2003), but has been carried forward as there are no movement controls on fruit.	Yes
Synanthedon hector Butler, 1878 [Sesiidae]		Yes (CAB International 2004)	No (Nielsen *et al.* 1996)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Telorta acuminata (Butler, 1878) [Noctuidae]	Noctuid moth	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Adults suck sap of citrus trees (MAFF 1990).	No
Trichoplusia ni (Hubner, 1802) [Noctuidae]	Cabbage looper	Yes (CAB International 2007)	No (Nielsen *et al.* 1996)	No – Eggs are laid on the upper surface of citrus leaves, and larvae feed on the leaves of citrus (Jeppson 1989). Unshu is not a host for this species in Japan (MAFF 2009).	No
Thyas juno (Dalman, 1823) [Noctuidae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990). This species is not likely to follow the import pathway (USDA 2002).	No
Xestia c-nigrum (Linnaeus, 1758) [Noctuidae]	Spotted cutworm	Yes (CAB International 2004)	No (Nielsen *et al.* 1996)	No – Both larvae and adult noctuid moths are inactive during the day and hide amongst the foliage or leaf litter. During the night, adults usually feed on overripe or fermenting fruit (Common 1990).	No
Xylena formosa (Butler, 1878) [Noctuidae]	Cutworm	Yes (MAFF 1990)	No (Nielsen *et al.* 1996)	No – Adults feed on the sap from citrus trees (MAFF 1990).	No
Zamacra juglansiaria Graeser, 1888 [Geometridae]		Yes (MAFF 2003)	No (Nielsen *et al.* 1996)	No – Larvae eat leaves of walnut, elm, beech and rose (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Orthoptera (crickets; grasshoppers; katydids)					
Atractomorpha lata (Motschulsky, 1866) [Syn.: *Atractomorpha bedeli*, Bolivar, 1884] [Pyrgomorphidae]	Smaller long-headed locust	Yes (MAFF 2003)	No (Rentz 2000)	No – Pest of soybean, kidney beans, Chinese radish, Chinese cabbage, cabbage and chrysanthemum (MAFF 2003). Attacks leaves of *Solidago altissima* (Kajita 1979). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Chondracris rosea (De Geer, 1773) [Acrididae]		Yes (CAB International 2004)	No (Rentz 2000)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Gampsocleis burgeri (Haan, 1842) [Tettigoniidae]	Kirigirisu	Yes (MAFF 2003)	No (Eades and Otte 2008)	No – Pest of soy and gladiolus (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Gastrimargus transversus (Thunberg, 1815) [Acrididae]		Yes (MAFF 2003)	No (Rentz 2000)	No – Pest of foxtail millet, Chinese millet, barnyard millet, and sugar cane (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Holochlora japonica (Brunner v. Wattenwyl, 1878) [Tettigoniidae]	Japanese broadwinged katydid	Yes (MAFF 1990)	No (Eades and Otte 2008)	No – Associated with young shoots of citrus (MAFF 1990). *Holochlora* spp are phytophagous (Muralirangan 1979).	No
Holochlora longifissa (Matsumura and Shiraki, 1908) [Tettigoniidae]	Bush cricket	Yes (MAFF 1990)	No (Eades and Otte 2008)	No – Associated with leaves of citrus (MAFF 1990). *Holochlora* spp are phytophagous (Muralirangan 1979).	No
Ornebius kanetataki (Matsumura, 1904) [Gryllidae]	Fruit cricket	Yes (MAFF 1990)	No (Eades and Otte 2008)	Yes – Associated with leaves, twigs and fruits of citrus (MAFF 1990).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Oxya japonica (Thunberg, 1815) [Acrididae]	Short winged grasshopper	Yes (Itoh and Ichikawa 1995)	Yes (Rentz 2000; AICN 2008)		No
Parapodisma spp. [Acrididae]	Grasshopper	Yes (MAFF 1990)	No (Rentz 2000)	No – Associated with leaves of citrus (MAFF 1990).	No
Patanga japonica (Bolivar, 1898) [Acrididae]	Grasshopper	Yes (MAFF 1990)	No (Rentz 2000)	No – Associated with buds of citrus (MAFF 1990).	No
Phaulula gracilis (Brunner von Wattenwyl, 1891) [Tettigoniidae]	Bush cricket	Yes (MAFF 1990)	No (Eades and Otte 2008)	No – Feeds on leaves of citrus (MAFF 1990). Although this pest is listed on the MAFF (1990) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Teleogryllus emma (Ohmachi and Matsuura, 1951) [Gryllidae]	Emma field cricket	Yes (MAFF 1990)	No (Eades and Otte 2008)	No – Associated with twigs, young shoots and leaves of citrus (MAFF 1990).	No
Tettigonia orientalis Uvarov, 1924 [Tettogoniidae]		Yes (MAFF 2003)	No (Eades and Otte 2008)	No – Pest of barley, tobacco, dahlia and narcissus (MAFF 2003). Although this pest is listed on the MAFF (2003) pest list, there is no confirmation of it being on unshu mandarin or fruit of unshu mandarin.	No
Thysanoptera (thrips)					
Acallurothrips nogutii (Kurosawa, 1993) [Phlaeothripidae]		Yes (Okajima 1993; MAFF 2003)	No (Mound 2001)	No – fungus feeder, found on dead branches (Okajima 1993).	No
Chaetanaphothrips orchidii (Moulton, 1907) [Thripidae]	Citrus rust thrips	Yes (Kudo 1985)	Yes (Smith *et al*., 1997; APPD 2008) Not present in WA (DAFWA 2008b)	Yes – Eggs are laid in fruit or leaf material. Causes rust marks on fruit between fruit or fruit/leaf contact points due to feeding damage (Smith *et al*. 1997). No records of this species on citrus in Japan.	Yes (for WA)

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Frankliniella intonsa (Trybom, 1895) [Thripidae]	Intonsa flower thrips	Yes (MAFF 1990)	No (Mound 2001)	Yes – *F. intonsa* has been found on the fruit of citrus species in Taiwan (Chiu *et al.* 1991).	Yes
Frankliniella occidentalis (Pergande, 1895) [Thripidae]	Western flower thrips	Yes (MAFF 1990)	Yes (Mound 2001). Under official control in Tas. and the NT (NTDPIFM 2008; DPIWTas 2008).	Yes – Polyphagous, attacks flowers of several species, and scars the surface of *Prunus* fruit (OEPP/EPPO 1989). It may lay eggs in young fruit, and citrus is listed as a host (CAB International 2004). Eggs are oviposited in the peel of unshu mandarin (Tsuchiya *et al.* 1995).	Yes (for NT and Tas.)
Haplothrips chinensis Priesner, 1933 [Phlaeothripidae]	Rose thrips	Yes (MAFF 1990)	No (Mound 2001)	No – Associated with flowers of citrus (MAFF 1990). Is a pest of vegetable crops in Korea (Woo 1988).	No
Heliothrips haemorrhoidalis (Bouché, 1833) [Thripidae]	Greenhouse thrips	Yes (MAFF 1990)	Yes (Mound 2001)		No
Megalurothrips distalis (Karny, 1913) [Thripidae]	Thrips	Yes (MAFF 1990)	No (Mound 2001)	No – Associated with flowers of citrus (MAFF 1990). Damages buds of flowers of many leguminous plants (Ananthakrishnan 1993).	No
Microcephalothrips abdominalis (Crawford, 1910) [Thripidae]	Composite thrips	Yes (Nakao 1999)	Yes (APPD 2008; DAFWA 2008a)		No
Pseudodendrothrips mori (Niwa, 1908) [Thripidae]	Mulberry thrips	Yes (Miyazaki and Kudo 1989)	Yes (Mound 2001; DAFWA 2008a)		No
Scirtothrips dorsalis (Hood, 1919) [Thripidae]	Yellow tea thrips	Yes (MAFF 1990)	Yes (Mound 2001)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Thrips coloratus (Schmutz, 1913) [Syn.: *Thrips japonicus* Bagnall, 1914] [Thripidae]	Loquat thrips	Yes (MAFF 1990)	Yes (Mound 2001). Not present in WA (DAWA 2003a).	No – Associated with flowers of citrus. Highly unlikely to be on the fruit pathway (DAWA 2003a).	No
Thrips flavus (Schrank, 1776) [Thripidae]	Honeysuckle thrips	Yes (MAFF 1990)	No (Mound 2001)	No – Associated with flowers of citrus (MAFF 1990) and flowers, leaves and shoots of cucurbits (Wen and Lee 1982).	No
Thrips hawaiiensis (Morgan, 1913) [Thripidae]	Flower thrips	Yes (MAFF 1990)	Yes (Mound 2001)		No
Thrips palmi Karny, 1925 [Thripidae]	Melon thrips	Yes (MAFF 1990)	Yes (Mound 2001). SA, Tas., NT and WA apply quarantine restrictions for movements of melon thrips hosts (Plant Diseases Regulations WA 1989; NTDPIFM 2008; PIRSA 2006; DPIWTas 2008)	Yes – High population numbers may cause a silvery or bronzed appearance on plant surfaces, especially on the midrib and veins of leaves and on the surface of fruit (CAB International 2007). Associated with leaves, flowers (Mound 1996) and fruit (Nakazawa 1981), although it feeds primarily on leaves (Lewis 1997). In Japan, damage caused by *T. palmi* has been described as yellowing of the leaves, topping, scratches on the fruits, malformation of the fruits and poor fruiting (Nakazawa 1981), and citrus is listed as a host (CAB International 2007).	Yes (for SA, Tas., NT, WA)
Thrips setosus Moultan, 1928 [Thripidae]		Yes (Sakurai *et al.* 2004)	No (Mound 2001)	No – In Korea this pest is known to affect the leaves and roots of citrus (USDA 2002).	No
Thrips tabaci (Lindemann, 1888) [Thripidae]	Onion thrips	Yes (MAFF 1990)	Yes (Mound 2001)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
PATHOGENS					
BACTERIA					
Candidatus Liberibacter asiaticus Jagouexi *et al.* 1994 [*Candidatus* Liberobacter asiaticum]	Citrus greening (Huanglongbing) disease	Yes (MAFF 1990)	No (da Graca 1991; Bellis *et al.* 2005)	No – Although this pathogen infects the whole tree including leaves, fruit and roots, and is restricted to the phloem (da Graca 1991; Garnier and Bové 2000), it is not present on Honshu Island (MAFF 2003; Appendix E).	No
Pseudomonas syringae pv. *syringae* van Hall 1902	Black pit	Yes (Bradbury 1986)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Rhizobium radiobacter (Smith and Townsend, 1907) Young *et al.* 2001 [Syn.: *Agrobacterium tumefaciens* (Smith and Townsend, 1907) Conn 1942]		Yes (CAB International 2004)	Yes (Sampson and Walker 1982; Cook and Dube 1989; Shivas 1989)		No
Xanthomonas citri subsp. *citri* (*ex* Hasse) Gabriel *et al.* 1989 [Syn.: [*Xanthomonas axonopodis* pv. *citri* (Hasse 1915) Vauterin *et al.* 1995; *Xanthomonas campestris* pv. *citri* (Hasse 1915) Dye 1978]	Asiatic citrus canker	Yes (MAFF 1990)	Yes, under official control (QDPIF 2006a)	Yes – Infects twigs, leaves and fruit of citrus trees and reproduces in lesions on leaves, stems and fruits (Schubert *et al.* 2001).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
FUNGI					
Alternaria alternata (Fr.) Keissl. [Anamorphic Pleosporaceae]	Alternaria leaf spot	Yes (SBML 2007) No evidence of other *Alternaria* species are known to occur in Japan on citrus, such as *A. alternaria* pv. *citri* and any of the ten recently described *Alternaria* species by Simmons (1999) was found.	Yes (Shivas 1989; APPD 2007)		No
Alternaria citri Ellis & N. Pierce [Anamorphic Pleosporaceae]	Fruit rot, Black rot, Alternaria rot	Yes (MAFF 1990) No evidence of other *Alternaria* species are known to occur in Japan on citrus, such as *A. alternaria* pv. *citri* and any of the ten recently described *Alternaria* species by Simmons (1999) was found.	Yes (Shivas 1989; APPD 2007)		No
Alternaria pellucida E. G. Simmons		Yes (ATCC 2008; Farr *et al.* 2008; CABI Bioscience 2008)	No (No records found)	Yes – The fungus has been found on Japanese unshu mandarin fruit (ATCC 2008; Farr *et al.* 2008; CABI Bioscience 2008).	Yes
Armillaria mellea (Vahl) P. Kumm. [Pterulaceae]	Armillaria root rot	Yes (MAFF 1990)	Yes (Knorr 1965; Shivas 1989; Graham 2000)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Ascochyta pisi Lib. [Anamorphic Mycosphaeraceae]	Freckle	Yes (Timmer 2000c)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Aspergillus niger Tiegh. [Anamorphic Dothioraceae]	Aspergillus rot	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Athelia rolfsii (Curzi) C. C. Tu & Kimbr. Anamorph: *Sclerotium rolfsii* (Sacc.) [Atheliaceae]	Damping off	Yes (MAFF 1990)	Yes (Shivas 1989; APPD 2007)		No
Aureobasidium pullulans (de Bary) G. Arnaud	Fruit rot, core rot	Yes (MAFF 1990)	Yes (Shivas 1989; APPD 2007)		No
Botryosphaeria dothidea (Moug.) Ces. & De Not. [Syn.: *Dothiorella gregaria* Sacc.] [Botryosphaeraceae]	Stem-end rot	Yes (Graham and Menge 2000)	Yes (APPD 2007), including WA (Barber *et al.* 2005).		No
Botryosphaeria ribis Grossenb. & Duggar [Botryosphaeraceae]		Yes (CAB International 2004)	Yes, including WA (APPD 2007)		No
Botrytis cinerea Pers. [Anamorphic Sclerotiniaceae]	Botrytis blight; Gray mould	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Capnodium citri Berk. & Desm., [Syn.: *Capnodium salicinum* Mont.] [Capnodiaceae]	Sooty mould	Yes (MAFF 1990)	Yes (APPD 2007). Not present in WA (DAWA 2003a)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Capnodium fuliginodes Rehm [Capnodiaceae]	Sooty mould	Yes (MAFF 1990)	Yes (APPD 2007)		No
Cercospora penzigii Sacc. [Syn.: *C. fumosa* Penz.] [Anamorphic Mycosphaerellaceae]	Sweet orange leaf spot	Yes (Timmer 2000c)	No (No records found)	No – Causes leaf spot on sweet orange in Japan (Timmer 2000c).	No
Chaetoscorias vulgaris W. Yamam. [Capnodiaceae]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Chaetothyrium javanicum (Zimm.) Boedijin [Syn.: *Phaeosaccardinula javanica* (Zimm.) W. Yamam.] [Chaetothyriaceae]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Cochliobolus lunatus R. R. Nelson and Haasis [Anamorph: *Curvularia lunata* (Wakk.) Boedijn. [Pleosporaceae]	Leaf spot	Yes (SBML 2007)	Yes (Shivas 1989; APPD 2007)		No
Cochliobolus tuberculatus Silvan. [Pleosporaceae]	Leaf spot	Yes (Sivanesan 1990)	Yes, but no record for WA (APPD 2007)	No – inor pest causing leaf spot. Fruit rot only noted in guava, but not in citrus (Sivanesan 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Colletotrichum acutatum J.H. Simmonds [Anamorphic Glomerellaceae]	Anthracnose	Yes (JSCC 2007). For information; the strain of *C. acutatum* that causes postbloom fruit drop is not known to occur in Japan (Timmer 2000d).	Yes (Shivas 1989; APPD 2007)		No
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. [Teleomorph: *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk [Glomerellaceae]]	Anthracnose	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Corticium koleroga (Cooke) Höhn. [Syn.: *Pellicuaria koleroga* Cooke] [Corticiaceae]	Thread blight	Yes (Ito 1958)	No (No records found)	Yes – Associated with twigs, fruit and leaves of citrus trees (Timmer 2000b). In Japan it is reported on *Gingko biloba* (Ito 1958) but according to Farr *et al.* (2008), citrus species are hosts.	Yes
Cylindrocladium citri (H. S. Fawc. & Klotz) Boedijn & Ritz. Bos [Nectriaceae]	Decay of citrus fruit	Yes (Crous and Wingfield 1993)	No (No records found).	No – Causes decay of citrus fruit which would not be packed for export. Decay of citrus fruit caused by this fungus has only been observed in the USA. (Crous and Wingfield 1993). and the single report of this fungus in Japan is from forest soils (Farr *et al.* 2008). Fungus reproduces by conidia and chlamydospores. Transmitted by wind and splash dispersal (Crous and Wingfield 1993).	No
Diaporthe citri F.A. Wolf Anamorph: *Phomopsis citri* H. Fawc. [Diaporthaceae]	Melanose	Yes (MAFF 1990)	Yes, including WA (APPD 2007)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Diaporthe medusaea Nitschke Anamorph: *Phomopsis rudis* (Fr.:Fr.) Höhn. [Diaporthaceae]	Gummosis	Yes (MAFF 1990)	Yes (APPD 2007). Not present in WA (DAWA 2003a)	Yes – Small, brown to reddish-brown pustules are present on the surface of citrus fruit (MAFF 1990)	Yes (WA only)
Erythricium salmonicolor (Berk. & Broome) Burdsall [Phanerochaetaceae]	Pink disease	Yes (MAFF 1990)	Yes, but not in WA (Mayers and Persley 1993; DAWA 2003a; APPD 2007)	No – Associated with stems, twigs and branches of citrus (MAFF 1990; Mayers and Persley 1993).	No
Fusarium lateritium Nees Teleomorph: *Gibberella baccata* (Wallr.) Sacc. [Nectriaceae]	Bud blight	Yes (Ueno *et al.* 1977; Saito and Matuo 1982)	Yes (Shivas 1989; APPD 2007)		No
Fusarium oxysporum Schltdl. [Anamorphic Nectriaceae]	Fusarium rot	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Fusarium solani (Mart.) Sacc. Teleomorph: *Haematonectria haematococca* (Berk. & Broome) Samuels & Rossman [Nectriaceae]	Collar rot	Yes (MAFF 1990)	Yes (Shivas 1989; APPD 2007)		No
Ganoderma applanatum (Pers.) Pat. [Ganodermacaceae]	Stem heart rot	Yes (MAFF 1990)	No (May *et al.* 2003)		No
Geotrichum candidum Link [Anamorphic Dipodascaceae]	Sour rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007).		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Geotrichum candidum var. *citri-aurantii* (Ferraris) Cif. & F. Cif. [Anamorphic Dipodascaceae]	Sour rot	Yes (MAFF 1990)	Yes (Pitkethley 1998), including WA (Shivas 1989)		No
Gibberella fujikuroi (Sawada) Wollenw. Anamorph: *Fusarium moniliforme* J. Sheld. [Nectriaceae]		Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Gloeodes pomigena (Schwein.) Colby Teleomorph: *Phyllachora pomigena* (Schwein.) Sacc. [Phyllachoraceae]	Sooty blotch	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Guignardia citricarpa Kiely [Syn.: *Phoma erratica* var. *mikan* Hara] Anamorph: *Phoma citricarpa* McAlpine var. *mikan* Hara [Botryosphaeriaceae]	Citrus black spot	Yes (MAFF 1990)	Yes (subtropical areas of Australia, including Qld, NSW, NT) (APPD 2007) and listed as *Phyllosticta citricarpa* for WA (Shivas 1989). Regulated pest for SA.	Yes – Fungus can be present on fruit (CAB International 2007).	Yes (SA)
Helicobasidium mompa Tanaka [Hellicobasidiaceae]	Violet root rot	Yes (MAFF 1990)	No (No records found)	No – Associated with roots and stems of citrus (Knorr 1973; MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Hyocapnodium japonicum (Hara) W. Yamam. [Syn.: *Limacinia japonicum* Hara] [Incertae sedis]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. [Anamorphic Hellicobasidiaceae]	Stem end rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Leptoxyphium axillatum (Cooke) S. Hughes [Syn.: *Capnodium axillatum* Cooke] [Capnodiaceae]	Sooty mould	Yes (Rodriguez *et al.* 2002)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Limacinia harae W. Yamam. [Incertae sedis]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Macrophomina phaseolina (Tassi) Goid [Anamorphic Mycosphaerellaceae]	Charcoal root rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Meliola butleri Syd. & P. Syd. [Meliolaceae]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Mycosphaerella citri Whiteside Anamorph: *Stenella citri-grisea* (F.E. Fisher) Sivan. [Mycosphaerellaceae]	Greasy spot	Yes (CAB International 2004)	Yes (CAB International 2004; APPD 2008)		No)
Mycosphaerella horii Hara [Mycosphaerellaceae]	Grey leaf spot	Yes (MAFF 1990)	No (No records found)	No – The fungus causes a grey leaf spot of citrus in Japan (Wellings 1981; Timmer and Gottwald 2000).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Mycosphaerella pinodes (Berk. and A. Bloxam) Vestergr. Anamorph: *Ascochyta pinodes* L.K. Jones [Mycosphaerellaceae]	Leaf blight	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Neocapnodium tanakae (Shirai & Hara) W. Yamam. [*Capnodium tanakae* Shirai & Hara] [Capnodiaceae]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Penicillium digitatum (Pers.) Sacc. [Anamorphic Trichocomaceae]	Green mould	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Penicillium fructigenum Takeuchi [Anamorphic Trichocomaceae]	Fruit rot	Yes (Fawcett 1936; USDA 1995)	No (No records found)	Yes – Causes fruit rot in citrus in Japan (Fawcett 1936; USDA 1995).	Yes
Penicillium italicum Wehmer [Anamorphic Trichocomaceae]	Blue mould	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Phoma pinodella (L.K. Jones) Morgan-Jones and K.B. Burch [Anamorphic Leptospheriaceae]	Freckle	Yes (Timmer 2000c)	Yes (APPD 2007)		No
Phomopsis spp. [Diapothaceae]	Stem-end rot	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989)		No
Phyllosticta beltranii Penz. [Anamorphic Botryosphaeriaceae]	Leaf spot	Yes (MAFF 1990)	No (No records found)	No – On leaves. Leaf symptoms are small necrotic spots with a grey centre surrounded by a yellow halo (MAFF 1990).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Phyllosticta erratica Ellis & Everh. [Anamorphic Botryosphaeriaceae]	Leaf spot	Yes (MAFF 1990)	No (No records found)	No – The genus *Phyllosticta* is associated with citrus leaves (Timmer 2000c).	No
Rhizoctonia solani J.G. Kühn Teleomorph: *Thanatephorus cucumeris* (A.B. Frank) Donk [Ceratobasidiaceae]	Root rot	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Rosellinia necatrix Berl. ex Prill. Anamorph: *Dematophora necatrix* R. Hartig [Xylariaceae]	White root rot	Yes (MAFF 1990)	Yes (Shivas 1989; APPD 2007)		No
Schizothyrium pomi (Mont. & Fr.) Arx [Schizothyriaceae]	Fly speck	Yes (MAFF 1990)	Yes (Shivas 1989; APPD 2007)		No
Sclerotinia sclerotiorum (Lib.) de Bary [Sclerotiniaceae]	Cottony rot, Twig blight	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Scorias citrina (Hara) W. Yamam. [Syn.: *Antennella citrina* Hara] [Capnodiaceae]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Septobasidium pseudopedicellatum Burt [Septobasidiaceae]	Felt	Yes (USDA 1995)	No (No records found). Not present in WA (DAWA 2003a)	No – Associated with twigs (Whiteside 2000). Not associated with unshu fruit (USDA 1995).	No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Sphaceloma fawcettii Jenkins Teleomorph: *Elsinoë fawcetti* Bitancourt & Jenkins [Elsinoaceae]	Citrus scab	Yes – Pathotype present in Japan has not been identified (MAFF 1990)	Yes. The lemon and Tryon's pathotypes occur in eastern Australia (Tan *et al*. 1996). Not in WA (APPD 2007)	Yes – Associated with fruit, leaves and stems of citrus (MAFF 1990). Affects many varieties of citrus including mandarins and fruit is liable to carry the pest in trade/transport (CAB International 2007)	Yes
Sporobolomyces roseus Kluyver & C.B. Niel [Anamorphic Sporidiales]	Pseudo greasy spot	Yes (MAFF 1990)	Yes (Lamb and Brown 1970; APPD 2007). Not present in WA (DAWA 2003a).	No – Infects leaves of citrus (MAFF 1990).	No
Thielaviopsis basicola (Berk. & Broome) Ferraris [Anamorphic Ceratocystidaceae]	Black root rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Triposporiopsis spinigera (Höhn.) W. Yamam. [Capnodiaceae]	Sooty mould	Yes (MAFF 1990)	No (No records found)	Yes – Sooty mould fungi are found superficially on plant parts including fruit, growing on honey dew secretions of insects (Laemmlen 2003; Baker *et al.* 2008).	Yes
Straminopila					
Phytophthora citrophthora (R.E. Sm. & E.H. Sm.) Leonian [Pythiaceae]	Brown rot	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No
Phytophthora nicotianae Breda de Haan [Pythiaceae]	Black shank	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Shivas 1989; APPD 2007)		No

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Pythium aphanidermatum (Edson) Fitzp. [Pythiaceae]	Root rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Pythium irregulare Buisman [Pythiaceae]	Root rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
Pythium splendens Hans Braun [Pythiaceae]	Root rot	Yes (CAB International 2004)	Yes (Shivas 1989; APPD 2007)		No
VIRUSES					
Citrus leaf rugose virus [Genus: *Ilarvirus*]	Citrus leaf rugose	Yes (MAFF 1990)	Yes (Brunt *et al.* 1996). Not present in WA (DAWA 2003b).	Yes – Fruits of infected trees are small and lumpy (Brunt *et al.* 1996).	Yes (for WA only)
Citrus psorosis virus [Genus: *Ophiovirus*]	Psorosis complex	Yes (CMI 1984)	Yes (Fraser and Broadbent 1979; Cook and Dube 1989). Not present in WA (DAWA 2003b).	Yes – Graft-transmitted disease (Derrick and Barthe 2000). Therefore if the plant is infected the virus may enter the fruit via phloem.	Yes (for WA only)
Apple stem grooving virus (Syn: Citrus tatter leaf virus) [Genus: *Capillovirus*]	Tatter leaf and citrange stunt	Yes (MAFF 1990)	Yes (Brunt *et al.* 1996). Not present in WA (DAWA 2003b).	Yes – Graft-transmitted virus (MAFF 1990; Miyakawa and Ito 2000). Although generally associated with leaves, buds and trunk (MAFF 1990; Miyakawa and Ito 2000) the virus may enter the fruit via phloem.	Yes (for WA only)

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
Citrus tristeza virus (Syn: Hassaku dwarf virus) [Genus: *Closterovirus*]	Citrus quick decline	Yes (MAFF 1990)	Yes (Cook and Dube 1989; Brunt *et al.* 1996). Two sweet orange stem pitting strains restricted only to Queensland and are under official control in other States including WA (DAWA 2003a; PHA 2004b).	Yes – Disease is readily graft-transmitted (Lee and Bar-Joseph 2000) and if the plant is infected the virus may enter the fruit via phloem.	Yes
Citrus enation – woody gall virus	Vein enation	Yes (MAFF 1990)	Yes (Brunt *et al.* 1996). Not present in WA (DAWA 2003b).	Yes – Transmitted by insect vectors and grafting (Brunt *et al.* 1996). Although generally associated with leaves and stems (MAFF 1990) it may enter the fruit via phloem.	Yes (for WA only)
Citrus yellow mottle associated virus	Citrus yellow mottle disease	Yes (MAFF 1990)	No (No records found)	Yes – Graft transmissible agent (Garnsey 2000). Therefore if the plant is infected the virus may enter the fruit via phloem.	Yes
Satsuma dwarf virus (Syn: Citrus mosaic virus, natsudaidai dwarf virus, navel orange infectious mottling virus). (Genus: *Sadwavirus*)	Satsuma dwarf	Yes (MAFF 1990); Citrus mosaic strain of this virus has been reported only from Japan and is widespread and increasing in importance there (EPPO 2005).	No (EPPO 2005)	Yes — Graft transmitted disease. The citrus mosaic strain of this virus produces symptoms on fruits. On satsumas, these are green blotches or ring shaped spots on the rind at colour break and delayed colouring of the spotted area (MAFF 1990; Iwanami and Koizumi 2000; EPPO 2005).	Yes

Pest	Common name	Present in Japan	Present in Australia	Presence on fresh unshu mandarin fruit	Consider further
VIROIDS					
Citrus bent leaf viroid (Genus: *Apscaviroid*)		Yes (Ito *et al.* 2002)	No–Presence in WA unknown (DAWA 2003a)	Yes – Graft transmissible (Ashulin *et al.* 1991). Therefore if the plant is infected the viroid may enter the fruit via phloem.	Yes
Citrus exocortis viroid (Genus: *Pospiviroid*)	Exocortis	Yes (MAFF 1990)	Yes, (Cook and Dube 1989; Duran-Vila *et al.* 2000b). Not present in WA (DAWA 2003b).	Yes– – Graft transmissible (Duran-Vila *et al.* 2000b). Therefore if the plant is infected the viroid may enter the fruit via phloem.	Yes (for WA only)
Citrus viroid III (Genus: *Apscaviroid*)		Yes (Ito *et al.* 2002)	No–Presence in WA unknown (DAWA 2003a)	Yes – Graft transmissible (Najar and Duran-Vila 2004). Therefore if the plant is infected the viroid may enter the fruit via phloem.	Yes
Citrus viroid IV (Genus:*Cocadviroid*)		Yes (Ito *et al.* 2002)	No–Presence in WA unknown (DAWA 2003a)	Yes – Graft transmissible (Najar and Duran-Vila 2004). Therefore if the plant is infected the viroid may enter the fruit via phloem.	Yes
Citrus viroid original source (Genus: *Apscaviroid*)		Yes (Ito *et al.* 2002)	No–Presence in WA unknown (DAWA 2003a)	Yes – Graft transmissible (Vernière *et al.* 2004). Therefore if the plant is infected the viroid may enter the fruit via phloem.	Yes
Hop stunt viroid (Genus: *Hostuviroid*)	Cachexia	Yes (Shikata 1990)	Yes (CAB International 2004). Not present in WA (DAWA 2003b).	Yes – Graft-transmitted (Duran-Vila *et al.* 2000a). Therefore although generally associated with leaves (Momma and Takahashi 1982; Roy and Ramachandran 2003) the viroid may enter the fruit via phloem. The citrus type Hop stunt viroid has been isolated from the fruit peel of Etrog citron (Shikata 1990).	Yes (for WA only)

Appendix A 2: Potential for establishment or spread and associated consequences for pests of fresh unshu mandarin fruit from the production area

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
ARTHROPODS						
ACARI (mites)						
Aculops pelekassi [Eriophyidae]	Pink citrus rust mite	Feasible	Citrus varieties are the only known hosts (Childers *et al.* 2004) and this species has a high reproductive rate (Seki 1981). The mites congregate at leaf edges (Futch *et al.* 2001) and so are easily distributed by wind.	Significant	Fruit damage is the main concern, although the mite also damages leaves and stems (Childers *et al.* 2004). It is considered to be of major economic importance in humid citrus-growing regions of the world (McCoy 1996).	Yes
Panonychus citri [Tetranychidae]	Citrus red mite	Feasible	Wide host range (CAB International 2004) and already established in Australia, being restricted to the central coast of NSW, where it is subject to quarantine restrictions (Smith *et al.* 1997).	Significant	Considered an economically important and widespread pest of citrus crops (CAB International 2004).	Yes (absent from WA, under official control in NSW)

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
INSECTA (insects)						
Diptera (true flies, mosquitoes)						
Bactrocera tsuneonis [Tephritidae]	Japanese orange fly	Feasible	Infests fruits within *Citrus* spp. (White and Elson-Harris 1994).	Significant	Serious and widespread pest of citrus in subtropical areas of Japan, Taiwan, Vietnam, China (Zhang 1989; White and Elson-Harris 1994; EPPO 2007) requiring control measures where it occurs (Wang *et al.* 1990; Zhang 1989). Male flies are non-lure responsive (White and Elson-Harris 1994).	Yes
Limonia amatrix (Alexander, 1922) [Tipulidae]	Citrus crane fly	Feasible	The host range for this species is unknown apart from feeding on *Citrus unshiu*. However other *Citrus* spp. are wide spread in Australia and similar climatic conditions exist between the designated export areas in Japan and Australia.	Not significant	No evidence could be found of economic or environmental damage due to this species.	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Hemiptera (aphids; leafhoppers; mealybugs; psyllids; scales; true bugs; whiteflies)						
Andaspis hawaiiensis [Diaspididae]	Armoured scale	Feasible	One record of this scale species (a few specimens) affecting leaves and fruit in Western Samoa (Williams and Watson 1988). Williams and Watson (1988) report that this species was found on numerous other plant species, including *Falcataria mollucana* (syn. *Albizia falcataria*).	Not significant	Economically not significant.	No
Howardia biclavis [Diaspididae]	Mining scale	Feasible	Wide host range (Williams and Watson 1988) including several garden ornamentals (Zimmerman 1948), high reproductive rate (Beardsley and Gonzalez 1975) and already established in eastern Australia on various hosts. Long distance dispersal occurs by passive transport of infested plant material (Tenbrink and Hara 1994).	Significant	Mining scale feeds on plant sap causing loss of vigour, deformation of infested plant parts, loss of leaves, and sometimes death of the plant (Beardsley and Gonzalez 1975). Listed as a serious and widespread pest (Miller and Davidson 1990).	Yes (for WA, SA)

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Ischnaspis longirostris [Diaspididae]	Black thread scale	Feasible	This species has a wide host range (Williams and Watson 1988) and is already established in Queensland (APPD 2008). Can be dispersed by wing and plant material (Beardsley and Gonzalez 1975).	Significant	Considered an important pest in Malaysia, Brazil and the USA (Watson 2005).	Yes (for WA)
Lepidosaphes gloverii [Diaspididae]	Glover scale	Feasible	Wide host range, although most commonly found on citrus (Williams and Watson 1988) and already established in New South Wales and Queensland (Smith *et al.* 1997). Can be easily dispersed by wind and plant material (Williams and Watson 1988).	Significant	Heavy infestation can cause a delay in the development of colour in maturing fruit (Bruwer 1998).	Yes (for SA)
Lepidosaphes pinnaeformis [Diaspididae]	Purple scale	Feasible	Wide host range, including commercial fruit trees (*Pyrus, Prunus, Citrus*). Already established in New South Wales, Queensland, Victoria (APPD 2008) and Tasmania (Ben-Dov *et al.* 2005).	Significant	Heavy infestation on the fruit can lead to yield loss, distortion and discolouration.	Yes (for WA)

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Lopholeucaspis japonica [Diaspididae]	Pear white scale	Feasible	Polyphagous pest whose main crop hosts are species of citrus (CAB International 2004). Easily dispersed by wind, birds, or fruit pickers (Williams and Watson 1988).	Significant	Attacks all citrus severely and trees are killed by heavy infestations (CAB International 2004). It has caused serious problems on satsumas (*Citrus unshiu*), mandarins and lemons in Azerbaijan and Georgia (CAB International 2004).	Yes
Morganella longispina [Diaspididae]	Plumose scale	Feasible	Polyphagous pest of citrus and many other commercial and ornamental hosts (Ben-Dov *et al.* 2005; CAB International 2007). Already established on the east coast of Australia (APPD 2007).	Significant	Williams and Watson (1988) informed on damage caused by this species to grapefruit, lemon, and fig in Tahiti.	Yes (for WA, SA)
Parlatoria cinerea [Diaspididae]	Armoured scale	Feasible	Wide host range, although most commonly found on citrus. Can be easily dispersed by wind and plant material (Williams and Watson 1988).	Significant	Williams and Watson (1988) record this species as a common pest on the stems, branches, leaves and fruit of citrus. Branches often die and sometimes the entire tree can perish (Williams and Watson 1988).	Yes
Parlatoria pergandii [Diaspididae]	Chaff scale	Feasible	Restricted host range most commonly found on citrus (Williams and Watson 1988) and already established in Queensland (Smith *et al.* 1997); easily dispersed by wind and plant material (Williams and Watson 1988).	Significant	Causes green spot on fruit making them unsuitable for the fresh market (Cartwright and Browning 2003). Listed as a serious and widespread pest (Miller and Davidson 1990).	Yes (for WA, SA)

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for economic consequences**		**Consider pest further**
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Parlatoria theae Cockerell, 1896 [Diaspididae]	Tea parlatoria scale	Feasible	Wide host range (Watson 2005). Can be dispersed by wing and plant material (Beardsley and Gonzalez 1975).	Significant	This species is an important pest of camellia in the USA and a pest of apple in the Republic of Georgia and Turkey (Watson 2005).	Yes
Parlatoria ziziphi [Diaspididae]	Black parlatoria scale	Feasible	Feeds almost exclusively on citrus and is rarely recorded on other hosts. It has established in the USA. This species attaches firmly to the fruit and so can disperse with product movement (Fasulo and Brooks 2004).	Significant	High numbers of scales can adhere strongly to the fruit, making it unsightly and unsaleable in fresh fruit markets (Fasulo and Brooks 2004). Scales have been intercepted by AQIS inspectors on citrus fruit imported from California into Australia.	Yes
Planococcus kraunhiae [Pseudococcidae]	Japanese mealybug	Feasible	Wide host range, including several ornamentals (Narai and Murai 2002; Ben-Dov *et al.* 2005). Between two and three generations per annum occur in Japan (USDA 1995). Long distance dispersal is by wind and movement of plant material (USDA 1995).	Significant	This species is a significant pest of mandarins. Satsuma mandarins from Japan require methyl bromide fumigation for this pest for export to the US (Misumi *et al.* 1994; USDA 1995). It is also a serious pest of pear and persimmon (Tanaka and Kobayashi 1971; Park and Hong 1992)	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Planococcus lilacinus [Pseudococcidae]	Coffee mealybug	Feasible	Wide host range including several garden ornamentals (Ben-Dov *et al.* 2005); easily dispersed by wind and plant material (Williams and Watson 1988).	Significant	This species is a serious pest of cocoa (Cox 1989) causing severe damage to young trees by killing the tips of branches. It is such an important pest of coffee, cocoa, custard apples, coconuts and mandarins in parts of India that chemical control is warranted (Ben-Dov 1994; CAB International 2004).	Yes
Pseudaonidia duplex [Diaspididae]	Camphor scale	Feasible	Wide host range (Ben Dov *et al.* 2005) and suitable climate present in the PRA area. Easily dispersed by wind, plant material or fruit pickers (Williams and Watson 1988).	Significant	Attacks all parts of *Citrus* species, including leaves, branches and fruit (Jeppson 1989; Kim *et al*. 2000; Watson 2005).	Yes
Pseudaonidia trilobitiformis [Diaspididae]	Trilobite scale	Feasible	Wide host range (Williams and Watson 1988) and suitable climate present in PRA area. Easily dispersed by wind, plant material or fruit pickers (Williams and Watson 1988).	Significant	This species affects the trunks, leaves and fruit of hosts (Pantoja and Peńa 2006), including *Citrus maxima* (Morton 1987).	Yes (for WA, SA)
Pseudococcus comstocki [Pseudococcidae]	Comstock mealybug	Feasible	Wide host range (Ben-Dov *et al.* 2005) and high reproductive rate (Meyerdirk and Newell 1979).	Significant	Capable of causing serious economic losses in several horticultural crops (Murakami *et al.* 1967; Bartlett *et al.* 1978; Ervin *et al.* 1983; Weires 1984; Park and Hong 1992; CAB International 2004).	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Pseudococcus cryptus [Pseudococcidae]	Citrus mealybug	Feasible	Wide host range (Ben-Dov *et al*. 2005). Easily dispersed by wind and plant material (Williams and Watson 1988).	Significant	Accidentally introduced into Israel where it became a pest of citrus (Ben-Dov 1988).	Yes
Unaspis euonymi (Comstock, 1881) [Diaspididae]	Euonymus scale	Feasible	Wide host range including many *Euonymus* spp. (Ben-Dov *et al*. 2005). Can be dispersed by wing and plant material (Beardsley and Gonzalez 1975).	Significant	Is a significant pest of *Euonymus* spp. in the USA and Turkey (Van Driesche *et al*. 1998; Van Driesche and Nunn 2003; Ozyurt and Ulgenturk 2007).	Yes
Unaspis yanonensis [Diaspididae]	Arrowhead scale	Feasible	First instar larvae can be naturally be dispersed by wind and animals. Can be dispersed internationally on citrus fruits (Cab International 2007).	Significant	Significant pest of *Citrus* species in Japan, and can kill heavily infested trees (Murakami 1970). Attacked fruits lose their commercial value because of the feeding punctures of the pest (CAB International 2007).	Yes
Lepidoptera (butterflies; moths)						
Adoxophyes dubia [Tortricidae]	Smaller tea tortrix	Feasible	The species is recorded on *Ribes* (Yasuda 1998a), *Camellia sinensis* and some other plant species (Sakamaki and Hayakawa 2004) in Japan.	Significant	*Ribes* species and *Camellia sinensis* are important commercial crops in Australia and are hosts to this pest (Yasuda 1998a; Sakamaki and Hayakawa 2004). The pest would have significant consequences on these crops if it should arrive in Australia.	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Adoxophyes honmai [Tortricidae]	Smaller tea tortrix	Feasible	Hosts include *Citrus* spp., *Camellia sinensis* (tea), *Actinidia deliciosa* (kiwi fruit) and *Quercus* spp., etc (Yasuda 1998b).	Significant	Important commercial crops like citrus, tea, grape, kiwi fruit and oak are hosts (Yasuda 1998b). The pest can have significant consequences on these crops if it should arrive in Australia.	Yes
Adoxophyes orana fasciata [Tortricidae]	Summer fruit tortrix	Feasible	Host range includes apple (CAB International 2004) and Japanese pear (Yukinari 1996). It is capable of flight between host plants and orchards (Shirasaki 1989).	Significant	It is a pest of a wide range of economic crops such as apple, pear, apricot, citrus, cherry, currants, berry fruits, etc and important tree species such as oak and willow (Davis *et al.* 2006), and is serious enough in Japan to warrant control measures such as biological control and mating disruption (Oku 1993; Sekita 1996).	Yes
Homona magnanima [Tortricidae]	Large tea tortrix	Feasible	Hosts include apple, pear, stonefruit, persimmons, tea and roses (CAB International 2007). Adults are capable longrange fliers (Shirai and Kosugi 1997)	Significant	Economically important pest. Larval feeding can severely damage foliage and young shoots which can lead to defoliation and crop loss (Takaji 1976)	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Eumeta japonica [Psychidae]	Giant bagworm	Feasible	Host range includes Fagaceae species and other ornamental plants (Zhang 1994; Robinson *et al.* 2007). High fecundity (Nishida 1983). Female Psychidae are not winged, but remain in the larval case to copulate and lay their eggs. First instar larvae spin quantities of silk, which may act as a balloon and enable the larva to be transported by wind. The larva soon constructs a small conical case of silk and plant material. Winged male adults are capable of rapid flight (Common 1990).	Significant	This species is an important pest of ornamental trees and shrubs in Japan (Nishida 1983; Zhang 1994). It is a minor pest of Japanese pear (Izawa *et al.* 2000).	Yes

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for economic consequences**		**Consider pest further**
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Eumeta minuscula [Psychidae]	Tea bagworm	Feasible	Host range includes citrus, pears, apricots, tea, persimmons, cherries (Zhang 1994). High fecundity (Nishida 1983). Female Psychidae are not winged, and remain in the larval case to copulate and lay their eggs. First instar larvae spin quantities of silk, which may act as a balloon and enable the larva to be transported by wind. The larva soon constructs a small conical case of silk and plant material. Winged male adults are capable of rapid flight (Common 1990).	Significant	This species is an important pest of ornamental trees and shrubs in Japan (Nishida 1983), and a pest of several crop species (Zhang 1994).	Yes
Stathmopoda auriferella [Oecophoridae]	Apple heliodinid	Feasible	Larvae feed on fruit, flowers and leaves of citrus (MAFF 1990). Other species of *Stathmopoda* are widely distributed in Australia, but none are fruit pests (Common 1990).	Significant	Pest of kiwifruit in Korea (Park *et al.* 1994). Pest of navel orange, mango (Badr *et al.* 1986) and grapes (APHIS 2003).	Yes
Orthoptera (crickets; grasshoppers; katydids)						
Ornebius kanetataki [Gryllidae]	Fruit cricket	Feasible	Adults occur between August and November in Japan (Hashimoto 2005). Overwinters at the egg stage (Kim 2000).	Not significant	*Ornebius kanetataki* causes shallow rind damage to citrus fruit in Japan (UEC 2002), and there is no evidence that it damages any other plant species.	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Thysanoptera (thrips)						
Chaetanaphothrips orchidii [Thripidae]	Citrus rust thrips	Feasible	Polyphagous species (Childers and Nakahara 2006) which is already established in Australia (Smith *et al*., 1997).	Significant	Considered a pest of economic importance for citrus in Florida (Childers and Nakahara 2006). Damage to citrus rind may affect marketability. Is a significant pest of *Anthurium* spp. damaging unopened buds and affecting marketability (CAB International 2007).	Yes (WA)
Frankliniella intonsa [Thripidae]	Intonsa flower thrips	Feasible	Host range includes capsicum, tomato, cotton, rice and peach (CAB International 2007). High reproductive rate - there are up to 22 generations per year, with females each laying up to 76 eggs each (Tang 1976).	Significant	Causes a medium level of damage on citrus in Korea, and control measures are considered necessary. *Frankliniella intonsa* is associated with economic damage of several crop species: asparagus, chrysanthemum, okra, tomatoes and peas. As part of a pest complex, *F. intonsa* has been associated with economic damage to strawberries in Italy and the UK, lucerne in former Czechoslovakia and nectarines in Greece (CAB International 2007).	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Frankliniella occidentalis [Thripidae]	Western flower thrips	Feasible	Very wide host range including citrus, cucurbits, strawberry, apple, wheat and grapevine (CAB International 2004). High reproductive rate (Katayama 1997), with more than one generation per year (McDonald *et al.* 1998). Adults are capable of flight (Pearsall 2002).	Significant	*Frankliniella occidentalis* is a pest of several economically important crop species (Lewis 1997; CAB International 2004). It is also a vector of plant viruses (Lewis 1997; Inoue *et al.* 2004)	Yes (NT, Tas.)
Thrips palmi [Thripidae]	Melon thrips	Feasible	Main hosts are plants in the Cucurbitaceae and Solanaceae families (CAB International 2007). Short lifecycle of about 18 days and high fecundity of up to 200 eggs per female (Wang *et al*. 1989).	Significant	It is a major pest of cucurbits and solanaceous pests in many tropical regions (CAB International 2007).	Yes (NT, SA, Tas., WA)

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
PATHOGENS						
BACTERIA						
Xanthomonas citri subsp. *citri*	Asiatic citrus canker	Feasible	Narrow host range (Schubert *et al.* 2001). May be spread by rain splash and contaminated harvesting tools.	Significant	Can cause defoliation and premature fruit-drop. Infected fruit can carry visible canker lesions with significant consequences for fruit marketing (Schubert *et al.* 2001). Economic damage to the local citrus industry could be substantial as a result of reductions in the amount of marketable fruit.	Yes
FUNGI						
Alternaria pellucida	Alternaria leaf spot	Feasible	Fugus can be associated with waste fruit or rind discarded to waste. It produces conidia (CABI Bioscience 2008) that can be wind dispersed.	Not significant	No – Although the fungus has been found on Japanese unshu mandarin fruit (ATCC 2008; Farr *et al*. 2008; CABI Bioscience 2008) its single isolation occurred in 1968. There have been no other reports including any damage or rot in fruit during the last 40 years, indicating it is of no economic significance.	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Capnodium citri	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No
Chaetoscorias vulgaris	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Chaetothyrium javanicum	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No
Corticium koleroga	Thread blight	Feasible	Coffee is the main host of this fungus (Segura *et al.* 2004). Host range in Mexico also includes apple trees (Jimenez-Fonseca and Mendoza-Zamora 1990) and pear trees (Chavez-Alfaro *et al.* 1995). Citrus species are hosts in the USA, some South American and Caribbean countries (Farr *et al.* 2008).	Not significant	On citrus, this fungus is seldom severe enough to require treatment and it is controlled with copper fungicides (Timmer 2000b). Copper fungicides are applied throughout the growing season in unshu production in Japan.	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Diaporthe medusaea	Gummosis	Feasible	This pathogen already occurs in the eastern states of Australia on *Erigeron* (Asteraceae) (APPD 2007).	Not significant	There is limited information regarding this fungus on citrus in Japan (MAFF 1990), indicating that it is of minor importance. In Japan, this fungus is recorded as being less pathogenic on citrus than *Diaporthe citri* (Yamato 1977). While present in eastern Australia, it has not been recorded on *Citrus* spp. in Australia. Sporulation of this fungus occurs on dead plant material (Yamato 1976; JCACF 2002).	No
Guignardia citricarpa	Citrus black spot	Not feasible	This fungus is of subtropical distribution (Miles *et al.* 2004). The climate in SA is not suitable for the survival and therefore establishment of this fungus in SA (Paul *et al.* 2004).			No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Hypocapnodium japonicum	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No
Leptoxyhium axillatum	Sooty mould	Feasible	Fungus is a typical component of sooty moulds on a wide range of host. It produces conidia that can be wind dispersed (Rodriguez *et al.* 2002).	Not significant	No – Although this fungus is associated with *Citrus* sp., it grows on honey dew of scale insects and is not considered a real disease of plants (Rodriguez *et al.* 2002).	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Limacinia harae	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No
Meliola butleri	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for economic consequences**		**Consider pest further**
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Neocapnodium tanakae	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No
Penicillium fructigenum	Fruit rot	Feasible	Infected fruit can be discarded into waste in Australia and *Penicillium* species produce large amounts of conidia dispersed in air (Agrios 2005).	Not significant	This pathogen is considered non-actionable in USA in spite of not being reported in that country (USDA 1995).	No
Scorias citrina	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Sphaceloma fawcettii	Citrus scab	Feasible	Attacks several varieties of citrus (Timmer 2000a). Leaves are most susceptible to infection just as they emerge from the bud, and they become immune before reaching full size. Fruit remain susceptible to infection for about three months after petal fall (Whiteside 1988).	Significant	Shoot infection can be severe enough to cause stunting of susceptible rootstock seedlings in nurseries and seedbeds. Infection of actively emerging shoot apices causes much distortion of shoots and leaves. Infection of very young fruit produces warty outgrowths on the rind (Timmer 2000a). Heavily infected fruit may drop, and those remaining on the tree may be scarred and distorted to such a degree that they become unmarketable as fresh fruit (Knorr 1973).	Yes
Triposporiopsis spinigera	Sooty mould	Feasible	Fungus is present superficially on the fruit rind discarded to waste and spores and mycelial fragments are windborne (Baker *et al.* 2008).	Not significant	Sooty mould fungi are not parasitic and only grow superficially on plant surfaces. They only lessen the aesthetic value of plant parts occasionally, or when on leaves slightly lower the vigor of plants by blocking sunlight essential for photosynthesis (Baker *et al.* 2008). USA considers sooty mould fungi not recorded in that country as non-actionable (USDA 1995).	No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Viruses						
Citrus leaf rugose virus	Citrus leaf rugose	Not feasible	Virus transmitted by grafting and mechanical inoculation (Brunt *et al.* 1996). Brunt *et al.* (1996) speculate that it is possibly seed transmitted but there is no supporting evidence. Also, although the virus is found in Australia except in Western Australia, there is no evidence of spread (Brunt *et al.* 1996). Unshu mandarins are seedless (Chapter 3). Therefore, establishment from imported fruit is unlikely.			No
Citrus psorosis virus	Psorosis complex	Not feasible	Graft-transmitted disease (Derrick and Barthe 2000). Seed and insect vectors failed to transmit the virus (Thind *et al.* 1999) Establishment of a graft-transmissible disease from imported fruit is unlikely.			No
Apple stem grooving virus	Tatter leaf and citrange stunt	Not feasible	The virus is graft-transmitted (MAFF 1990; Miyakawa and Ito 2000), and establishment in Australia through imported fruit is unlikely.			No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Citrus tristeza virus	Citrus quick decline	Not feasible	Disease is aphid and graft -transmitted (Brunt *et al.* 1996; Lee and Bar-Joseph 2000). Establishment in Australia through imported fruit is unlikely. Long distance spread between countries is by movement of infected budwood. The virus is transmitted in a non-persistent manner by its aphid vectors. Association of aphids with export fruit is unlikely. Virus is not transmitted by seed (Brunt *et al.* 1996). Unshu mandarins are seedless (Chapter 3).			No
Citrus enation – woody gall virus	Vein enation	Not feasible	Transmitted by insect vectors and grafting (Brunt *et al.* 1996), and therefore establishment through imported fruit is unlikely.			No
Citrus yellow mottle associated virus	Citrus yellow mottle disease	Not feasible	Graft transmissible agent (Garnsey 2000), so establishment through imported fruit is unlikely.			No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Satsuma dwarf virus (Citrus mosaic virus, natsudaidai dwarf virus, navel orange infectious mottling virus).	Satsuma dwarf	Not feasible	Graft-transmitted (Iwanami and Koizumi 2000), so establishment in Australia through imported fruit is unlikely. Seed transmission was reported in bush bean but not observed in other other hosts. Natural spread through an unknown soilborne vector has been observed in Japan but entry of soil with imported fruit is unlikely. Hence, establishment through imported fruit is not possible.			No
Viroids						
Citrus bent leaf viroid		Not feasible	No – Graft transmissible (Ashulin *et al.* 1991). Establishment through imported fruit is unlikely.			No
Citrus exocortis viroid	Exocortis	Not feasible	No – Graft transmissible; not vector or seed transmission; dissemination occurs principally through propagation of symptomless infected budwood (Duran-Vila *et al.* 2000b). Establishment through imported fruit is unlikely.			No
Citrus viroid III		Not feasible	No – Graft transmissible (Najar and Duran-Vila 2004). Establishment through imported fruit is unlikely.			No

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for economic consequences		Consider pest further
		Feasible/ not feasible	**Comments**	**Significant/ not significant**	**Comments**	
Citrus viroid IV		Not feasible	No – Graft transmissible (Najar and Duran-Vila 2004). Establishment through imported fruit is unlikely.			No
Citrus viroid original source		Not feasible	No – Graft transmissible (Vernière *et al.* 2004). Establishment through imported fruit is unlikely.			No
Hop stunt viroid	Cachexia	Not feasible	No – Graft transmissible (Duran-Vila *et al.* 2000a). Establishment through imported fruit is unlikely.			No

Appendix B: Additional data for quarantine pests

Quarantine pest	*Howardia biclavis* (Comstock, 1883)
Synonyms	*Chionaspis biclavis* Comstock, 1883 *Chionaspis biclavis detecta* Maskell, 1895 *Megalodiaspis biclavis* (Comstock, 1883)
Common name(s)	Mining scale
Main hosts	Associated with *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Acacia pubescens* (downy wattle), *Acalypha grandis*, *Acalypha* sp., *Achras sapota* (sapodilla), *Allamanda cathartica schottia* (yellow allamanda), *Allamanda hendersonii* (pahtoh), *Althaea* sp. (marshmallows), *Andira inermis* (angelin), *Annona muricata* (soursop), *Annona reticulata* (custard apple), *Annona squamosa* (sugar apple), *Artemisia abrotanum* (southern wormwood), *Artocarpus integrifolia* (jackfruit), *Ascyrum* sp., *Bauhinia monandra* (orchid tree), *Bauhinia purpurea* (purple orchid tree), *Bauhinia variegata* (orchid tree), *Begonia* sp. (begonias), *Bignonia* sp., *Bixa orellana* (achiote), *Blighia sapida* (akee), *Brunfelsia nitida* (lady of the night), *Buddleia davidii* (butterfly bush), *Bursera simaruba* (gumbilimbo tree), *Cajanus cajan* (pigeonpea), *Calophyllum brasiliense* (Santa María), *Calophyllum* sp., *Camellia sinensis* (tea), *Carica papaya* (papaya), *Casearia sylvestris* (crackopen), *Cassia* sp., *Castanea* sp., *Casuarina* sp. (she-oaks), *Catesbaea spinosa* (Catesby's lilythorn), *Celtis sinensis* (Chinese hackberry), *Cestrum diurnum* (day jasmine), *Chiococca* sp., *Chrysalidocarpus lutescens* (Madagascar palm), *Chrysophyllum cainito* (star apple), *Cinchona succirubra* (red quinine tree), *Cinnamomum* sp. (cinnamon), *Cissus sicyoides* (princess vine), *Citharexylum* sp. (coreopsis), *Citrus aurantifolia* (sour orange), *Citrus limon* (lemon), *Citrus medica* (citron), *Clusia flava*, *Clusia lacuma nervosa*, *Clusia rosea* (autograph tree), *Codiaeum variegatum* (croton), *Coffea arabica* (coffee), *Combretum micropetalum*, *Cordia interrupta*, *Cordia macrostachya*, *Cordia polycephala*, *Cosmos caudatus* (wild cosmos), *Cotinus* sp. (smoke trees), *Croton discolor* (maran), *Croton lucidus* (firebush), *Cupania* sp., *Cuphea* sp., *Cydonia oblonga* (quince), *Datura suaveolens* (angel's trumpet), *Desmodium incanum* (kaimi clover), *Diospyros ebenum* (ebony), *Dodonaea* sp. (hopbush), *Duranta plumieri*, *Duranta repens* (sky flower), *Echites melaleuca*, *Elaeocarpus* sp. (quandongs), *Euonymus* sp. (spindle trees), *Eupatorium* sp., *Euphorbia* sp. (milkweeds), *Ficus aspera* (clown fig), *Ficus benjamina* (weeping fig), *Ficus carica* (common fig), *Ficus laurifolia*, *Flacourtia* sp., *Gardenia jasminoides* (cape jasmine), *Gardenia* sp. (gardenia), *Genipa americana* (jaguar), *Gesneria pedunculosa* (arbol de navidad), *Graptophyllum pictum* (caricature plant), *Grevillea robusta* (silky oak), *Guarea trichilioides* (American muskwood), *Guettarda scabra* (roughleaf velvetseed), *Hibiscus mutabilis* (confederate rose), *Hibiscus rosasinensis* (Chinese hibiscus), *Hibiscus* sp. (hibiscus), *Hibiscus syriacus* (shrub althea), *Hibiscus tiliaceus* (mahoe), *Hippomane mancinella* (manzanillo), *Hippomane* sp., *Hydnocarpus* sp., *Hydnocarpus wightiana* (jangli), *Ilex urbaniana* var. *riedlaei* (Urban's holly), *Indigophera* sp. (indigoes), *Inga laurina* (sacky sac bean), *Ipomoea tiliacea* (sweet potato), *Iresine* sp. (bloodleaf), *Ixora coccinea* (jungle geranium), *Ixora* sp., *Jasminum humile* (yellow jasmine), *Jasminum sambac* (Arabian jasmine), *Jasminum simplicifolius* (stiff jasmine), *Jasminum trifoliatum*, *Jatropha integerrima* (peregrine), *Juglans* sp. (walnuts), *Justicia spicigera* (mohintli), *Justicia* sp., *Khaya* sp. (African mahogany), *Lagerstroemia indica* (crepe myrtle), *Landolphia heudelotii*, *Lantana camara* (lantana), *Leucaena* sp., *Ligustrum* sp. (privets), *Phyla stoechadifolia* (southern fogfruit), *Litchi* sp. (lychee), *Lonicera* sp. (honeysuckles), *Lucuma serpentaria*, *Manilkara zapota* (sapodilla), *Lycopersicon* sp. (tomato), *Maba buxifolia*, *Macadamia ternifolia* (macadamia nut), *Macaranga* sp., *Malphigia* sp., *Malus pumila* (apple), *Mammea americana* (mamey apple), *Mangifera indica* (mango), *Manilkara bidentata* (ausubo), *Manilkara zapota* (sapodilla), *Matisia cordata* (South American sapote), *Melia azederach* (white cedar), *Melicoccus bijugatus* (Spanish lime), *Metrosideros* sp., *Miconia laevigata* (smooth johnnyberry), *Microcitrus australasica* (Australian finger lime), *Microglossa zeylanica*, *Micropholis crysophylioides*, *Morinda* sp., *Moringa oleifera* (horseradish tree), *Morus nigra* (black mulberry), *Mundulea suberosa* (silver bush, cork bush), *Murraya exotica* (Chinese box), *Myrica cerifera* (southern wax myrtle), *Myristica macrantha*, *Dimocarpus longan* (longan), *Nerium oleander* (oleander), *Nyctanthes sambac* (Arabian jasmine), *Ochna sopata*, *Ocotea leucoxylon* (loblolly sweetwood), *Olea europaea* (olive), *Osteomeles anthyllidifolia* (Hawai'i hawthorn), *Parinari laurinum*, *Parthenocissus* sp. (Boston ivy), *Passiflora laurifolia* (yellow water-lemon), *Persea americana* (avocado), *Phoradendron* sp. (mistletoes), *Photinia wrightiana*, *Phytolaca rivinoides*, *Piper aduncum* (spiked pepper), *Piper methysticum* (kava), *Piper nigrum*

	(black pepper), *Piper rivinoides*, *Pithecellobium dulce* (Manila tamarind), *Pittosporum* sp., *Plectranthus amboinicus* (Mexican mint), *Plumeria alba* (white frangipani), *Poinsettia* sp., *Polyalthia longifolia* (ashok tree), *Pouteria campechiana* (yellow sapote), *Pouteria obovata* (yellow boxwood), *Prunus* sp., *Psidium guajava* (guava), *Psychotria uliginosa* (wild coffee), *Pterocarpus indicus* (Burmese rosewood), *Punica granatum* (pomegranate), *Pyrus* sp. (pears), *Quisqualis indica* (Rangoon creeper), *Raimannia* sp. (evening primrose), *Randia aculeata* (white indigoberry), *Raphiolepis* sp. (hawthorns), *Rhus leucantha* (winged sumac), *Royena* sp., *Ruta chalepensis* (fringed rue), *Saba senegalensis*, *Sapium* sp. (milktree), *Schinus* sp. (peppertree), *Sida* sp., *Solanum melongena* (eggplant), *Solanum seaforthianum* (Brazilian nightshade), *Stachytarpheta jamaicensis* (light-blue snakeweed), *Strobilanthes isophyllus*, *Swietenia* sp. (mahogany)], *Syzygium cleyeraefolium*, *Tabernaemontana citrifolia* (milkwood), *Tabernaemontana divaricata* (pinwheelflower), *Tamarindus* sp. (tamarind), *Tecoma capensis* (cape honeysuckle), *Terminalia catappa* (Indian almond), *Terminalia tomentosa* (Indian laurel), *Thea* sp. (tea plant), *Thouinia strata*, *Tithonia diversifolia* (tree marigold), *Toxicodendron* sp. (poison ivy), *Trachelospermum jasminoides* (Chinese star jasmine), *Trema micranthum* (Jamaican nettletree), *Trichilia* sp., *Triumfetta semitriloba* (burbrush), *Urena* sp., *Wistaria* sp. (wisterias) (Ben-Dov *et al.* 2005).
Distribution	*Howardia biclavis* is present in Antigua and Barbuda, Argentina, Australia (Queensland), Bahamas, Barbados, Bermuda, Bonin Islands, Brazil, China, Columbia, Cook Islands, Cuba, Czech Republic, Dominica, Dominican Republic, Ecuador, Federated States of Micronesia, Fiji, France, French Guiana, French Polynesia, Galapagos Islands, Germany, Ghana, Guyana, Haiti, Hawaiian Islands, India, Indonesia, Ireland, Italy, Jamaica, Japan, Kenya, Madagascar, Mauritius, Mexico, Montserrat, New Caledonia, Niue, Palau, Panama, Papua New Guinea, Peru, Philippines, Poland, Puerto Rico and Vieques Island, Russia, Saint Croix, Saint Kitts and Nevis Islands, Sardinia, Singapore, Spain, Sri Lanka, Rodriques Island, Sao Tome and Principe, South Africa, Taiwan, Tonga, Trinidad and Tobargo, United Kingdom, United States of America (California, District of Columbia, Florida, Kansas, Maryland, Missouri, New York, Ohio, Pennsylvania), Vanuatu, Venezuela, Western Samoa, Zanzibar and Zimbabwe (Ben-Dov *et al.* 2005).
Quarantine pest	*Ischnaspis longirostris* (Signoret, 1982)
Synonyms	*Ischnaspis filiformis* Douglas, 1887 *Ischnaspis longirostris* Hempel, 1900 *Ischnaspis piliformis* Riley & Howard, 1893 *Lepidosaphes ritsemabosi* Fernald, 1903 *Mytilaspis longirostris* Signoret, 1882 *Mytilaspis ritzemae* Leonardi, 1901
Common name(s)	black thread scale, black line scale
Main hosts	The main hosts of *Ischnaspis longirostris* are *Citrus*, *Cocos nucifera* (coconut), *Coffea* (coffee), *forest trees* (woody plants) and *Mangifera indica* (mango) (CAB International 2007).
Distribution	*Ischnaspis longirostris* is present in the Admiralty Islands, Angola, Antigua and Barbuda, Argentina, Australia (Northern Territory, Queensland, South Australia), Bahamas, Barbados, Belize, Bermuda, Bonin Islands, Brazil (Bahia, Distrito Federal (=Brasilia), Espirito Santo, Minas Gerais, Parana, Para, Pernambuco, Rio Grande do Sul, Santa Catarina, Sao Paulo), Cameroon, Canada (Ontario), Canary Islands, Cape Verde, Colombia, Cook Islands, Costa Rica, Cuba, Czechoslovakia, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Fiji, France, French Polynesia (Tahiti), Germany, Ghana, Grenada, Guadeloupe, Guam, Guinea, Guyana, Hawaiian Islands (Hawaii, Kauai, Lanai, Maui, Molokai, Oahu), India (Karnataka), Indonesia (Java), Ireland, Italy, Jamaica, Japan, Kenya, Madagascar, Malaysia (Malaya), Martinique, Mauritius, Mexico, Mozambique, New Caledonia, Nigeria, Northern Mariana Islands (Saipan Island), Palau, Panama, Papua New Guinea, Philippines (Luzon), Portugal, Puerto Rico & Vieques Island (Puerto Rico), Reunion, Saint Croix, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Singapore, Solomon Islands, South Africa, Sri Lanka, Suriname, Sweden, Taiwan, Tanzania, Tonga, Trinidad and Tobago (Trinidad), Uganda, United Kingdom (England), United States of America (California (reported eradicated in California), Connecticut, District of Columbia, Florida, Georgia, Illinois, Louisiana, Maryland, Massachusetts, Missouri, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia), U.S. Virgin Islands, Vanuatu, Venezuela, Western Samoa, Zaire, Zanzibar and Zimbabwe (Ben-Dov *et al.* 2008).

Quarantine pest	*Lepidosaphes pinnaeformis* Bouché, 1851
Synonyms	*Aspidiotus pinnaeformis* Bouché, 1851 *Mytilaspis pinnaeformis* Signoret, 1870 *Mytilaspis machili* Maskell, 1898 *Lepidosaphes machili* Fernald, 1903 *Lepidosaphes pinnaeformis* Green, 1905 *Lepidosaphes tuberculata* Malenotti, 1916 *Lepidosaphes tubercolata* Leonardi, 1920 *Lepidosaphes tuberculatus* Green, 1921 *Scrupulaspis machili* MacGillivray, 1921 *Parlatoria pinnaeformis* Bodkin, 1922 *Lepidosaphes cymbidicola* Kuwana, 1925 *Lepidosaphes ezokihadae* Kuwana, 1932 *Lepidosaphes cinnamomi* Takahashi, 1933 *Lepidosaphes piniformis* Lindinger, 1934 *Mytilococcus piniformis* Lindinger, 1936 *Mytilococcus tuberculata* Lupo, 1939 *Lepidosaphes pinniformis* Schmutterer, 1952 *Eucornuaspis machili* Borchsenius, 1963 *Eucornuaspis pinnaeformis* Wise, 1977 *Mytilococcus machili* Zahradník, 1977
Common name(s)	purple scale, cymbidium scale, Machilus oystershell, mussel scale
Main hosts	The hosts of *Lepidosaphes pinnaeformis* include *Rhapis* sp., *Tetradymia glauca*, *Tetradymia* sp., *Cercidiphyllum japonicum*, *Cercidiphyllum* sp., *Cycas revolute*, *Cycas* sp., *Daphniphyllum membranaceum*, *Daphniphyllum* sp., *Elaeagnus* sp., *Croton* sp., *Quercus* sp., *Illicium religiosum*, *Illicium* sp., *Stauntonia keitaoensis*, *Stauntonia* sp., *Cinnamomum camphora*, *Cinnamomum japonicum*, *Cinnamomum kanchirai*, *Cinnamomum pedunculata*, *Cinnamomum* sp., *Lindera communis*, *Lindera oldhamii*, *Lindera* sp., *Litsea glauca*, *Litsea* sp., *Machilus kusanoi*, *Machilus* sp., *Machilus thunbergii*, *Machilus thunbergii glaucescens*, *Neolitsea sericea*, *Neolitsea* sp., *Persea* sp., *Phoebe* sp., *Magnolia grandiflora*, *Magnolia* sp., *Michelia compressa*, *Michelia orchidis*, *Michelia* sp., *Ficus* sp., *Cattleya* sp., *Cymbidium oleifolium*, *Cymbidium pendulum*, *Cymbidium* sp., *Cymbidium tracyanum*, *Cymbidium virescens*, *Cymbidium yamajii*, *Dendrobium* sp., *Banksia* sp., *Pomaderris apetala*, *Pomaderris* sp., *Prunus persica*, *Prunus* sp. *Pyrus cydonia*, *Pyrus* sp., *Ophiopogon* sp., *Citrus aurantium*, *Citrus* sp., *Phellodendron amurense*, *Phellodendron sachalinense*, *Phellodendron* sp., *Taxus cuspidate* and *Taxus* sp. (Ben-Dov *et al*. 2008).
Distribution	*Lepidosaphes pinnaeformis* is distributed in Angola, Argentina, Australia (Tasmania), Brazil, China (Hainan, Shanxi (=Shansi)), Crete, Czechoslovakia, Egypt, France, Germany, Guatemala, Guyana, Hawaiian Islands (Hawaii), India (West Bengal), Iran, Italy, Japan (Hokkaido, Honshu, Kyushu, Shikoku), Latvia, Malta, Morocco, Portugal, Spain, Syria, Taiwan, Turkey, United Kingdom (England), United States of America (California, Delaware, District of Columbia, Florida, Maryland, Massachusetts, New Jersey, New York, Pennsylvania), Uzbekistan (Tashkent Oblast) and Vietnam (Ben-Dov *et al*. 2008).
Quarantine pest	*Lopholeucaspis japonica* (Cockerell, 1897)
Synonyms	*Leucaspis japonicus* Cockerell, 1897 *Leucaspis japonica darwiniensis* Green, 1916 *Leucodiaspis japonica* (Cockerell, 1897) *Leucodiaspis hydrangeae* Takahashi, 1934 *Leucodiaspis japonica darwiniensis* (Green, 1916) *Leucaspis hydrangeae* (Takahashi, 1934) *Lopholeucaspis japonica* (Cockerell, 1897) *Lopholeucaspis japonica darwiniensis* (Green 1916) *Lopholeucaspis menoni* (Borchsenius, 1964) *Lopholeucaspis darwiniensis* (Green 1916) *Leucaspis menoni* Takagi, 1969
Common name(s)	Pear white scale
Main hosts	Associated with *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Acer palmatum* (Japanese maple), *Acer saccharum* (sugar maple), *Acer* sp. (maple), *Alnus japonica* (Japanese alder), *Camellia sinensis* (tea), *Camellia* sp., *Celastrus orbiculatus* (Oriental bittersweet vine), *Chaenomeles lagenaria* (flowering quince), *Citrus aurantium* (sour orange), *Citrus nobilis deliciosa*, *Citrus* sp., *Cytisus*

	scoparius (scotch broom), *Cytisus* sp. (broom), *Diospyros kaki* (persimmon), *Distylium racemosum* (Isu tree), *Enkianthus* sp., *Euonymus alata* (winged spindle tree), *Euphorbia* sp., *Eurya crenatifolia*, *Fagus* sp. (beech), *Ficus bengalensis* (banyan tree), *Ficus carica* (fig tree), *Ficus glomerata*, *Ficus orbicularis*, *Ficus religiosa* (Bo-tree), *Ficus* sp. (figs), *Fraxinus japonica* (Japanese ash), *Hydrangea integra*, *Hydrangea* sp., *Ligustrum* sp. (privet), *Liquidambar formosana*, *Magnolia souleana*, *Malus pumila* (apple), *Malus* sp., *Paeonia moutan* (Chinese tree-peony), *Paeonia* sp., *Paeonia suffruticosa* (tree peony), *Pittosperum tobira*, *Poncirus trifoliata* (Japanese bitter orange), *Populus* sp. (poplar), *Prunus mume* (Japanese apricot), *Prunus* sp., *Pyracantha* sp. (firethorns), *Pyrus serotina* (wild pear), *Pyrus* sp. (pears), *Rhododendron* sp. (rhododendrons), *Rosa* sp. (roses), *Salix aegyptiaca* (Mediterranean willow), *Salvadora* sp., *Styrax japonica* (Japanese snowbell), *Syringa vulgaris* (common lilac), *Tilia miqueliana* (lime), *Ulmus* sp. (elm), *Viburnum macrocephalum keteleeri* (Chinese snowball), *Vitis* sp., *Vitis vinifera* (grape), *Zelkova serrata* (Japanese zelkova) (Ben-Dov *et al.* 2005).
Distribution	*Lopholeucaspis japonica* is present in Azerbaijan, Bangladesh, Brazil, China, Georgia, India, Iran, Japan, Korea, Pakistan, Turkey, Russia, Ukraine and the United States of America (CAB International 2007).
Quarantine pest	*Parlatoria theae* (Cockerell, 1896)
Synonyms	*Parlatoreopsis theae* Kawai, 1972 *Parlatoria dives* McKenzie, 1945 *Parlatoria euonymi* McKenzie, 1945 *Parlatoria pergandei dives* Bellio, 1929 *Parlatoria pergandei theae* Kuwana, 1902 *Parlatoria theae* Leonardi, 1903 *Parlatoria theae euonymi* Cockerell, 1897 *Parlatoria theae evonymi* Leonardi, 1903 *Parlatoria theae viridis* Cockerell, 1896 *Parlatoria theae viridis* Leonardi, 1903 *Parlatoria viridis* Cockerell, 1897 *Syngenaspis theae* MacGillivray, 1921 *Syngenaspis theae euonymi* MacGillivray, 1921 *Syngenaspis theae viridis* MacGillivray, 1921
Common name(s)	Tea parlatoria scale
Main hosts	*Parlatoria theae* is a polyphagous species. It has been recorded on hosts from 21 families. Host include species of *Acer*, *Arbutus*, *Aucuba*, *Bauhinia*, *Camellia*, *Celtis*, *Citrus*, *Codiaeum*, *Cornus*, *Crataegus*, *Diospyros*, *Elaeagnus*, *Enkianthus*, *Eriobotrya*, *Euonymus*, *Euphorbia*, *Eurya*, *Hibiscus*, *Ilex*, *Magnolia*, *Malus*, *Osmanthus*, *Persea*, *Photinia*, *Poncirus*, *Prunus*, *Pyracantha*, *Pyrus*, *Ribes*, *Rosa*, *Staphylea*, *Syringa*, *Trochodendron*, *Viburnum* and *Vitis* (Watson 2008).
Distribution	*Parlatoria theae* is present in Belgium, Canada (Ontario (In the Ontario Agricultural College greenhouse at Guelph.)), China (Fujian, Guangdong, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Liaoning, Ningxia, Shandong, Sichuan, Yunnan, Zhejiang), France, Georgia, Greece, Hawaiian Islands, Iran, Italy, Japan (Honshu, Kyushu, Shikoku), Madeira Islands, Netherlands, Philippines, Portugal, Russia, Spain, Taiwan, Ukraine, United Kingdom (England) and United States of America (California, District of Columbia, Georgia , Maryland, Mississippi, Missouri, New York, North Carolina, Texas, Virginia) (Ben-Dov *et al.* 2008).
Quarantine pest	*Pseudaonidia duplex* (Cockerell, 1896)
Synonyms	*Aspidiotus theae* Maskell*, 1891, nom. nud.* *Aspidiotus duplex* Cockerell, 1896 *Aspidiotus theae rhododendri* Green, 1900 *Pseudaonidia rhododendri* Fernald, 1903 *Pseudaonidia rhododendri thearum* Fernald, 1903
Common name(s)	Camphor scale
Main hosts	*Acer palmatum, Acer matsumurae, Alnus hirsuta, Castanea pubinervis, Castanopsis cuspidata, Cinnamomum camphor, Citrus junos, Citrus natsudaidai, Eurya japonica, Eurya ochracea, Ficus carica, Ficus kingiana, Illicium religiosum, Ligustrum, Michelia fuscata, Myrica rubra, Nephelium litchi, Olea fragrans, Osmanthus fragrans, Photinia glabra, Pyracantha angustifolia, Quercus phillyraeoides, Rhododendron arboretum, Rhus succedanea, Ternstroemia japonica, Thea japonica, Thea sasanqua, Thea sinensis.* (Ben-Dov *et al.* 2005).

Distribution	India (Assam); Indonesia (Java); Sri Lanka; Taiwan; China (Honan); Georgia (Abkhaz ASSR, Adzhar ASSR); Japan (Honshu, Kyushu, Shikoku); South Korea; Hawaiian Islands (Hawaii); United States of America (Alabama, California, Florida, Georgia, Louisiana, Mississippi, Texas, Virginia) (Ben-Dov *et al.* 2005).
Quarantine pest	*Unaspis euonymi* (Comstock, 1881)
Synonyms	*Chionaspis euonymi* Comstock, 1881 *Chionaspis evonymi* Targioni Tozzetti, 1884 *Chionaspis nemausensis* Signoret, 1886 *Unaspis euconymi* Tao, 1999 *Unaspis euonymi* Ferris, 1937 *Unaspis evonymi* Bodenheimer, 1953 *Unaspis hakayamai* Borchsenius, 1966 *Unaspis hakayamai* Takahashi & Kanda, 1939
Common name(s)	euonymus scale, spindle berry scale
Main hosts	Hosts include species of *Aspidistra*, *Buxus*, *Celastrus*, *Citrus*, *Daphne*, *Euonymus*, *Fraxinus*, *Hedera*, *Hibiscus*, *Ilex*, *Jasminum*, *Ligustrum*, *Lonicera*, *Olea*, *Pachistima*, *Pachysandra*, *Prunus*, *Syringa* and *Viscum* (Ben-Dov *et al*. 2008).
Distribution	*Unaspis euonymi* is present in Algeria, Argentina, Armenia, Austria, Azerbaijan, Bolivia, Bulgaria, Canada (British Columbia), Canary Islands, China (Guangdong, Guangxi, Henan, Hubei, Hunan, Jiangsu, Nei Monggol, Shandong, Shanxi, Sichuan, Hong Kong, Xizang), Egypt, France, Georgia (Abkhaz ASSR, Adzhar ASSR), Greece, Hungary, Iran, Israel, Italy, Japan (Hokkaido, Honshu, Kyushu, Shikoku), Malta, Mexico, Morocco, Portugal, Romania, Russia (Krasnodar Kray), Sardinia, Sicily, South Korea, Spain, Switzerland, Turkey, Ukraine (Krym (=Crimea) Oblast), United Kingdom (England), United States of America (Alabama, Arizona Arkansas, California, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia, Wisconsin), Uzbekistan and Yugoslavia (Macedonia) (Ben-Dov *et al*. 2008).
Quarantine pest	*Planococcus kraunhiae* (Kuwana, 1902)
Synonyms	*Dactylopius kraunhiae* Kuwana, 1902 *Pseudococcus kraunhiae* (Kuwana 1902) *Planococcus siakwanensis* Borchsenius, 1962
Common name(s)	Japanese mealybug
Main hosts	Associated with the fruit, leaves and twigs of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Agave americana* (Century plant), *Artocarpus lanceolata*, *Casuarina stricta* (she oak), *Citrus nobilis* (tangor), *Citrus paradisi* (grapefruit), *Codiaeum variegatum pictum* (variegated laurel), *Coffea arabica* (coffee), *Crinum asiaticum* (poison bulb), *Cydonia sinensis* (quince), *Digitaria sanguinalis* (crab-grass), *Diospyros kaki* (Japanese kaki), *Ficus carica* (fig), *Gardenia jasminoides* (common gardenia), *Ilex* sp. (holly), *Magnolia grandiflora* (magnolia), *Musa basjoo* (Japanese banana), *Nandina domestica* (heavenly bamboo), *Nerium indicum* (oleander), *Olea chrysophylla* (olive), *Platanus orientalis* (sycamore), *Portulaca oleracea* (portulaca), *Trachycarpus excelsus fortunei* (wind-mill palm), *Wisteria floribunda* (wisteria) (Ben-Dov *et al.* 2005).
Distribution	*Planococcus kraunhiae* is present in China, Korea, Philippines, Taiwan and the United States of America (Ben-Dov *et al.* 2005).
Quarantine pest	*Planococcus lilacinus* (Cockerell, 1905)
Synonyms	*Pseudococcus tayabanus* Cockerell, 1905 *Dactylopius coffeae* Newstead, 1908 *Pseudococcus coffeae* (Newstead, 1908) *Dactylopius crotonis* Green, 1911 *Pseudococcus crotonis* (Green, 1911) *Pseudococcus deceptor* Betrem, 1937 *Tylococcus mauritiensis* Mamet, 1939 *Planococcus crotonis* (Green, 1911) *Planococcus tayabanus* (Cockerell, 1905) *Planococcus indicus* Arasthi and Shafee, 1987
Common name(s)	Coffee mealybug

Main hosts	The host range of *P. lilacinus* is extremely wide. It attacks over 65 genera of plants in 35 families, including Anacardiaceae, Asteraceae, Euphorbiaceae, Fabaceae, Leguminosae and Rutaceae (Ben-Dov *et al.* 2005). *Planococcus lilacinus* attacks *Theobroma cacao* (cocoa), *Psidium guajava* (guava), *Coffea spp.* (coffee), *Mangifera indica* (mango) (Ben-Dov *et al.* 2005), and other tropical and sub-tropical fruits and shade trees (IIE 1995).
Distribution	*P. lilacinus* occurs mainly in the Palaearctic, Malaysian, Oriental, Australasian and Neotropical regions, and is the dominant cocoa mealybug in Sri Lanka and Java (Entwistle 1972). Williams (1982) reported that the species was probably introduced into the South Pacific from Southern Asia. In Asia, *P. lilacinus* is recorded from Bangladesh, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Maldives, Myanmar, Philippines, Sri Lanka, Taiwan, Thailand, Viet Nam and Yemen (CAB International 2007).
Quarantine pest	*Pseudococcus comstocki* (Kuwana, 1902)
Synonyms	*Dactylopius comstocki* Kuwana, 1902
Common name(s)	Comstock mealybug, Japanese mealybug.
Main hosts	Associated with the fruit and branches of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Aesculus* spp. (horse chestnut), *Aglaia odorata* (Chinese perfume tree), *Alnus japonica* (Japanese alder), *Amaryllis vittata, Artemisia, Buxus microphylla* (littleleaf boxwood), *Camellia japonica* (Camellia), *Castanea* (chestnut), *Catalpa* (northern catalpa), *Celtis willdenowiana* (enoki), *Cinnamomum camphorae* (camphor tree), *Citrus* (citrus), *Crassula tetragona* (miniature pine tree), *Cydonia oblonga* (quince), *Cydonia sinensis* (Chinese quince), *Deutzia parviflora typical* (gaura), *Dieffenbachia picta* (dumb cane), *Erythrina indica* (rainbow eucalyptus), *Euonymus alatus* (winged euonymus), *Fatsia japonica* (Japanese aralia), *Ficus carica* (fig), *Fiwa japonica, Forsythia koreana* (forsythia), *Gardenia jasminoides* (gardenia), *Ginkgo biloba* (ginkgo), *Hydrangea* (hydrangea), *Ilex cornuta* (Chinese holly), *Ilex crenata microphylla* (korean gem), *Krauhnia, Lagerstroemia indica* (crape myrtle), *Ligustrum ibota angustifolium, Lonicera* (honeysuckles), *Loranthus* (mistletoe), *Malus pumila* (paradise apple), *Malus sylvestris* (crab apple), *Masakia japonica* (Japanese euonymus), *Monstera deliciosa* (monstera), *Morus alba* (white mulberry), *Musa* (bananas), *Nephelium lappaceum* (rambutan), *Opuntia dillenii* (prickly pear), *Orixa japonica* (Japanese orixa), *Pandanus* (screwpines), *Persica vulgaris* (peach), *Pinus thunbergiana* (Japanese black pine), *Populus* (poplar), *Prunus mume* (Japanese apricot), *Punica granatum* (pomegranate), *Pyrus communis* (European pear), *Pyrus serotina culta* (black cherry), *Rhamnus* (buckthorn), *Rhododendron mucronulatum* (Korean rhododendron), *Sasamorpha* (bamboo), *Taxus* (yew), *Torreya nucifera* (Japanese torreya), *Trema orientalis* (nalita), *Viburnum awabucki* (acacia confuse), *Zinnia elegans* (zinnia) (Ben-Dov *et al.* 2005).
Distribution	*Pseudococcus comstocki* is present in Afghanistan, Argentina, Armenia, Azerbaijan, Brazil, Canada, Canary Islands, China, Federated States of Micronesia, Indonesia, Iran, Italy, Japan, Kampuchea, Kazakhstan, Madeira Islands, Malaysia, Mexico, Northern Mariana Islands, Russia, Saint Helena, South Korea, Sri Lanka, Tajikistan, Turkmenistan, United States of America, Uzbekistan and Vietnam (Ben-Dov *et al.* 2005).
Quarantine pest	*Pseudococcus cryptus* Hempel, 1918
Synonyms	*Pseudococcus citriculus* Green, 1922 *Planococcus cryptus* (Hempel, 1918) *Pseudococcus spathoglottidis* Lit, 1992 *Pseudococcus mandarinus* Das and Ghose, 1996
Common name(s)	Citriculus mealybug
Main hosts	*Ananas sativa*, *Annona muricata*, *Areca catechu*, *Artocarpus altilis*, *Artocarpus incisa* (breadfruit), *Artocarpus odoratissimus*, *Avicennia officinalis*, *Bauhinia purpurea*, *Calophyllum inophyllum*, *Citrus aurantifolia* (lime), *C. aurantium*, *C. grandis*, *C. limon* (lemon), *C. paradisi* (grapefruit), *C. reticulata* (mandarin), *C. sinensis* (orange), *Cocos nucifera* (coconut), *Coelogyne dayana*, *Coffea arabica* (Arabian coffee), *Coffea liberica*, *Crinum asiaticum*, *Cyrtostachys renda*, *Dillenia indica*, *Elaeis guineensis*, *Eugenia malaccensis*, *Garcinia kydia*, *Garcinia mangostana* (mangosteen), *Glycine max*, *Hevea brasiliensis* (rubbertree), *Hibiscus tiliaceus*, *Lansium domesticum*, *Litchi chinensis* (lychee), *Mangifera indica* (mango), *Melastoma melobothricum*, *Melastoma normale*, *Millettia niuewenhuisii*, *Moringa oleifera*, *Musa sapientum*, *Myristica fragrans*, *Nephelium lappaceum*, *Ocotea pedalifolia*, *Osbornia ocdonta*, *Pandanus upoluensis*, *Passiflora foetida*, *Persea americana* (avocado), *Phalaenopsis amatilis*, *Phoenix*

	dactylifera, *Piper methysticum*, *Psidium guajava* (guava), *Punica granatum*, *Raphioperdalum bellatulum*, *Rhizophora apiculata*, *Ryparosa fasciculata*, *Spathoglottis plicata*, *Strychnos vanpurkii*, *Tamarindus indica*, *Vanda teres*, *Vitis vinifera* (grapevine) (Ben-Dov *et al.* 2005).
Distribution	*Pseudococcus cryptus* is widely distributed in South East Asia, tropical Africa, mideastern Mediterranean and South America. Afghanistan, American Samoa, Andaman Islands, Argentina, Bangladesh, Bhutan, Brazil, British Indian Ocean Territory, Brunei, Cambodia, China, Costa Rica, El Salvador, Federated States of Micronesia, Hawaiian Islands, India, Indonesia, Iran, Israel, Japan, Kenya, Laos, Malaysia, Maldives, Mauritius, Nepal, Palau, Paraguay, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand, U.S. Virgin Islands, Viet Nam, Western Samoa, Zanzibar (Ben-Dov *et al.* 2005).
Quarantine pest	*Adoxophyes dubia* Yasuda, 1998
Synonyms	
Common name(s)	Tea form
Main hosts	*Lyonia* sp., *Ribes* sp. (Yasuda 1998a), *Aucuba japonica*, *Myrica rubra*, *Camellia sinensis* (tea) *Solanum nigrum* (Sakamaki and Hayakawa 2004).
Distribution	Japan [southern Honshu, Shikoku, Kyushu, Okinawa, the Ryukyu Islands] (Yasuda 1998a).
Quarantine pest	*Adoxophyes honmai* Yasuda, 1988
Synonyms	
Common name(s)	Smaller tea tortrix, tea form, tea tortrix moth, smaller tea tortrix moth, tea tortricid moth
Main hosts	*Camellia sinensis* (tea) (Yasuda 1998a; Sakamaki and Hayakawa 2004), *Hedera thombea* (bean), *Eucalyptus* spp. (Nasu *et al.* 2004), *Viburnum suspensum* (Sakamaki and Hayakawa 2004).
Distribution	Japan [Honshu, possibly Shikoku and Kyushu] (Yasuda 1998a; Sakamaki and Hayakawa 2004).
Quarantine pest	*Adoxophyes orana fasciata* (Walsingham, 1900)
Synonyms	*Adoxophyes fasciata* Walsingham, 1900
Common name(s)	Leafroller moth, smaller tea tortrix, smaller tortrix, summer fruit tortrix, summer fruit tortrix moth, apple form
Main hosts	Associated with *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 2003) (synonym: *Citrus reticulata* Blanco '*Satsuma', Citrus reticulata* Blanco *'Unshiu'*). Other hosts include: *Malus pumila* (apple) (CAB International 2004).
Distribution	Japan [Hokkaido and Honshu] (Yasuda 1998a; Sakamaki and Hayakawa 2004).
Quarantine pest	*Homona magnanima* (Diakonoff, 1948)
Synonyms	
Common name(s)	Oriental tea tortrix, leaf roller
Main hosts	Main hosts of *H. magnanima* are *Arachis*, *Camellia sinensis* (tea), *Chrysanthemum indicum* (chrysanthemum), *Citrus*, *Diospyros kaki* (persimmon), *Eurya*, *Glycine*, *Lithocarpus edulis*, *Malus domestica* (apple), *Nandina domestica* (heavenly bamboo), *Paeonia* (peonies), *Paulownia tomentosa* (paulownia), *Podocarpus*, *Prunus* (stone fruit), *Prunus avium* (sweet cherry), *Pyrus* (pears), *Rhododendron* (Azalea), *Rosa* (roses) and *Solanum melongena* (aubergine) (CAB International 2007).
Distribution	*Homona magnanima* is present in Japan (Honshu, Kyushu), Taiwan (CAB International 2007) and Korea (Lee *et al.* 1992).
Quarantine pest	*Eumeta japonica* (Heylaerts, 1884)
Synonyms	
Common name(s)	Giant bagworm
Main hosts	Larvae feed on the leaves, twigs and surface of fruit of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Castanea crenata*, *Lithocarpus edulis* (Robinson *et al.* 2007), *Pyrus pyrifolia* (Japanese pear) (Izawa *et al.* 2000), *Quercus acutissima*, *Quercus glauca*, *Quercus serrata*, *Quercus variabilis* (Robinson *et al.* 2007).

Distribution	*Eumeta japonica* is present in Japan (Robinson *et al.* 2007).
Quarantine pest	*Eumeta minuscula* Butler, 1881
Synonyms	*Clania minuscula* (Butler, 1881) *Cryptothelea minuscula* (Butler, 1881) *Mahasena minuscula* (Butler, 1881)
Common name(s)	Tea bagworm
Main hosts	Larvae feed on the leaves, twigs and surface of fruit of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Abelia grandiflora*, *Acacia mangium*, *Araucaria cunninghamii*, *Averrhoa carambola* (star fruit), *Camellia sinensis* (tea), *Castanea crenata*, *Citrus* spp., *Coffea liberica*, *Diospyros kaki* (persimmon), *Eucalyptus deglupta*, *Eugenia jambos*, *Lantana* spp., *Lithocarpus edulis*, *Mimosa pigra*, *Prunus* spp., *Psidium guajava* (guava), *Pyrus* spp., *Quercus acutissima*, *Quercus cerris*, *Quercus phillyraeoides*, *Quercus serrata*, *Quercus variabilis*, *Shorea maxima*, *Theobroma cacao*, *Toxicodendron succedaneum* (Robinson *et al.* 2007).
Distribution	*Eumeta minuscula* is present in China (CAB International 2004); Hong Kong, India, Japan (Robinson *et al.* 2007); Korea [Republic of] (CAB International 2004); Malaysia (Robinson *et al.* 2007); Vietnam (CAB International 2004).
Quarantine pest	*Stathmopoda auriferella* (Walker, 1864)
Synonyms	*Gelechia auriferella* Walker, 1864 *Stathmopoda adulatrix* Meyrick, 1917 *Stathmopoda theoris* Meyrick, 1906
Common name(s)	Apple heliodinid
Main hosts	The larvae feed on the fruit, flowers and leaves of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Acacia nilotica* (Robinson *et al.* 2007), *Actinidia deliciosa* (kiwifruit) (Yamazaki and Sugiura 2003), *Albizia altissima* (Robinson *et al.* 2007), *Citrus reticulata* (mandarin) (Yamazaki and Sugiura 2003), *Citrus sinensis* (navel orange) (CAB International 2004), *Cocos nucifera* (coconut palm), *Coffea canephora* (coffee), *Coffea liberica* (liberica coffee), *Helianthus annuus* (sunflower) (Yamazaki and Sugiura 2003), *Kerria communis* (lac scale) (Robinson *et al.* 2007), *Malus pumila* var. *domestica* (fuji apple) (AQIS 1998), *Mangifera indica* (mango) (CAB International 2004); *Persea* spp. (avocado) (Yamazaki and Sugiura 2003), *Nephelium ophiodes*, *Pinus roxburghii* (chir pine), *Prunus salicina*, *Prunus persica* (peach), *Prunus persica* var. *nucipersica* (nectarine), *Punica granatum* (pomegranate) (Yamazaki and Sugiura 2003), *Sorghum bicolor bicolor* (sorghum), *Tistania* sp (Robinson *et al.* 2007), *Vitis vinifera* (table grape) (Yamazaki and Sugiura 2003).
Distribution	Egypt (Badr *et al.* 1986); Greece (Nel and Nel 2003); India (Robinson *et al.* 2007); Indonesia, Japan [Osaka City, Honshu] (Yamazaki and Sugiura 2003); Korea [Republic of] (Park *et al.* 1994); Malaysia, Pakistan, Philippines, Seychelles, Sri Lanka, Thailand (Robinson *et al.* 2007).
Quarantine pest	*Chaetanaphothrips orchidii* (Moulton, 1907)
Synonyms	*Euthrips orchidii* Moulton, 1907
Common name(s)	citrus rust thrips, anthurium thrips, orchid thrips, red rust thrips of banana, banana rust thrips
Main hosts	Main hosts of *Chaetanaphothrips orchidii* are *Alternanthera* (Joyweed), *Anthurium andreanum*, *Bougainvillea*, *Chrysanthemum* (daisy), *Musa* (banana), *Petroselinum crispum* (parsley) and *Zea mays* (maize). Minor hosts are *Acer palmatum* (Japanese maple), *Adiantum* (maidenhair ferns), *Amaranthus* (grain amaranth), *Begonia*, *Citrus reticulata x paradisi* (tangelo), *Citrus sinensis* (navel orange), *Citrus x paradisi* (grapefruit), *Coix lacryma-jobi* (Job's-tears), *Cryptotaenia canadensis* (honewort), *Epiphyllum*, *Euphorbia* (spurges), *Ipomoea batatas* (sweet potato), *Iresine* (blood-leaf), *Litchi chinensis* (lichi), *Lycopersicon*, *Paspalum conjugatum* (sour paspalum), *Passiflora* (passionflower) and *Pisonia* (CAB International 2007)
Distribution	*Chaetanaphothrips orchidii* is present in Australia (New South Wales, Queensland), Brazil (Minas Gerais), China (Taiwan), Costa Rica, Dominica, Dominican Republic, Ecuador, Grenada, Guadeloupe, Honduras, India (Kerala, Tamil Nadu, West Bengal), Indonesia (Java), Jamaica, Japan (Honshu, Kyushu), Malaysia, Mauritius, Mexico, Nepal, Puerto Rico, Saint Lucia, Sao Tome and Principe, Sri Lanka, Suriname, Tonga, Trinidad and Tobargo and United States of America (California, Florida, Hawaii, Illinois,

	Louisiana, Massachusetts) (CAB International 2007).
Quarantine pest	*Frankliniella intonsa* (Trybom, 1895)
Synonyms	*Frankliniella intonsa f. norashensis* Yakhontov and Jurbanov, 1957 *Thrips intonsa* Trybom, 1895 *Frankliniella formosae* Moulton, 1928
Common name(s)	Flower thrips
Main hosts	*Abelmoschus esculentus* (okra), *Arachis hypogaea* (groundnut), *Asparagus officinalis* (asparagus), *Capsicum annuum* (capsicum), *Chrysanthemum indicum* (chrysanthemum), *Fragaria* (strawberry), *Glycine max* (soyabean), *Gossypium* (cotton), *Lycopersicon esculentum* (tomato), *Medicago sativa* (lucerne), *Oryza sativa* (rice), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Prunus persica* (peach), *Vigna angularis* (adzuki bean) (CAB International 2007).
Distribution	This species is distributed across Asia, Europe and North America (CAB International 2007).
Quarantine pest	*Frankliniella occidentalis* (Pergande, 1895)
Synonyms	*Euthrips helianthi* Moulton, 1911 *Euthrips tritici californicus* Moulton, 1911 *Frankliniella chrysanthemi* Kurosawa, 1941 *Frankliniella canadensis* Morgan, 1925 *Frankliniella claripennis* Morgan, 1925 *Frankliniella conspicua* Moulton, 1936 *Frankliniella dahliae* Moulton, 1948 *Frankliniella dianthi* Moulton, 1948 *Frankliniella nubila* Treherne, 1924 *Frankliniella occidentalis brunnescens* Priesner, 1932 *Frankliniella occidentalis dubia* Priesner, 1932 *Frankliniella syringae* Moulton, 1948 *Frankliniella trehernei* Morgan, 1925 *Frankliniella tritici maculata* Priesner, 1925 *Frankliniella tritici moultoni* Hood, 1914 *Frankliniella umbrosa* Moulton, 1948 *Frankliniella venusta* Moulton, 1936
Common name(s)	Western flower thrips
Main hosts	*Allium cepa* (onion), *Amaranthus palmeri* (Palmer amaranth), *Arachis hypogaea* (groundnut), *Beta vulgaris* (beetroot), *Beta vulgaris* var. *saccharifera* (sugarbeet), *Brassica oleracea* var. *capitata* (cabbage), *Capsicum annuum* (capsicum), *Carthamus tinctorius* (safflower), *Chrysanthemum morifolium* (chrysanthemum), *Citrus* x *paradisi* (grapefruit), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita maxima* (giant pumpkin), *Cucurbita pepo* (ornamental gourd), *Cyclamen*, *Dahlia*, *Daucus carota* (carrot), *Dianthus caryophyllus* (carnation), *Euphorbia pulcherrima* (poinsettia), *Ficus carica* (fig), *Fragaria ananassa* (strawberry), *Fuchsia*, *Geranium* (cranesbill), *Gerbera jamesonii* (African daisy), *Gladiolus hybrids* (sword lily), *Gossypium* (cotton), *Gypsophila* (baby's breath), *Hibiscus* (rosemallows), *Impatiens* (balsam), *Kalanchoe*, *Lactuca sativa* (lettuce), *Lathyrus odoratus* (sweet pea), *Leucaena leucocephala* (leucaena), *Limonium sinuatum* (sea pink), *Lisianthus*, *Lycopersicon esculentum* (tomato), *Malus domestica* (apple), *Medicago sativa* (lucerne), Orchidaceae (orchids), *Petroselinum crispum* (parsley), *Phaseolus vulgaris* (common bean), Pisum *sativum* (pea), *Prunus armeniaca* (apricot), *Prunus domestica* (plum), *Prunus persica* (peach), *Prunus persica* var. *nucipersica* (nectarine), *Purshia tridentata* (bitterbrush), *Raphanus raphanistrum* (wild radish), *Rhododendron* (Azalea), *Rosa* (roses), *Saintpaulia ionantha* (African violet), *Salvia* (sage), *Secale cereale* (rye), *Sinapis arvensis* (wild mustard), *Sinningia speciosa* (gloxinia), *Solanum melongena* (aubergine), *Sonchus* (Sowthistle), *Syzygium jambos* (rose apple), *Trifolium* (clovers), *Triticum aestivum* (wheat), *Vitis vinifera* (grapevine) (CAB International 2007).
Distribution	Asia, Europe, North Central and South America, New Zealand and Australia (CAB International 2007).
Quarantine pest	*Thrips palmi* Karny, 1925
Synonyms	*Chloethrips aureus* Ananthrakrishnan and Jagadish, 1967 *Thrips gossypicola* (Priesner, 1939) *Thrips gracilis* Ananthrakrishnan and Jagadish, 1968 *Thrips leucadophilus* Priesner, 1936

Common name(s)	Melon thrips
Main hosts	*Allium cepa* (onion), *Capsicum annum* (capsicum), *Chrysanthemum* (daisy), *Citrus*, *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita pepo* (ornamental gourd), Fabaceae (leguminous plants), *Glycine max* (soyabean), *Gossypium* (cotton), *Helianthus annuus* (sunflower), *Lactuca sativa* (lettuce), *Lycopersicon esculentum* (tomato), *Mangifera indica* (mango), *Nicotiana tabacum* (tobacco), Orchidaceae (orchids), *Oryza sativa* (rice), *Persea americana* (avocado), *Phaseolus* (beans), *Phaseolus vulgaris* (common bean), *Sesamum indicum* (sesame), *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Vigna unguiculata* (cowpea) (CAB International 2007).
Distribution	Asia, Africa, North Central and South America, Oceania (CAB International 2007).
Quarantine pest	*Bactrocera tsuneonis* (Miyake, 1919)
Synonyms	*Dacus tsuneonis* Miyake *Dacus cheni* Chao *Tetradacus tsuneonis* (Miyake)
Common name(s)	Japanese orange fly
Main hosts	The larvae feed inside the fruit of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Citrus aurantium* (sour orange), *Citrus reticulata (*mandarin), *Citrus sinensis* (navel orange), *Fortunella margarita* (oval kumquat), *Fortunella x crassifolia* (Meiwa kumquat) (CAB International 2007); Ponkan, komikan, tachibana (MAFF information)
Distribution	China (Guangxi, Hunan, Sichuan (CAB International 2008); Jiangsu (EPPO 2007); Taiwan (EPPO 2007); Japan (Kyushu and the Ryukyo Islands (White and Elson-Harris 1994; EPPO 2007); Vietnam (EPPO 2007).
Quarantine pest	*Sphaceloma fawcettii* Jenkins
Synonyms	*Sphaceloma citri* Jenkins *Sphaceloma fawcettii* var. *fawcettii* Jenkins *Sphaceloma fawcettii* var. *scabiosa* Jenkins *Sporotrichum citri* Butler *Ramularia scabiosae* McAlpine and Tryon *Elsinoë fawcetti* Bitancourt and Jenkins [teleomorph]
Common name(s)	Citrus scab, common scab of orange, sour orange scab (CAB International 2004).
Main hosts	Members of the family Rutaceae particularly: *Citrus aurantium* (sour orange), *C. hystrix* (papeda lime), *C. jambhiri* (rough lemon), *C. latifolia* (Tahitian limes), *C. limon* (lemon), *C. limonia* (lemandarin, Mandarin lime), *C. madurensis* (calamondin), *C. x nobilis* (tangor), *C. x paradisi* (grapefruit), *C. reticulata* (mandarin), *C. sinensis* (some cultivars of sweet orange), *C. unshiu* (Satsuma orange) and *Poncirus trifoliata* (trifoliate orange) (CAB International 2004; CABI and EPPO 1997b). Most cultivars of *C. latifolia* (Tahitian limes), *Fortunella margarita* (oval kumquat), *C. sinensis* (sweet orange) and *C. maxima* (pummelo) are more resistant. *C. aurantium* (sour orange) is attacked by only the Florida Broad Host Range pathotype that is also capable of infecting *C. sinensis* (sweet orange) fruit. *C. x paradisi* (grapefruit) is affected by the Florida Broad and Narrow Host Range pathotypes but not by Tryon's or the lemon pathotypes. All pathotypes affect *C. jambhiri* (rough lemon) and *C. limon* (lemon). Tryon's pathotype attacks certain *C. reticulata* (mandarin) cultivars whereas the lemon pathotype does not (Timmer *et al.* 1996a).
Distribution	American Samoa; Argentina; Australia (Tryon's and lemon pathotypes only - New South Wales, Northern Territory, Queensland and Victoria); Bangladesh; Barbados; Belize; Bermuda; Bolivia; Brazil (Bahia, Ceara, Espirito Santo, Minas Gerais, Rio de Janeiro, São Paulo); Brunei Darussalam; Cambodia; Cayman Islands; China (Fujian, Guangdong, Guangxi, Guizhou, Hong Kong (restricted), Hubei, Hunan, Jiangxi, Sichuan, Taiwan (restricted), Yunnan, Zhejiang); Colombia; Cook Islands; Costa Rica; Cuba; Dominica; Dominican Republic; Ecuador; El Salvador; Ethiopia; Fiji; French Guiana; French Polynesia; Gabon; Ghana; Georgia; Grenada; Guadeloupe; Guam; Guatemala; Guyana; Haiti; Honduras; India (Assam, Karanataka, Madhya Pradesh, Maharashtra, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal); Indonesia (Irian Jaya, Java, Kalimantan); Jamaica; Japan (Honshu, Ryukyu Archipelago); Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Laos; Madagascar; Malawi; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Maldives; Martinique; Mexico; Micronesia, Federated States of (dubious record); Mozambique; Myanmar; Nepal; New Caledonia; New Zealand; Nicaragua; Nigeria; Pakistan; Panama; Papua New Guinea;

	Paraguay; Peru; Philippines; Puerto Rico; Saint Lucia; Samoa; Sierra Leone; Solomon Islands; Somalia; South Africa; Spain (Canary Islands); Sri Lanka; Suriname; Tanzania; Thailand; Trinidad and Tobago; Uganda; United States (Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, Texas); Uruguay (restricted); Vanuatu; Venezuela; Vietnam; Zaire; Zambia; Zimbabwe (restricted) (CABI and EPPO 1997b; CAB International 2004).
Quarantine pest	*Xanthomonas citri* subsp. *citri* (*ex* Hasse 1915) Gabriel *et al.* 1989
Synonyms	*Bacillus citri* (Hasse) Holland 1920 *Bacterium citri* (Hasse) Doidge 1916 *Phytomonas citri* (Hasse) Bergey *et al.* 1923 *Pseudomonas citri* Hasse 1915 *Xanthomonas axonopodis* pv. *aurantifolii* Vauterin *et al.* 1995 *Xanthomonas campestris* pv. *aurantifolii* Gabriel *et al.* 1989 *Xanthomonas campestris* pv. *citri* (Hasse 1915) Dye 1978 *Xanthomonas citri* (ex Hasse 1915) nom. rev. Gabriel *et al.* 1989 *Xanthomonas citri* f. sp. *aurantifoliae* Namekata & Oliveira 1972.
Common name(s)	Citrus canker, Asiatic citrus canker, citrus bacteriosis, false canker, South American canker, Mexican lime cancrosis.
Main hosts	*Xanthomonas citri* subsp. *citri* is a pathogen of *Citrus unshiu* Marcow. (unshu mandarin) in Japan (MAFF 1990). Other hosts include: *Aegle marmelos* (bael fruit), *Casimiroa edulis* (white sapote), *Citrus aurantiifolia* (lime), *Citrus aurantium* (sour orange), *Citrus hassaku (*Hassaku), *Citrus hystrix* (Tahiti lime), *Citrus iyo* (Iyokan), *Citrus junos* (yuzu), *Citrus limetta* (sweet lemon tree), *Citrus limon* (lemon), *Citrus madurensis* (calamondin), *Citrus maxima* (pummelo), *Citrus medica* (citron), *Citrus natsudaidai* (natsudaidai), *Citrus reshni* (Cleopatra mandarin), *Citrus reticulata* (mandarin), *Citrus reticulata* x *Poncirus trifoliata* (citrumelo), *Citrus sinensis* (navel orange), *Citrus sunki* (sour mandarin), *Citrus tankan* (Satsuma), *Citrus unshiu* (Satsuma), *Citrus x paradisi* (grapefruit), *Fortunella japonica* (round kumquat), *Fortunella margarita* (oval kumquat), *Ferronia limonia* (syn. *Limonia acidissima*) (elephant apple), *Poncirus trifoliata* (trifoliate orange) (CAB International 2004). Hosts native to Australia include: *Acronychia acidula* (lemon aspen), *Citrus australasica* (Australian finger lime), *Citrus australis* (Australian round lime), *Citrus garrawayi* (Mount White lime), *Citrus glauca* (native lime), *Citrus gracilis* (Kakadu lime), *Citrus inodora* (Russel River lime), *Clauseana lansium* (wampi), *Micromelum minutum* (lime berry), *Murraya ovatifoliolata* (native mock orange) (QDPIF 2006b). The pathogen has also been associated with other plant species such as grasses and weeds, surviving in their root zone (rhizosphere). Goto *et al.* (1975a) reported its presence on the grass *Zoysia japonica* in Japan, which grew in close proximity with citrus canker infected trees in Japan. Similarly the pathogen has been associated with goat weed (*Ageratum conyzoides* L.) in India (Kalita *et al.* 1997). However, the epidemiological significance of these sources remains unclear.
Distribution	Afghanistan, Argentina, Australia (restricted distribution, under official control) (QDPIF 2006a; ProMED 2007), Bangladesh, Belau, Bolivia, Brazil, British Virgin Islands, Cambodia, China, Christmas Island, Cocos Islands, Comoros, Congo Democratic Republic, Fiji, Gabon, India, Indonesia, Iran, Ivory Coast, Japan, Korea [Republic of], Korea [DPR], Laos, Madagascar, Malaysia, Maldives, Mauritius, Micronesia, Myanmar, Nepal, Oman, Pakistan, Papua New Guinea, Paraguay, Philippines, Réunion, Saudi Arabia, Seychelles, Singapore, Sri Lanka, Tanzania, Thailand, United Arab Emirates, Uruguay, United States of America (Florida), Vietnam, Yemen (CAB International 2004). The geographical distribution of *X. citri* subsp. *citri* differs for different strains of citrus canker. Canker A (Asiatic canker) is found in Asia, South America, Oceania and the USA; canker B (cancrosis B) in South America; canker C (Mexican lime cancrosis) in Brazil; and canker D (citrus bacteriosis) in Mexico. An outbreak of the Asiatic strain of *X. citri* subsp. *citri* occurred in a geographically isolated citrus growing region in Queensland in 2004 where the pest continues to be under eradication (QDPIF 2006a).

Appendix C: Biosecurity framework

Australia's biosecurity policies

The objective of Australia's biosecurity policies and risk management measures is the prevention or control of the entry, establishment or spread of pests and diseases that could cause significant harm to people, animals, plants and other aspects of the environment.

Australia has diverse native flora and fauna and a large agricultural sector, and is relatively free from the more significant pests and diseases present in other countries. Therefore, successive Australian Governments have maintained a conservative, but not a zero-risk, approach to the management of biosecurity risks. This approach is consistent with the World Trade Organization's (WTO's) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

The SPS Agreement defines the concept of an 'appropriate level of protection' (ALOP) as the level of protection deemed appropriate by a WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. Among a number of obligations, a WTO Member should take into account the objective of minimising negative trade effects in setting its ALOP.

Like many other countries, Australia expresses its ALOP in qualitative terms. Australia's ALOP, which reflects community expectations through Australian Government policy, is currently expressed as providing a high level of sanitary and phytosanitary protection, aimed at reducing risk to a very low level, but not to zero.

Consistent with the SPS Agreement, in conducting risk analyses Australia takes into account as relevant economic factors:

- the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease in the territory of Australia
- the costs of control or eradication of a pest or disease
- and the relative cost-effectiveness of alternative approaches to limiting risks.

Roles and responsibilities within Australia's quarantine system

Australia protects its human[14], animal and plant life or health through a comprehensive quarantine system that covers the quarantine continuum, from pre-border to border and post-border activities.

Pre-border, Australia participates in international standard-setting bodies, undertakes risk analyses, develops offshore quarantine arrangements where appropriate, and engages with our neighbours to counter the spread of exotic pests and diseases.

At the border, Australia screens vessels (including aircraft), people and goods entering the country to detect potential threats to Australian human, animal and plant health.

[14] The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine.

The Australian Government also undertakes targeted measures at the immediate post-border level within Australia. This includes national co-ordination of emergency responses to pest and disease incursions. The movement of goods of quarantine concern within Australia's border is the responsibility of relevant state and territory authorities, which undertake inter- and intra-state quarantine operations that reflect regional differences in pest and disease status, as a part of their wider plant and animal health responsibilities.

Roles and responsibilities within the Department

The Australian Government Department of Agriculture, Fisheries and Forestry is responsible for the Australian Government's animal and plant biosecurity policy development and the establishment of risk management measures. The Secretary of the Department is appointed as the Director of Animal and Plant Quarantine under the *Quarantine Act 1908* (the Act).

There are three groups within the Department primarily responsible for biosecurity and quarantine policy development and implementation:

- Biosecurity Australia conducts risk analyses, including IRAs, and develops recommendations for biosecurity policy as well as providing quarantine advice to the Director of Animal and Plant Quarantine and AQIS.
- AQIS develops operational procedures, makes a range of quarantine decisions under the Act (including import permit decisions under delegation from the Director of Animal and Plant Quarantine) and delivers quarantine services.
- Product Integrity, Animal and Plant Health Division (PIAPH) coordinates pest and disease preparedness, emergency responses and liaison on inter- and intra-state quarantine arrangements for the Australian Government, in conjunction with Australia's state and territory governments.

Roles and responsibilities of other government agencies

State and territory governments play a vital role in the quarantine continuum. Biosecurity Australia and PIAPH work in partnership with state and territory governments to address regional differences in pest and disease status and risk within Australia, and develop appropriate sanitary and phytosanitary measures to account for those differences. Australia's partnership approach to quarantine is supported by a formal Memorandum of Understanding that provides for consultation between the Australian Government and the state and territory governments.

Depending on the nature of the good being imported or proposed for importation, Biosecurity Australia may consult other Australian Government authorities or agencies in developing its recommendations and providing advice.

As well as a Director of Animal and Plant Quarantine, the Act provides for a Director of Human Quarantine. The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine and Australia's Chief Medical Officer within that Department holds the position of Director of Human Quarantine. Biosecurity Australia may, where appropriate, consult with that Department on relevant matters that may have implications for human health.

The Act also requires the Director of Animal and Plant Quarantine, before making certain decisions, to request advice from the Environment Minister and to take the advice into account when making those decisions. The Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA) is responsible under the *Environment Protection and Biodiversity Conservation Act 1999* for assessing the environmental impact associated with proposals to import live species. Anyone proposing to import such material should contact DEWHA directly for further information.

When undertaking risk analyses, Biosecurity Australia consults with DEWHA about environmental issues and may use or refer to DEWHA's assessment.

Australian quarantine legislation

The Australian quarantine system is supported by Commonwealth, state and territory quarantine laws. Under the Australian Constitution, the Commonwealth Government does not have exclusive power to make laws in relation to quarantine, and as a result, Commonwealth and state quarantine laws can co-exist.

Commonwealth quarantine laws are contained in the *Quarantine Act 1908* and subordinate legislation including the *Quarantine Regulations 2000*, the *Quarantine Proclamation 1998*, the *Quarantine (Cocos Islands) Proclamation 2004* and the *Quarantine (Christmas Island) Proclamation 2004*.

The quarantine proclamations identify goods, which cannot be imported, into Australia, the Cocos Islands and or Christmas Island unless the Director of Animal and Plant Quarantine or delegate grants an import permit or unless they comply with other conditions specified in the proclamations. Section 70 of the *Quarantine Proclamation 1998*, section 34 of the *Quarantine (Cocos Islands) Proclamation 2004* and section 34 of the *Quarantine (Christmas Island) Proclamation 2004* specify the things a Director of Animal and Plant Quarantine must take into account when deciding whether to grant a permit.

In particular, a Director of Animal and Plant Quarantine (or delegate):

- must consider the level of quarantine risk if the permit were granted, and
- must consider whether, if the permit were granted, the imposition of conditions would be necessary to limit the level of quarantine risk to one that is acceptably low, and
- for a permit to import a seed of a plant that was produced by genetic manipulation – must take into account any risk assessment prepared, and any decision made, in relation to the seed under the Gene Technology Act, and
- may take into account anything else that he or she knows is relevant.

The level of quarantine risk is defined in section 5D of the *Quarantine Act 1908*. The definition is as follows:

reference in this Act to a *level of quarantine risk* is a reference to:

(a) the probability of:

  (i) a disease or pest being introduced, established or spread in Australia, the Cocos Islands or Christmas Island; and

  (ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and

(b) the probable extent of the harm.

The *Quarantine Regulations 2000* were amended in 2007 to regulate keys steps of the import risk analysis process. The Regulations:

- define both a standard and an expanded IRA,

- identify certain steps, which must be included in each type of IRA,
- specify time limits for certain steps and overall timeframes for the completion of IRAs (up to 24 months for a standard IRA and up to 30 months for an expanded IRA),
- specify publication requirements,
- make provision for termination of an IRA, and
- allow for a partially completed risk analysis to be completed as an IRA under the Regulations.

The Regulations are available at www.comlaw.gov.au.

International agreements and standards

The process set out in the *Import Risk Analysis Handbook 2007* is consistent with Australia's international obligations under the SPS Agreement. It also takes into account relevant international standards on risk assessment developed under the International Plant Protection Convention (IPPC) and by the World Organisation for Animal Health (OIE).

Australia bases its national risk management measures on international standards where they exist and when they achieve Australia's ALOP. Otherwise, Australia exercises its right under the SPS Agreement to apply science-based sanitary and phytosanitary measures that are not more trade restrictive than required to achieve Australia's ALOP.

Notification obligations

Under the transparency provisions of the SPS Agreement, WTO Members are required, among other things, to notify other members of proposed sanitary or phytosanitary regulations, or changes to existing regulations, that are not substantially the same as the content of an international standard and that may have a significant effect on trade of other WTO Members.

Risk analysis

Within Australia's quarantine framework, the Australian Government uses risk analyses to assist it in considering the level of quarantine risk that may be associated with the importation or proposed importation of animals, plants or other goods.

In conducting a risk analysis, Biosecurity Australia:

- identifies the pests and diseases of quarantine concern that may be carried by the good
- assesses the likelihood that an identified pest or disease or pest would enter, establish or spread
- assesses the probable extent of the harm that would result.

If the assessed level of quarantine risk exceeds Australia's ALOP, Biosecurity Australia will consider whether there are any risk management measures that will reduce quarantine risk to achieve the ALOP. If there are no risk management measures that reduce the risk to that level, trade will not be allowed.

Risk analyses may be carried out by Biosecurity Australia's specialists, but may also involve relevant experts from state and territory agencies, the Commonwealth Scientific and Industrial

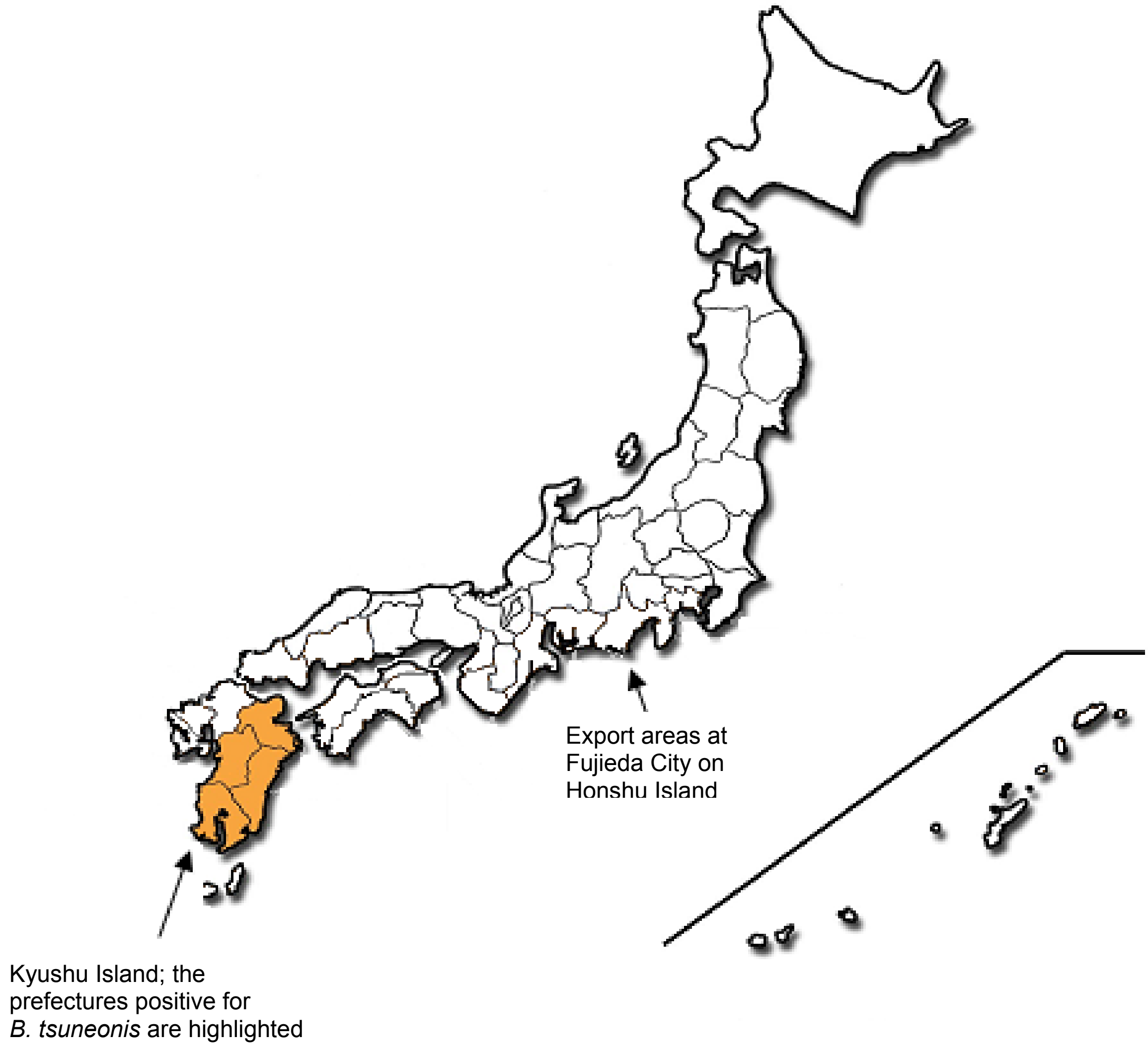
Research Organisation (CSIRO), universities and industry to access the technical expertise needed for a particular analysis.

Risk analyses are conducted across a spectrum of scientific complexity and available scientific information. An IRA is a type of risk analysis with key steps regulated under the *Quarantine Regulations 2000*. Biosecurity Australia's assessment of risk may also take the form of a non-regulated analysis of existing policy or technical advice to AQIS. Further information on the types of risk analysis is provided in the *Import Risk Analysis Handbook 2007*.

Appendix D: Distribution of Japanese orange fly in Japan

Japan advised in 2008 that Japanese orange fly (*Bactrocera tsuneonis*) occurs in the Kumamoto, Oita, Miyazaki and Kagoshima Prefectures on Kyushu Island (Figure D1). It is also distributed on Tanegashima Island, Yakushima, Kuchinoerabujima, Nakanoshima and Amami Islands to the south of Kyushu Island, and in Taiwan, Vietnam and southern China. The species has never been reported in the Shizuoka Prefecture.

Figure D1: Distribution of *Bactrocera tsuneonis* on Kyushu Island, Japan



The USA, as of March 2004, imports fresh unshu mandarin from Japan from Honshu, Shikoku and specified Prefectures on Kyushu Island (i.e. Fukuoka, Kumanmoto, Nagasaki, and Saga, only). The export areas on Kyushu Island are also subject to monitoring for Japanese orange fly as the species is present in specified areas on the island (APHIS 2004; US Electronic Code of Federal Regulations 2008).

Unshu mandarins from Shikoku and specified Prefectures on Kyushu Island (i.e. Fukuoka, Kumanmoto, Nagasaki, and Saga, only) may be imported through authorised ports in the USA,

- subject to methyl bromide fumigation into any area of the Unites States, except for American Samoa, the Northern Mariana Islands, Puerto Rico, and the US Virgin Islands; or
- without methyl bromide fumigation into all States other than citrus producing States (i.e. Texas, Arizona, Florida, California, Louisiana, Hawaii) aside from American Samoa, the Northern Mariana Islands, Puerto Rico, and the US Virgin Islands (US Electronic Code of Federal Regulations 2008).

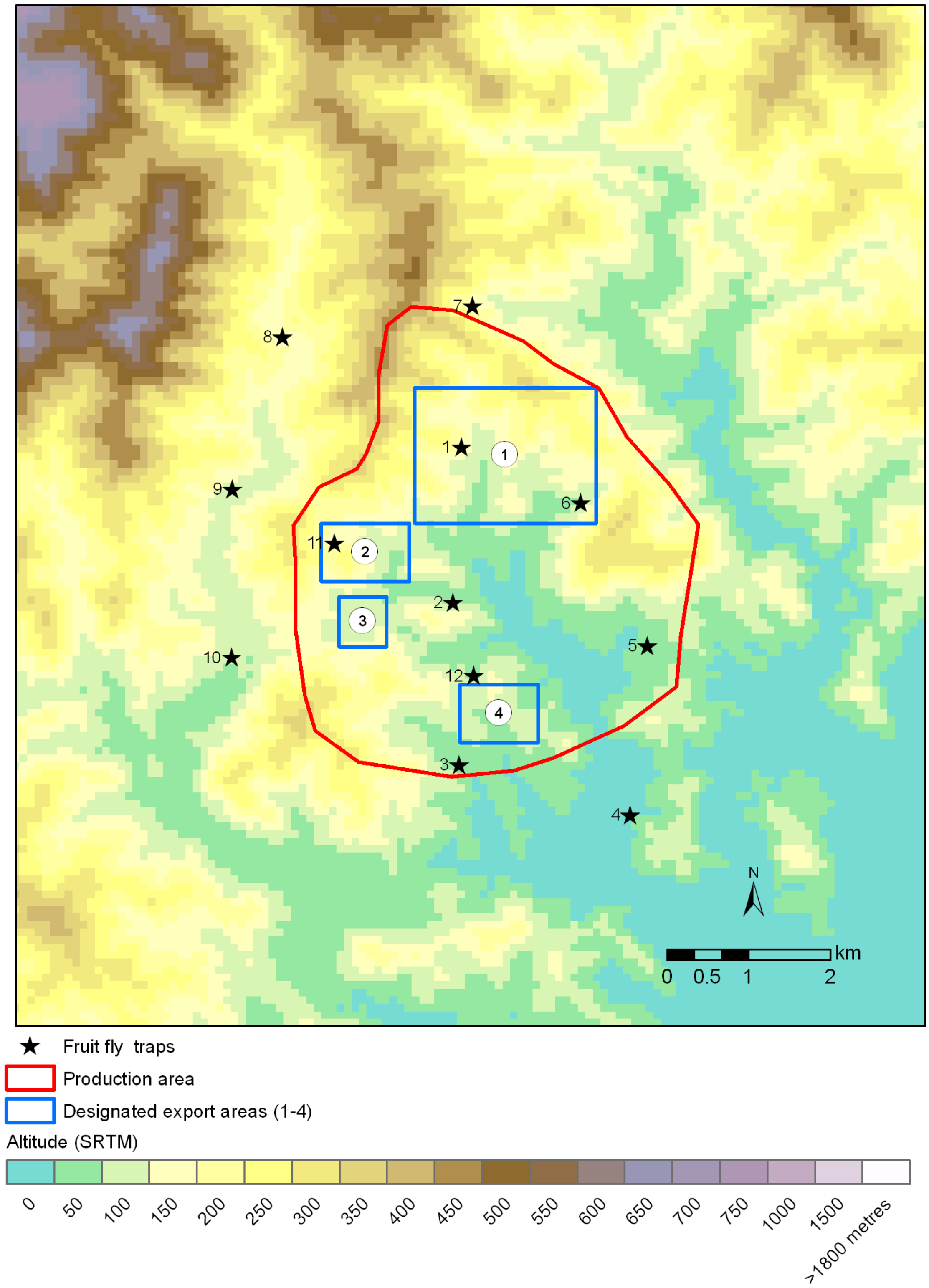
Methyl bromide fumigation is carried out at a rate of 3 lbs./1,000 cu. ft. for 2 hrs at 59ºF or above at normal atmospheric pressure (chamber only) with a load factor of 32% or below (US Electronic Code of Federal Regulations 2008).

Japan has a fruit fly monitoring program in place within and near the production area at Fujieda City. Each fruit fly monitoring site, of which there are 12, consist of one protein trap, one methyl eugenol and one cuelure trap. Japan advised that traps are installed on a 2 km grid. Protein trap lure replacement and trap clearances are on a fortnightly basis. No *B. tsuneonis* has been reported since monitoring for this fruit fly commenced in 2001. The location of the trapping grid is shown in Figure D2, below.

The coordinates for each of the trap installation sites near Fujieda City are:

	Longitude	Latitude
Trap 1:	E 138.13497	N 34.56323
Trap 2:	E 138.13463	N 34.55306
Trap 3:	E 138.13488	N 34.54260
Trap 4:	E 138.14568	N 34.54061
Trap 5	E 138.15035	N 34.55134
Trap 6	E 138.14371	N 34.56101
Trap 7	E 138.12387	N 34.57282
Trap 8	E 138.12387	N 34.57160
Trap 9	E 138.12187	N 34.56155
Trap 10	E 138.12184	N 34.55086
Trap 11	E 138.12593	N 34.55542
Trap 12	E 138.13545	N 34.55014

Figure D2: Trap installation points for *Bactrocera tsuneonis* monitoring both within and near the production area at Fujieda City



SRTM : Shuttle Radar Topographic Mission data

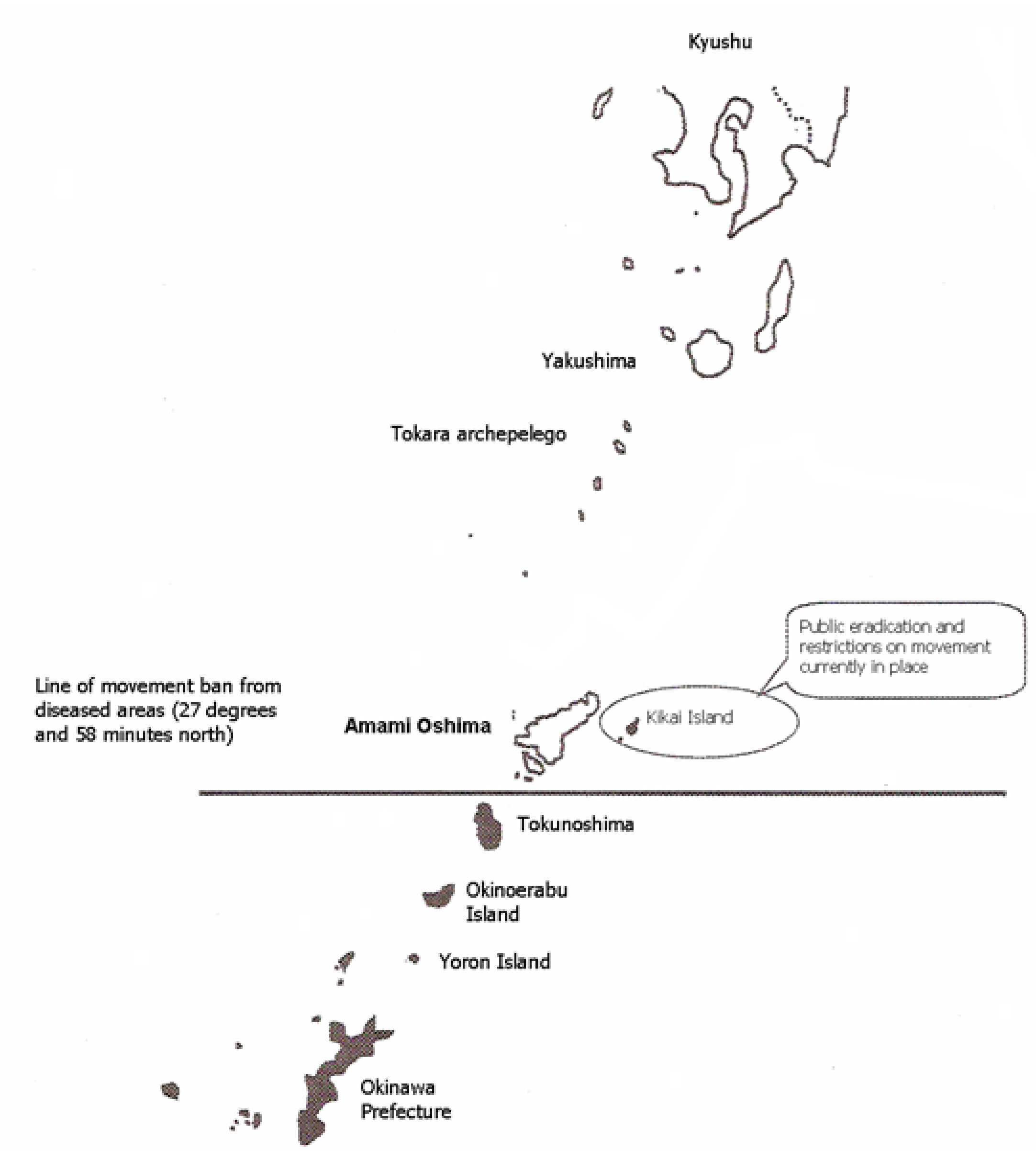
Appendix E: Distribution of citrus greening and citrus psyllid in Japan

Under Japanese plant protection law, both citrus greening (*Candidatus* Liberibacter asiaticum) and its vector, the Asian citrus psyllid (*Diaphorina citri*), are subject to movement restrictions. In 2003 Japan advised that movement of the pest and disease from regions where they occur is prohibited, and the movement of host material is restricted.

Since April 2007, a movement ban for citrus greening host commodities is in place for all areas south of latitude 27º 58N (i.e. all islands south of the Amami Oshima island group and including Kikai Island). In 2007 Japan advised that citrus greening on Kikai Island is currently undergoing eradication (refer to Figure E1). These islands are situated to the south of Kyushu Island and are about 1000 km to the south of the designated unshu mandarin export areas to Australia on Honshu Island.

While citrus greening is confined to the control zone, its vector, the Asian citrus psyllid occurs naturally throughout the chain of islands to the south of Kyushu Island including islands to the north of the citrus greening control zone (Kohno *et al.* 2002). However, Japan advised that the psyllid does not occur on the islands of Honshu, Kyushu or Hokkaido.

Figure E1: Japan's transport regulations in relation to citrus greening (as of April 2007)



Appendix F: Monitoring for citrus canker in the Shizuoka Prefecture

The Shizuoka Prefecture is part of the National Pest Outbreak Forecasting Program that undertakes pest and disease forecasting for specified agricultural crops, including unshu mandarins and other mid-season citrus. The National Pest Outbreak Forecasting Program operates under Japan's *Plant Protection Law and Regulations relevant to Plant Quarantine of 1950* (version 1 April 1997). These regulations refer to Japan's legislation pertaining to inspection, movement of plants and plant material, emergency control of pests and pest forecasting for high risk designated pests (Chapters 3, 4 and 5 of Japan's Plant Protection Law), which must be adhered to by all Prefectures to keep Japan free of, or to control, these pests.

Chapter 6 of Japan's Plant Protection Law provides a list of injurious animals and plants for which Prefectural governments have special powers to ensure freedom from (or control of) those pests that are of concern to a particular Prefecture. This list includes citrus canker.

The Prefectural Pest Forecasting Program is based on 30 sentinel inspection points where specified pest and disease levels are regularly monitored. The sentinel inspection points consist of 10 sites each in the eastern (Numatzu City), central (Shizuoka City) and western (Hamamatzu City) districts within the Prefecture. Japan advised that the two closest inspection points in relation to the designated export areas are Shizuoka City and Numatzu City, which of both of which are 25–50 km from the export areas.

The Pest Forecasting Program for citrus canker at the Shizuoka Prefectural level consists of monthly monitoring during the growing season from March to October. Each month a combined, random sample of 100 leaves (old leaves and new leaves) and fruit is collected from one citrus tree at each of the 30 sentinel stations. This sampling is conducted for two categories of citrus: unshu mandarins and other mid-season citrus. The following equation is used for obtaining monthly statistics that report on the absence/presence of citrus canker from unshu mandarin and other mid-season citrus at the Prefecture level:

$$\frac{100 \times 7A + 5B + 3C + D}{7 \times \text{leaf No}}$$ [10]

A = 21 and more lesions/leaf (or fruit)
B = 11–20 lesions per/leaf (or fruit)
C = 4–10 lesions/leaf (or fruit)
D = 1–3 lesions/leaf (or fruit)

at the 30 monitoring points.

Forecasting information is issued once per month and covers the status of the pest, the predicted level of an emerging pest, and evidence and proportion of fields (orchards) requiring controls. Forecasting information will include information on how to control the pest (e.g. pesticide dosage and timing). This information is disseminated speedily and appropriately to institutions, organisations and stakeholders that engage in the planning, provision of guidance and publicising of controls, to the national government offices in the affected prefecture and surrounding prefectures.

In addition, MAFF officers monitor unshu mandarin orchards exporting fruit from four designated export areas near Fujieda City to the USA and New Zealand twice through the production cycle. Monitoring is conducted after petal fall and prior to harvest.

MAFF inspectors inspect half of all orchards after petal fall and the other half of the orchards at the pre-harvest inspection, which includes inspection of export orchards and buffer orchards. MAFF assistant inspectors inspect the other half of orchards after petal fall and at pre-harvest. Within each orchard 30% of all unshu trees are inspected at random at both the after petal fall and the pre-harvest inspection.

The pre-harvest inspection for the USA consists of a joint field inspection of MAFF and the Animal and Plant Health Inspection Service (APHIS) personnel. According to information provided by Japan, there has been no detection of citrus canker in the export areas since trade in unshu mandarins commenced to the USA in 1968. New Zealand does not require a joint field inspection.

Glossary

Term or abbreviation	Definition
Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2008).
Appropriate level of protection (ALOP)	The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995).
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2008).
Area of low pest prevalence	An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2008).
Biosecurity Australia	A prescribed agency within the Australian Government Department of Agriculture, Fisheries and Forestry. Biosecurity Australia provides science-based quarantine assessments and policy advice that protects Australia's favourable pest and disease status and enhances Australia's access to international animal and plant related markets.
Consignment	A quantity of plants, plant products and/or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots) (FAO 2008). Unshu mandarin fruit covered by one phytosanitary certificate shipped via one port in Japan to a designated port in Australia.
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2008).
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2008).
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2008).
Establishment	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2008).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2008).
Fruits and vegetables	A commodity class for fresh parts of plants intended for consumption or processing and not for planting (FAO 2008).
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2008).
Import Permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2008).
Import Risk Analysis	The assessment of the level of risk associated with the importation, or proposed importation, of animal, plants or other goods and, where necessary, the identification of risk management options to limit the level of quarantine risk to one that is acceptably low (*Quarantine Act 1908*).
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2008).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations (FAO 2008).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced, or used (FAO 2008).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2008).

Term or abbreviation	Definition
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on phytosanitary measures or the Commission on phytosanitary measures, established under the IPCC (FAO 2008).
Introduction	The entry of a pest resulting in its establishment (FAO 2008).
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin etc., forming part of a consignment (FAO 2008). All unshu mandarin fruit packed for export to Australia each day by a registered packing house.
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the International Plant Protection Convention (FAO 2008).
Official control	The active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests (FAO 2008).
Pathway	Any means that allows the entry or spread of a pest (FAO 2008).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2008).
Pest categorisation	The process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest (FAO 2008).
Pest Free Area (PFA)	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2008).
Pest free place of production	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2008).
Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this conditions is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2008).
Pest Risk Analysis (PRA)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (FAO 2008).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and the magnitude of the associated potential economic consequences (FAO 2008).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2008).
pH	The measure of the acidity or alkalinity of a solution.
Phellogen	Plant meristem (growth layer) responsible for secondary growth of a corky protective layer.
Phytosanitary Certificate	Certificate patterned after the model certificates of the IPPC (FAO 2008).
Phytosanitary measure	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2008).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2008).
Polyphagous	Feeding on a relatively large number of hosts from different genera.

Term or abbreviation	Definition
PRA area	Area in relation to which a Pest Risk Analysis is conducted (FAO 2008).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2008).
Regulated article	Any plant, plant product, storage place, packing, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2008).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Spread	Expansion of the geographical distribution of a pest within an area (FAO 2008).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures (WTO 1995).
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests (FAO 2008).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.

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