



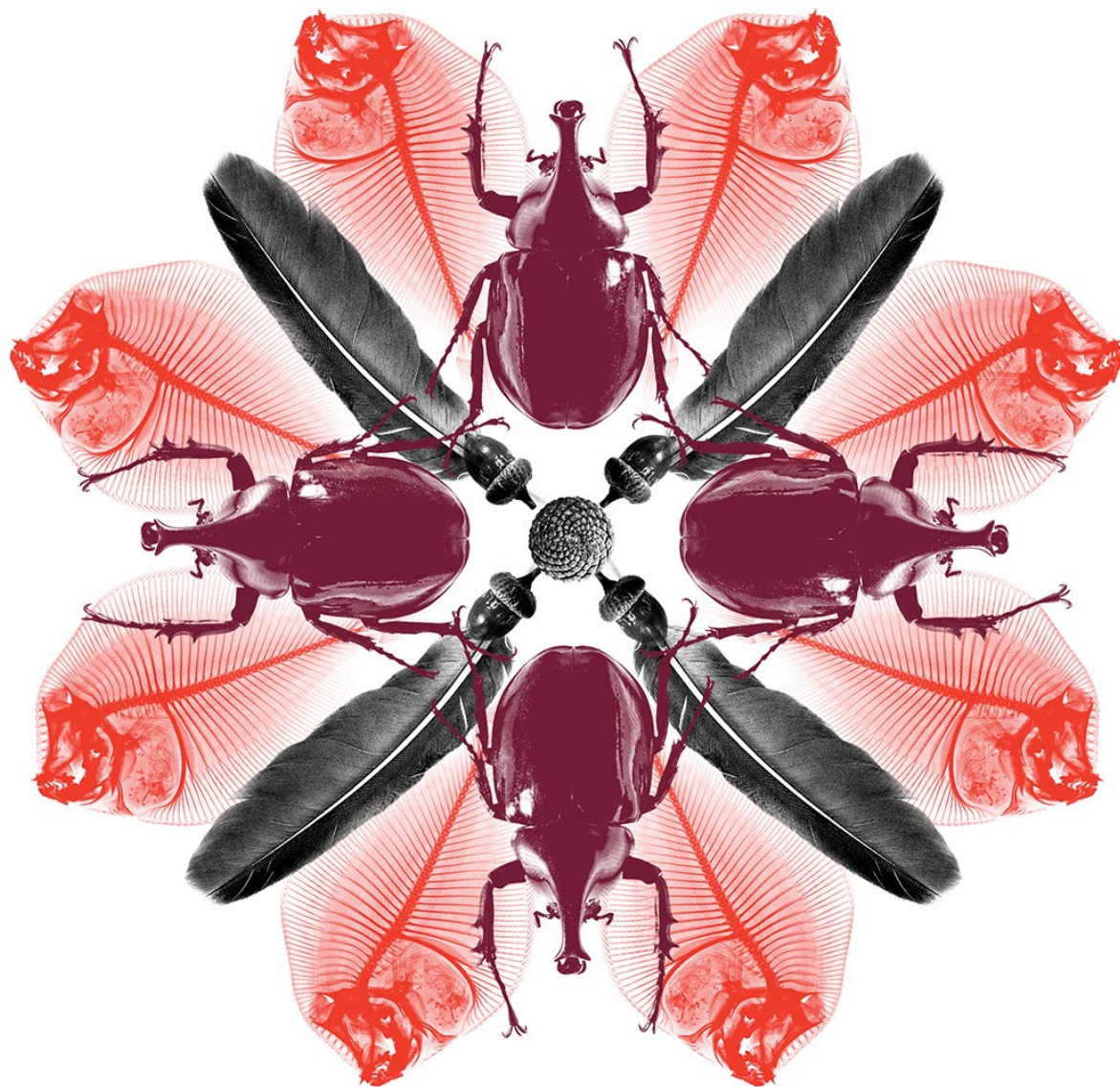
Australian Government

Department of Agriculture  
and Water Resources

# Final report for the review of biosecurity import requirements for Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu

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March 2018



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Australian Government Department of Agriculture and Water Resources  
GPO Box 858 Canberra ACT 2601

Switchboard: +61 2 6272 3933 or 1800 900 090

Facsimile: +61 2 6272 3307

Email: [plant@agriculture.gov.au](mailto:plant@agriculture.gov.au)

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## Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BA	Biosecurity Australia (now the Department of Agriculture and Water Resources)
BICON	Department of Agriculture and Water Resources Biosecurity Import Conditions database
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Fisheries and Forestry (now the Department of Agriculture and Water Resources)
DAWR	Department of Agriculture and Water Resources
FAO	Food and Agriculture Organization of the United Nations
IPC	International Phytosanitary Certificate
IPPC	International Plant Protection Convention
IRA	Import risk analysis
ISPM	International Standard for Phytosanitary Measures
NSW	New South Wales
NPPO	National Plant Protection Organisation
NT	Northern Territory
PRA	Pest risk assessment
Qld	Queensland
SA	South Australia
SPS	Sanitary and Phytosanitary
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

## Summary

The Australian Government Department of Agriculture and Water Resources (the department) has prepared this report to assess the biosecurity risk associated with the import of fresh Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu into Australia.

The department received formal requests from Samoa and Vanuatu for market access for fresh Tahitian limes. The Cook Islands, Niue and Tonga subsequently expressed interest in exporting fresh Tahitian limes to Australia. Given the similarities in pest status, all five countries have been included in this risk analysis.

Australia permits the importation of fresh limes from Egypt, New Caledonia, New Zealand, Spain and the United States of America (USA) for human consumption provided they meet Australian biosecurity requirements.

This report recommends that the importation of fresh Tahitian limes to Australia from all commercial production areas of the Cook Islands, Niue, Samoa, Tonga and Vanuatu be permitted, subject to a range of biosecurity conditions.

This report contains details of pests that are of quarantine concern to Australia with the potential to be associated with the importation of fresh Tahitian limes, the risk assessments for the identified quarantine pests, and the recommended risk management measures to reduce the biosecurity risk to an acceptable level.

Three pests have been identified as requiring risk management measures. All three pests are arthropods. These pests are *Dysmicoccus neobrevipes* (grey pineapple mealybug), *Planococcus minor* (Pacific mealybug) and *Pseudococcus cryptus* (cryptic mealybug).

*Planococcus minor* and *Pseudococcus cryptus* were assessed as being regional quarantine pests for Western Australia and *Dysmicoccus neobrevipes* was assessed as being a quarantine pest for all of Australia.

This report recommends risk management measures, combined with operational systems to reduce the risks posed by the three quarantine pests, to achieve the appropriate level of protection for Australia. The risk management measures include a pre-export phytosanitary inspection to be undertaken by the exporting country to ensure that each consignment is free of identified quarantine pests. All consignments will be inspected on arrival in Australia to verify the absence of pests. If consignments are found to be infested, they are subject to appropriate remedial action.

Written submissions on the draft report were received from six stakeholders. The final report takes into account stakeholder comments on the draft report. The department has made a number of changes to the risk analysis following consideration of stakeholder comments on the draft report and subsequent review of the literature. These changes include:

- Reviewing the pest risk assessment for *Elsinoë fawcettii*, including revising the likelihood of importation from 'low' to 'moderate', and the addition of new references.

- Updating the pest categorisation table to clarify the host association of *Homalodisca vitripennis* with citrus fruit and its potential to be imported in trade.
- Minor corrections, rewording and editorial changes for consistency and clarity.
- The addition of Appendix B 'Issues raised in stakeholder comments', which summarises the key stakeholder comments and how they were considered in the final report.



# 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 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 risk analysis 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 importing 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. If the risks cannot be mitigated to an acceptable level, the goods will not be imported into Australia until suitable measures are identified.

Successive Australian governments have maintained a stringent, but not a zero risk, approach to the management of biosecurity risks. This is expressed in terms of the ALOP for Australia, which is defined in the *Biosecurity Act 2015* as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's risk analyses are undertaken by the department using technical and scientific experts in relevant fields, and involve consultation with stakeholders at various stages during the process. The assessment may take the form of a biosecurity import risk analysis (BIRA), a review of biosecurity import requirements, or other non-regulated risk analyses such as pest-specific assessments, weed risk assessments and biological control agent assessments.

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016*, available on the [Department of Agriculture and Water Resources website](#).

## 1.2 This review of biosecurity import requirements

### 1.2.1 Background

Australia finalised import conditions for fresh Tahitian limes (*Citrus latifolia*) from New Caledonia in August 2006, following the release of an import risk analysis in May 2006 (BA 2006a). At that time Australia already permitted the importation of fresh Tahitian limes from Egypt, New Zealand, Spain and the USA.

Vanuatu initially requested market access for Tahitian limes in August 2006, and lodged a formal submission in August 2007. Samoa also informed Australia in 2006 that citrus, including Tahitian limes, was a high priority for market access. Additional information was received in a formal submission in March 2007, outlining Samoa's production practices and proposed export procedures.

The Cook Islands, Niue and Tonga subsequently indicated an interest in exporting limes to Australia, and these countries have been included in the review of biosecurity import



requirements. Given that the Cook Islands, Niue, Samoa, Tonga and Vanuatu have a similar pest status the review has assessed all five countries simultaneously.

The department announced the commencement of this review of biosecurity import requirements on 15 April 2016. An officer from the department visited Tahitian lime production areas in Vanuatu to verify pest prevalence in June 2016. Pest management practices, harvesting methods, processing and packing procedures for commercially produced limes were also observed and discussed.

The draft report was released for public comment on 6 June 2017.

### 1.2.2 Description of Tahitian limes

*Citrus latifolia* (family Rutaceae) has a number of common names including Tahitian lime, Persian lime and Bearss lime. The term Tahitian lime is used in this report to refer to *Citrus latifolia*.

The origins of the Tahitian lime are unclear, but it is likely to be a hybrid of West Indian lime (*Citrus aurantifolia*) and citron (*Citrus medica*) (Morton 1987). Previously it was considered to be a cultivar or subspecies of *Citrus aurantifolia*, and was not recognised as a separate species until 1951 (Grayum *et al.* 2012). It was probably introduced to the Mediterranean region from Persia (Iran) and later brought to Brazil by Portuguese traders. It was subsequently introduced to Australia from Brazil in 1824 (Morton 1987). Tahitian lime was introduced to California from Tahiti (French Polynesia) around 1850, purportedly grown from seeds extracted from imported fruit (Barnidge-McIntyre 2010), hence the common name.

The Tahitian lime tree is medium to large in size, growing up to six metres in height, with nearly thornless, widespread, drooping branches (Morton 1987). The fruit (Figure 1) is typically 5.5 to 8.0 centimetres long and 5.0 to 7.5 centimetres wide (Grayum *et al.* 2012), and oval, obovate, oblong or short-elliptical in shape. It is usually rounded at the base, and the apex is rounded with a short nipple (Morton 1987). The fruit is usually seedless, only rarely having one or a few seeds. Tahitian lime flowers have no viable pollen (Morton 1987).

**Figure 1 Tahitian limes packed for export, Port Vila, Vanuatu**



The fruit peel colour is vivid green to pale yellow in colour, but the peel colour is not a good indicator of fruit maturity. There is little quality difference between light green and yellow limes, although consumer preference in many countries is for green lime fruit (Pranamornkith 2009). Therefore, limes are usually harvested when they are fully developed, but the peel is still green in colour (Pranamornkith 2009). The fruit do not continue to ripen off the tree after harvest (non-climacteric), but the peel gradually loses its green colour in storage due to chlorophyll degradation (Pranamornkith 2009), eventually turning yellow.

### 1.2.3 Scope

The scope of this risk analysis is to consider the biosecurity risks that may be associated with the importation of commercially-produced fresh Tahitian lime (*Citrus latifolia*) fruit from the Cook Islands, Niue, Samoa, Tonga and Vanuatu for human consumption. The assessment does not consider other species of limes (West Indian limes, kaffir limes, rangpur limes) or other citrus species. In this report, Tahitian limes are defined as individual lime fruit, which may include a small amount of attached fruit stalk and calyx, but not other plant parts such as leaves.

### 1.2.4 Existing policy

#### International policy

In addition to the importation of fresh Tahitian lime fruit noted above (Section 1.2.1), Australia also allows the importation of fresh West Indian limes (*Citrus aurantifolia*; also known as key limes or Mexican limes), kaffir limes (*Citrus hystrix*) and rangpur limes (*Citrus limonia*) from New Zealand, Spain and the USA.

The import requirements for fresh limes for human consumption from these countries can be found in the department's Biosecurity Import Conditions (BICON) database on the [department's website](#).

The department has considered all the pests previously identified in the existing policies and, where relevant, the information in those assessments has been taken into account in this risk analysis. The department has also reviewed the latest literature to ensure that information in previous assessments is still valid.

This assessment considers pests associated with Tahitian lime fruit grown in the Cook Islands, Niue, Samoa, Tonga and Vanuatu.

#### Domestic arrangements

The Commonwealth 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 their individual jurisdictions. 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. Once plant and plant products have been cleared by Australian biosecurity officers, they may be subject to interstate movement conditions. It is the importer's responsibility to identify, and ensure compliance with all requirements.

### **1.2.5 Contaminating pests**

This report assesses pests with a known association with Tahitian lime fruit. However, other organisms may unintentionally be imported with the limes. These organisms are considered to be contaminating pests that could pose sanitary and phytosanitary risks. These risks are identified and addressed using existing operational procedures, which requires a 600 unit inspection of all consignments, or equivalent measures. The department will investigate if any pest detected in an imported consignment is of quarantine concern to Australia and requires remedial action.

### **1.2.6 Consultation**

The department notified stakeholders on 15 April 2016 in Biosecurity Advice 2016/12 of the formal commencement of a review of biosecurity import requirements for fresh Tahitian lime fruit from the Cook Islands, Niue, Samoa, Tonga and Vanuatu.

A pest categorisation list was provided to the state and territory governments prior to the formal release of the draft report to ensure that any pests regulated by states and territories were identified and considered accordingly. The department consulted with the relevant state and territory governments in Australia and the NPPOs of the exporting countries during the preparation of the draft report, which was released on 6 June 2017 for a 60 day public consultation period. Further consultation with the states and territories, NPPOs and the Australian citrus industry was undertaken during and after the stakeholder comment period.

## 2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The department has conducted this PRA in accordance with the international standards for phytosanitary measures (ISPM), including ISPM 2: *Framework for pest risk analysis* (FAO 2007) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013). The ISPMs have been developed under the International Plant Protection Convention (IPPC) (FAO 2011), which is recognised as the standard setting organisation for matters of plant health in the SPS Agreement (WTO 1995).

A PRA is ‘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 2016). A pest is ‘any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products’ (FAO 2016). This definition is also applied in the *Biosecurity Act 2015*.

Biosecurity risk consists of two major components: the likelihood 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 by taking into account the existing commercial production practices of the exporting country and on the basis that, on arrival in Australia, the department will verify that the consignment received is as described on the commercial documents and its integrity has been maintained.

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/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests’ (FAO 2016).

A glossary of the terms used in this report is provided on page 69.

PRAs are conducted in three consecutive stages: initiation, pest risk assessment and pest risk management.

### 2.1 Stage 1 Initiation

Initiation identifies the pest(s) and import pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area. For this report, the ‘PRA area’ is defined as Australia (excluding its external territories) for pests that are absent, or of limited distribution and under official control. However, for areas with regional freedom from a pest, the ‘PRA area’ may be defined on the basis of a specific region such as a state or territory of Australia.

The pests assessed for their potential to be on imported Tahitian lime fruit (produced using typical commercial production and packing procedures) are listed in Appendix A. This is not a comprehensive list of all pests associated with Tahitian lime trees, but concentrates on those that could be imported on commercial-quality lime fruit. Pests that are not associated with the fruit are not considered further in this review as they are not considered to be on the import

pathway. Potential contaminating pests that have no specific relation to lime fruit or the import pathway have not been listed, but will be addressed by Australia's operational procedures for managing contaminating pests.

For pests that have previously been considered in other risk assessments for which import conditions exist, this risk analysis specifically considered the likelihood of entry on Tahitian limes, and whether existing policy is adequate to manage the risks associated with its import. Where appropriate, a previous risk assessment was taken into consideration in this risk analysis.

## **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 magnitude of the associated potential economic consequences' (FAO 2016).

The following steps were used in the pest risk assessments.

### **2.2.1 Pest categorisation**

Pest categorisation identifies the pests that could potentially be imported on Tahitian lime fruit and that are quarantine pests for Australia, and thus require pest risk assessment. 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 2016).

Categorisation of quarantine pests on this pathway includes the following primary elements:

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

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

### **2.2.2 Assessment of the likelihood of entry, establishment and spread**

Details of how to assess the entry, establishment and spread of a pest are given in ISPM 11 (FAO 2013). The department uses the term 'likelihood' for the descriptors it uses for its estimates of likelihood of entry, establishment and spread, consistent with the terminology in the SPS Agreement (WTO 1995). A summary of this process is given below, followed by a description of the qualitative methodology used in this risk analysis.

#### **Likelihood of entry**

The likelihood of entry estimates whether a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state within Australia, 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 use in Australia and the generation and disposal of waste. In particular, the ability of the pest to survive is considered for each of these stages.

The likelihood of entry estimates for the identified quarantine pests are based on the commercial production, packaging and shipping practices of the exporting country.

This stage of the risk assessment is divided into two components: importation and distribution. The likelihood of importation considers the likelihood that a pest will arrive in Australia when a given commodity is imported. The likelihood of distribution considers the likelihood that the pest will be distributed within Australia as a result of the sale or disposal of the commodity, and subsequently transfer to a suitable host.

Factors considered in assessment of the likelihood of importation include:

- the geographical distribution and incidence of the pest in the source area
- the occurrence of the pest in a life-stage that is associated with the commodity
- the 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
- transport and storage procedures in the country of origin, and in transit to Australia.

Factors considered in assessment of the likelihood of distribution may include:

- commercial procedures (for example, refrigeration) applied to consignments during distribution within Australia
- dispersal mechanisms of the pest, including its vectors if relevant, that might allow movement from the pathway to a host
- proximity of entry, transit and destination points to hosts in Australia
- time of year at which importation takes place
- intended use of the commodity (for example, for planting, processing or consumption)
- risks from by-products and waste.

### **Likelihood of establishment**

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2016). In order to estimate the likelihood of establishment of a pest, reliable biological information (for example, of lifecycle, host range, epidemiology and survival) is obtained from the areas where the pest currently occurs. The conditions in the PRA area can then be compared with those in the areas where the pest currently occurs, and expert judgement used to assess the likelihood of establishment.

Factors considered in assessment of the likelihood of establishment in Australia include:

- the availability of hosts, alternative hosts and vectors

- the suitability of the environment
- the pest's reproductive strategy and potential for adaptation
- the minimum population needed for establishment
- cultural practices and control measures used against the pest.

### **Likelihood of spread**

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2016). Assessment of the likelihood of spread considers the factors relevant to the movement of the pest, after establishment on a host plant, to other susceptible host plants in other areas. In order to estimate the likelihood 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 those in the areas where the pest currently occurs, and expert judgement used to assess the likelihood of spread.

Factors considered in assessment of the likelihood of spread include:

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

### **Assigning likelihoods for entry, establishment and spread**

The likelihoods of entry (importation and distribution), establishment and spread are expressed using the terms high, moderate, low, very low, extremely low and negligible to indicate the relative possibilities of each event occurring. Definitions of 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.

**Table 2.1 Nomenclature of qualitative likelihoods**

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

### **Determining the likelihood of entry, establishment and spread**

The likelihood of entry (E) is determined by combining the likelihoods that the pest will be both imported and distributed into and within the PRA area, using a combinatorial assessment matrix (Table 2.2). This same matrix is then used to further combine the likelihoods of entry and



establishment; finally the combined likelihoods of entry and establishment (EE) are then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread (EES).

For example, for a pest for which the likelihood of importation is estimated to be 'low', distribution to be 'moderate', establishment to be 'high' and spread to be 'very low', the overall likelihood of entry, establishment and spread would be calculated as follows:

importation x distribution = [E]

**low x moderate = low**

[E] x establishment = [EE]

**low x high = low**

[EE] x spread = [EES]

**low x very low = very low**

**Table 2.2 Assessment matrix of rules for combining 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 trade continues and the overall volume of trade accumulates.

The department 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.

These considerations have been taken into account when setting up the matrix. Therefore any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on the department'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. If there are substantial changes in the volume and nature of the trade in specific commodities then the department will review the risk analysis and, if necessary, provide updated policy advice.

In considering the volume of trade in this risk analysis, the department has concluded that only a relatively low volume of trade is likely to occur, given the estimated quantities of production in the exporting countries.

### 2.2.3 Assessment of potential consequences

The objective of the consequences assessment is to provide an analysis of the likely consequences if the pests were to enter, establish and spread in Australia. The assessment considers potential 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 2016) and ISPM 11 (FAO 2013).

Direct pest effects are considered in the context of the effects on plant life or health, and other aspects of the environment. Indirect pest effects are considered in the context of costs of pest eradication or control, the effects on domestic and international trade and the environment. For each of these criteria, the consequences are estimated at four geographic levels: local, district, regional and national.

**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 (including Tasmania, but excluding the external territories).

For each criterion, the magnitude of the potential consequence at each of these levels is 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.

The estimates of the magnitude of the potential consequences over the four geographic levels are translated into an impact score (A–G) using Table 2.3. For example, a consequence with a magnitude of ‘significant’ at the ‘district’ level will have a consequence impact score of D.

**Table 2.3 Decision rules for determining the consequence impact scores**

Magnitude	Geographic scale			
	Local	District	Region	Nation
Indiscernible	A	A	A	A
Minor significance	B	C	D	E
Significant	C	D	E	F
Major significance	D	E	F	G

Note: In earlier qualitative PRAs, 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 to F has been 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.

The overall consequences rating for each pest is determined by combining the qualitative impact scores (A–G) for each direct and indirect consequence using mutually exclusive decision rules (Table 2.4).

**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

## 2.2.4 Estimation of the unrestricted risk

Once the assessment of the likelihood of entry, establishment and spread and for potential consequences are completed, the unrestricted risk can be determined for each pest or for groups of pests. This is determined by using a risk estimation matrix (Table 2.5) to combine the estimates of the likelihood 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 (for example, 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**

<b>Likelihood of pest entry, establishment and spread</b>	<b>Consequences of pest entry, establishment and spread</b>					
	<b>Negligible</b>	<b>Very low</b>	<b>Low</b>	<b>Moderate</b>	<b>High</b>	<b>Extreme</b>
<b>High</b>	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
<b>Moderate</b>	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
<b>Low</b>	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
<b>Very low</b>	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
<b>Extremely low</b>	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
<b>Negligible</b>	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

### 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.

### 2.2.6 Adoption of previous assessments

Some pests being considered may have been assessed previously by the department for different import pathways. The outcomes of previous assessments may be adopted for such pests where the available information suggests the risks would be similar for the new pathway being considered. The adoption of the outcomes of previous assessments is outlined here.

The reassessment of the likelihood of importation for pests that have been assessed previously is considered on a case-by-case basis by comparing factors relevant to the importation of the new commodity from the source country with those assessed previously. These factors include the commodity type, the prevalence of the pest and commercial production practices. The department may determine reassessment of the likelihood of importation is not required where the relevant factors are comparable to those considered in the previous assessments. There is also no need to reassess the likelihood of importation where changes to the likelihood rating for importation will not alter the unrestricted risk estimate.

The reassessment of the likelihood of distribution for pests that have been assessed previously is also considered on a case-by-case basis by comparing factors relevant to the distribution of the new commodity with those assessed previously. These factors include the commodity type, the time of year when importation occurs and the availability and susceptibility of hosts at that time. The department may determine reassessment of the likelihood of distribution is not required where the relevant factors are comparable to those considered in the previous assessments.

The likelihoods of establishment and spread of a pest, and the potential consequences, will be comparable to previous assessments regardless of the commodity/country pathway in which the pest is imported into Australia, as these likelihoods relate specifically to events that occur in Australia and are independent of the importation pathway. For pests that have been assessed previously, the department will review the latest literature. If there is no new information available that would significantly change the likelihood risk ratings for establishment and spread, and the consequences the pests may cause, the risk ratings given in the previous assessments for these components will be adopted.

### **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 effectiveness of any proposed phytosanitary measure (or combination of measures) is evaluated to ensure it reduces the restricted risk for the relevant pest or pests to meet Australia's ALOP.

The choice of measures to be applied is based on their effectiveness in reducing the likelihood of entry of the pest. ISPM 11 (FAO 2013) provides details on the identification and selection of appropriate risk management options. Measures commonly applied to traded commodities include:

- options for consignments—for example, 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, and restrictions on end-use, distribution and periods of entry of the commodity
- options preventing or reducing infestation in the crop—for example, 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—for example, pest-free area, pest-free place of production or pest-free production site
- 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 (Chapter 5).

### 3 Commercial production practices for Tahitian limes

This chapter provides information on the commercial production, harvest and post-harvest practices considered to be standard practices in the Cook Islands, Niue, Samoa, Tonga and Vanuatu for the production of fresh Tahitian limes for export. The export capabilities of these countries is also outlined.

#### 3.1 Considerations used in estimating unrestricted risk

Samoa and Vanuatu provided the department with information on the typical commercial practices adopted in the production of Tahitian limes for export. This information was complemented with data from published literature, observations from visits to production areas and other sources, all of which were taken into account when estimating the unrestricted risk of pests that may be associated with the import of this commodity.

Because this review is considering multiple countries with varying production and pest management requirements, the report makes minimal assumptions about the production practices involved. Therefore only basic standards of crop management and post-harvest handling practices are assumed to have occurred when assessing the pest risks. These practices are outlined below. However, it is required that all Tahitian limes be sourced from commercial growers, and exported from packing facilities known to the relevant NPPO.

Many growers are expected to apply pesticides and fungicides as part of pest management programs, which would reduce the likelihood of pests being present on imported fruit. However, as production practices are not standardised across all growers in all countries being assessed, pesticide and fungicide application has not been assumed when assessing the likelihood of importation.

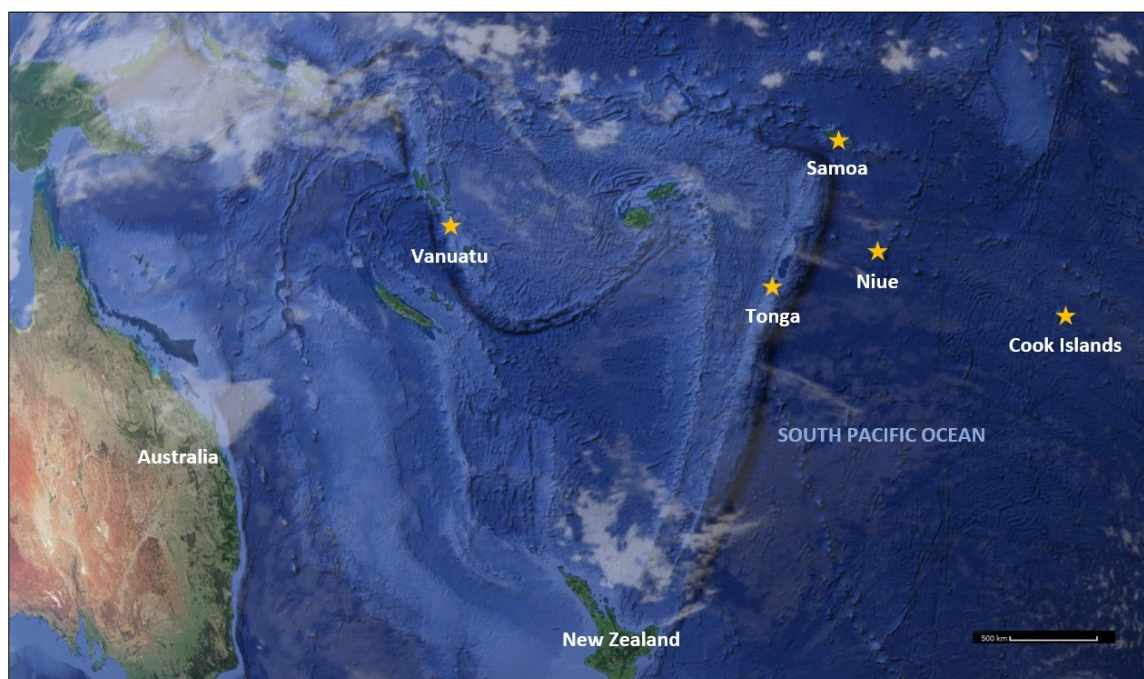
When assessing the likelihood of entry, it was considered that trade volumes would be relatively low for the foreseeable future, likely less than 20 tonnes per year. Commercial production of Tahitian limes in the Pacific Islands is mostly on a small scale, so there will be a limited volume of Tahitian limes available for export.

#### 3.2 The Cook Islands, Niue, Samoa, Tonga and Vanuatu

The Cook Islands, Niue, Samoa, Tonga and Vanuatu are small island nations in the South Pacific (Figure 2). These countries all have a tropical maritime climate, with distinct wet and dry seasons. The wet season is typically from November to April, with the dry season from May to October. Within each country there are local climatic variations that can affect the suitability for growing particular crops. This is due to the prevailing trade winds and mountainous terrain, and the different latitudes of islands, particularly in those with archipelagos spread over vast areas such as the Cook Islands and Tonga.

Tahitian limes are grown all year round in the Pacific Islands, although harvesting specifically for the export market may be limited by seasonal demand in overseas markets. Vanuatu typically exports limes to New Zealand from July to January.



**Figure 2 Location of Pacific Island countries considered in this report**

Source: Google Earth

### **The Cook Islands**

The Cook Islands consists of 15 major islands, geographically divided into two groups. The northern islands are low-lying coral atolls, whereas the southern islands are mainly the hilly remains of ancient volcanoes. Most of the population, and agricultural production for export markets, are concentrated on the island of Rarotonga, in the Southern Cook Islands, where the national capital Avarua and international airport are located.

### **Niue**

Niue is a raised coral atoll between the Cook Islands and Tonga. The island has a land area of less than 270 square kilometres, and a population of around 1400 people. Agriculture is an important sector of the Niuean economy, although still predominantly through small scale or subsistence farming. The main exports are vanilla, taro and noni (*Morinda citrifolia*), although limes have been a significant crop in the past. While Niue has an international airport, there are currently no direct commercial flights to Australia, and the only routine air access is via Auckland, New Zealand.

### **Samoa**

Samoa has two main islands, Upolu and Savai'i, as well as a number of smaller islands and islets. The USA territory of American Samoa, which lies around 70 kilometres to the east of Upolu, is not part of the Independent State of Samoa (previously known as Western Samoa). The Samoan islands are volcanic in origin, with narrow coastal plains and rugged mountainous interiors. Much of the population is involved in subsistence agriculture, with the main commodities grown being coconuts, bananas, taro, yams, coffee and cocoa; export volumes are small. Samoa has market access into New Zealand for citrus fruit, including Tahitian limes.

## Tonga

Tonga is an archipelago of 176 islands to the south of Samoa. The islands are widely spread across 700 000 square kilometres of the South Pacific in two parallel chains running north–south. The islands are administratively divided into three groups; the Vava’u group in the north, the Ha’apai group in the centre, and the Tongatapu group in the south. Most of the population live on the island of Tongatapu, which is the main commercial hub, and where the capital Nuku’alofa and international airport are situated. Commercial production of Tahitian limes is insignificant in Tonga, with ‘bush lime’ (*Citrus aurantifolia*) the most common type of lime grown.

## Vanuatu

Vanuatu lies to the northeast of New Caledonia, and consists of more than 80 islands, mostly mountainous and of volcanic origin, with narrow coastal plains. Cash crops such as copra, timber and cocoa are important exports, although much of the agricultural sector is small scale, growing coconuts, coffee, kava, taro, yams, fruit and vegetables. Tahitian lime production in Vanuatu for export to New Zealand is presently undertaken on the island of Efate, to the north of Mele Bay just outside Port Vila. The Vanuatu Department of Agriculture has been promoting increased plantings of Tahitian limes elsewhere on Efate, particularly on the drier eastern side of the island, so it is anticipated that future exports from Vanuatu may originate from orchards in other areas. Efate is likely to remain the main source of export production in Vanuatu due to the proximity of the seaport and airport providing access to Australia and other international markets.

### 3.3 Pre-harvest

Tahitian limes grown for export to Australia will be sourced from registered orchards where agronomic and sanitation procedures are implemented and monitored by the relevant National Plant Protection Organisation. Growers follow the field agronomic and pest management practices recommended by their agriculture departments. Extension officers regularly visit orchards to monitor compliance.

Nursery stock is generally sourced from government agriculture departments or from approved suppliers. In Vanuatu, Tahitian lime scions are grafted onto Meyer lemon rootstock, grown from seeds sourced from New Caledonia.

The young trees are usually planted in rows, forming hedgerows when they are mature. Spacing between rows allows for access to harvest the fruit. In Vanuatu, the trees usually reach full production after four years.

Pruning is undertaken when trees are young to establish the basic shape, and then periodically as the trees mature. Pruning may be done to either encourage growth or reduce tree size. Thinning of bearing trees encourages vegetative growth.

### 3.4 Harvesting and handling procedures

The limes are harvested by hand, with the fruit being twisted off the tree and placed directly into baskets or containers for transfer to the packing house.

Typical yield in Vanuatu is around 50 kilograms of fruit per tree annually. Fruit on the ground is not collected for export, and is removed from the orchard for appropriate disposal. Only sound Tahitian lime fruit are harvested and taken to the exporters' packing houses for washing, grading and packing.

### **3.5 Post-harvest**

The fruit are either prepared and packed in a facility on the farm where they were harvested, or transported to a packing house. The lime fruit are washed, dried and graded by hand. The fruit are checked for presence of pests and symptoms of infestation, as well as quality issues such as bruising, scarring, colour and size. Rejected fruit is removed from the pathway and discarded. Lime fruit of acceptable quality are then packed in cardboard boxes by hand. Boxed fruit may be stored under refrigeration for a few weeks until required for export. The fruit are then transported to an official NPPPO facility where the pre-export phytosanitary inspection is undertaken.

After clearance, the fruit are transferred to the airport or seaport for export. Tahitian lime export consignments from the Pacific Islands are typically small, usually less than 1500 kilograms, so airfreight is the preferred transport option. There are direct flights to Australia from the Cook Islands, Samoa, Tonga and Vanuatu, although cargo space is limited. Citrus consignments could be sea-freighted to international markets from the Pacific Islands.

### **3.6 Export capability**

It is difficult to anticipate potential export volumes from the Pacific region, but market forces will ultimately determine whether significant and sustained trade eventuates. Commercial production of Tahitian limes in the Pacific Islands is mostly small scale and focused on supplying local markets, and there are limited market access opportunities for growers.

A small number of growers in Samoa and Vanuatu currently export Tahitian limes to New Zealand, but trade volumes are small.

## 4 Pest risk assessments for quarantine pests

The pests associated with fresh Tahitian lime fruit from the Cook Islands, Niue, Samoa, Tonga and Vanuatu are identified in Appendix A. Some of these pests are present in parts of Australia, but in other areas are considered to be pests of regional concern as reflected in state quarantine regulations. In following parts of this section the acronym 'WA' is used to identify those pests regulated as quarantine pests by Western Australia.

Pest categorisation identified twelve quarantine pests associated with export-quality Tahitian limes produced in the Cook Islands, Niue, Samoa, Tonga and Vanuatu (Table 4.1), which could potentially be imported into Australia. Three of these quarantine pests are of national concern and nine are of regional concern to Western Australia only.

Most of the identified quarantine pests have been assessed previously by the department. Unless new information is available that suggests the risk would be different for this specific pathway, the outcomes of the previous assessments have been adopted for these pests. The acronym 'EP' ('existing policy') is used to identify those pests for which previous outcomes have been adopted.

**Table 4.1 Quarantine pests of Tahitian limes**

<b>Pest</b>	<b>Common name</b>	<b>Countries where pest is present</b>
<b>Soft scales [Hemiptera: Coccidae]</b>		
<i>Saissetia neglecta</i> De Lotto, 1969 [WA]	Caribbean black scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu
<b>Armoured scales [Hemiptera: Diaspididae]</b>		
<i>Chrysomphalus dictyospermi</i> (Morgan, 1889) [EP, WA]	Spanish red scale	Cook Islands, Niue, Samoa, Tonga
<i>Hemiberlesia cyanophylli</i> (Signoret, 1869) [EP, WA]	Cyanophyllum scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu
<i>Morganella longispina</i> (Morgan, 1889) [EP, WA]	Plumose scale	Cook Islands, Samoa, Tonga
<i>Parlatoria cinerea</i> Hadden, 1909 [EP]	Tropical grey chaff scale	Cook Islands, Niue, Samoa, Vanuatu
<i>Parlatoria pergandii</i> Comstock, 1881 [EP, WA]	Chaff scale	Cook Islands, Niue, Samoa
<i>Pinnaspis aspidistrae</i> (Signoret, 1869) [EP, WA]	Fern scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu
<i>Unaspis citri</i> (Comstock, 1883) [EP, WA]	Citrus snow scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu
<b>Mealybugs [Hemiptera: Pseudococcidae]</b>		
<i>Dysmicoccus neobrevipes</i> Beardsley, 1959 [EP]	Grey pineapple mealybug	Cook Islands, Samoa
<i>Planococcus minor</i> (Maskell, 1897) [EP, WA]	Pacific mealybug	Cook Islands, Niue, Samoa, Tonga, Vanuatu
<i>Pseudococcus cryptus</i> Hempel, 1918 [EP, WA]	Cryptic mealybug	Samoa
<b>Fungi [Dothideomycetes: Elsinoaceae]</b>		
<i>Elsinoë fawcettii</i> Bitanc. & Jenkins	Citrus scab	Cook Islands, Niue, Samoa, Tonga, Vanuatu

[EP] species has been assessed previously and import policy already exists

[WA] regional quarantine pest for Western Australia

## 4.1 Caribbean black scale

### *Saissetia neglecta* (WA)

*Saissetia neglecta* is not present in Western Australia and is a pest of regional quarantine concern for that state.

*Saissetia neglecta*, the Caribbean black scale, is a sap-sucking insect in the Coccidae (soft scale) family, which are closely related to mealybugs and armoured scales. Although soft scales lack the protective covering of the armoured scales, their cuticles are protected by a wax-like secretion, forming a shell that cannot be separated from the scale (Fasulo and Brooks 2013). There are more than 1000 described soft scale species, which are most abundant in the tropics and subtropics (Hodgson 1994). In warm climates, many soft scales are capable of rapid reproduction, and can have overlapping generations.

Soft scales mainly feed on perennial plants, particularly woody plants, and a number are important pests in agriculture, horticulture and forestry (Hodgson 1994). Scales feed on foliage, fruit and twigs of host plants. The depletion of sap by scale feeding reduces the vigour of host plants (Fasulo and Brooks 2013). Additionally, soft scales produce honeydew that is forcibly ejected over the foliage of the host. This provides a substrate for the growth of sooty moulds, which reduces the photosynthetic rate of the host plant (Hodgson 1994).

#### 4.1.1 Likelihood of entry

The likelihood of entry is considered in two parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that *Saissetia neglecta* will arrive in Western Australia with the importation of Tahitian limes from any country where this pest is present is assessed as High.

The following information provides supporting evidence for this assessment.

- *Saissetia neglecta* is present in the Cook Islands, Niue, Samoa, Tonga and Vanuatu (Williams and Watson 1990). It has been reported on a number of citrus species, including key limes (*Citrus aurantifolia*), in the Pacific Islands (Williams and Watson 1990). Given its association with citrus, it is considered likely that Tahitian limes would also host this scale.
- *Saissetia neglecta* nymphs and adults can be present on small twigs, particularly those bearing fruit (Fasulo and Brooks 2013), so scales could potentially be present on harvested fruit, particularly if the fruit stalk was intact.
- The small size and cryptic colouring of scales make them hard to detect, especially those in the crawler or second instar stages. However, adult females are more likely to be encountered on fruit, as the immature stages are typically found on the leaves only (Fasulo and Brooks 2013).
- The adult female Caribbean black scale is 3–5 millimetres long and brown to black in colour. The adult males are small, around 1 millimetre long and honey-yellow in colour, but are rarely encountered (Fasulo and Brooks 2013). They are visible to the naked eye.

- First instar ‘crawlers’ are a flattened oval shape, about 0.3 millimetres long and are mottled light brown with black eyes (Fasulo and Brooks 2013). The second instar is similar in appearance to the first, but larger in size. After the second moult, the female scale is tan to dark grey in colour. During this period the scales migrate from the leaves to small twigs, particularly to those twigs bearing fruit (Fasulo and Brooks 2013). As the female reaches the egg-laying stages, its shell becomes hardened and dark brown to black in colour (Fasulo and Brooks 2013).
- All scale stages have legs and are capable of moving (Gill 1988), but they will likely remain fixed to the fruit unless disturbed.
- Scales are often found in groups (Gill 1988), which would increase the likelihood of detection at harvest and during pre-export handling.
- *Saissetia neglecta* has been intercepted a number of times on citrus fruit entering the United States (García Morales *et al.* 2016).

The association of the Caribbean black scale with citrus fruit, and their small size and cryptic colouring (particularly the immature stages), means that scales could be on harvested fruit and escape detection during packing for export. This supports a likelihood estimate for importation of High.

#### **Likelihood of distribution**

The likelihood that *Saissetia neglecta* will be distributed within Western Australia in a viable state as a result of the processing, sale or disposal of Tahitian limes, and subsequently transfer to a susceptible host is assessed as Low.

The following information provides supporting evidence for this assessment.

- Tahitian lime fruit would be distributed for sale to various destinations in Australia, although predominantly to the larger population centres. They may be distributed through large fresh produce wholesale markets and then to supermarkets or other sellers, or directly to smaller retailers and thence to consumers.
- While all stages are capable of movement, the most active stage is the first instar crawler, particularly in its first 24 hours (Greathead 1997). Soft scale crawlers are positively phototropic, and will crawl towards light (Greathead 1997). Newly emerging crawlers may wander off the lime fruit during distribution if the opportunity arises.
- Adult scales and the second and third instar nymphs are likely to remain on a fruit throughout the distribution chain unless disturbed.
- The majority of fruit waste discarded in urban areas is likely to be disposed of via municipal waste management systems and potentially buried amongst other waste. Scales in waste material have a low likelihood of being dumped in the vicinity of suitable host plants.
- Crawlers may be carried by wind to new hosts. Crawlers typically climb to the upper parts of host plants to assist wind dispersal (Greathead 1997). Crawlers on fruit discarded on the ground or on a garden compost heap would be less successfully carried by the wind, and have high mortality from predation and environmental factors.



- Second and third instar nymphs and adult scales could potentially crawl to new hosts, but typically they do not move from a host once settled. Given their limited mobility, infested fruit would need to be discarded in close proximity to suitable plant hosts for this to occur.
- *Saissetia neglecta* has been recorded on hosts from at least 34 plant families (García Morales *et al.* 2016). Some of these hosts, including citrus, fig and banana (García Morales *et al.* 2016), are common in parts of Western Australia.

Despite the availability of suitable host plants and potential for Tahitian limes to be widely distributed after arrival in Western Australia, the limited mobility of most life stages of the scales and poor prospects of successfully finding a new host support a likelihood estimate for distribution of Low.

### Overall likelihood of entry

The likelihood that *Saissetia neglecta* will enter Western Australia and be distributed in a viable state to a suitable host, as a result of trade in Tahitian limes from any country where this pest is present, is assessed as Low.

#### 4.1.2 Likelihood of establishment

The likelihood that *Saissetia neglecta* will establish in Western Australia based on life cycle characteristics and a comparison of factors in the source and destination areas that affect pest survival and reproduction is assessed as High.

The following information provides supporting evidence for this assessment.

- The female lays an average of 2000 eggs, but the crawlers suffer significant mortality, particularly during periods of hot, dry weather (Fasulo and Brooks 2013).
- Reproduction is usually by parthenogenesis (fertilization by a male is not required) so a single scale may be able to establish a population (Fasulo and Brooks 2013).
- *Saissetia neglecta* is likely to have several overlapping generations in a year in tropical areas, allowing a population to rapidly establish. Up to four generations a year are reported in Florida (Fasulo and Brooks 2013).
- *Saissetia neglecta* has a predominantly tropical and subtropical distribution and it is widespread throughout the Pacific region (Williams and Watson 1990). Establishment in the central and northern coastal parts of Western Australia would be feasible where suitable hosts are present.
- Coccids are attended by ants, which improves the survival and reproductive capacity of the scales. Most honeydew-seeking ants will tend any scale species they come across, although some have more specific relationships (Gullan 1997). Ants protect scales from natural enemies, particularly predatory wasps and beetles (Gullan 1997), and remove honeydew. In the absence of ants, scales may become engulfed in their honeydew and die from asphyxiation or from the effect of sooty mould growth arising from honeydew contamination (Gullan 1997).



- Arboreal weaver ants commonly build silk shelters over scale insects on exposed foliage (Gullan 1997), providing shelter from predators. *Oecophylla smaragdina* and other ants known to associate with scales are present in Western Australia (ALA 2016).
- Predation of scales by wasps, spiders and birds may affect the potential for establishment. *Saissetia neglecta* can be attacked by the encyrtid wasps *Metaphycus helvolus* and *Metaphycus lounsburyi*, which are present in parts of Australia and have been used for biological control of soft scales (Bennett *et al.* 1976).

The parthenogenetic reproductive behaviour and high fecundity of this species, the presence of protective ant species known to associate with scales, and suitable climatic conditions in parts of Western Australia support a likelihood estimate for establishment of High.

#### 4.1.3 Likelihood of spread

The likelihood that *Saissetia neglecta* will spread in Western Australia, based on a comparison of factors in the area of origin and in Western Australia that affect the expansion of the geographic distribution of this pest, is assessed as Moderate.

The following information provides supporting evidence for this assessment.

- Once established, *Saissetia neglecta* is likely to spread to other areas, but is likely to be limited to tropical and subtropical coastal regions. This species is better adapted to humid climates than other species of black scales (Gill 1997).
- Black scale crawlers can be dispersed on wind currents, although movement of soft scales over substantial distances by wind currents has not been proven (Greathead 1997).
- Spread over greater distances is likely to occur through the movement of infested cuttings, nursery stock and produce (Greathead 1997).
- *Saissetia neglecta* is a polyphagous species, recorded on hosts from at least 34 plant families (García Morales *et al.* 2016). Suitable host plants are likely to be present in many parts of Western Australia. Hosts such as citrus and gardenias are common in urban areas.

This species is associated with a number of plant hosts, which may be moved over great distances, thereby spreading the pest. However, spread of the pest may be checked by its preference for humid climates. This supports a likelihood estimate for spread of Moderate.

#### 4.1.4 Overall likelihood of entry, establishment and spread

The likelihood that *Saissetia neglecta* will enter Western Australia as a result of trade in Tahitian limes from any country where this pest is present, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within Western Australia, is assessed as Low.

#### 4.1.5 Consequences

The potential consequences of the establishment of *Saissetia neglecta* in Western Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, the overall consequences are estimated to be Low.

Criterion	Estimate and rationale
<b>Direct</b>	
Plant life or health	<p>Impact score: D — major significance at the local level</p> <p><i>Saissetia neglecta</i> is injurious to many tree and shrub crops (Williams and Watson 1990). Damage from individual scales is relatively localised, but the collective effects of heavy infestations on the host can be considerable (Vranjic 1997), resulting in discolouration of leaves and fruit, and deformation of shoots, twigs and branches (Gill and Kosztarab 1997).</p> <p>Soft scales imbibe large quantities of plant sap, resulting in loss of plant vigour, poor growth, leaf drop, and die-back of twigs and branches (Gill and Kosztarab 1997). Feeding introduces toxic saliva into the plant tissues, which can result in lesions that disrupt both vascular tissue and associated photosynthetic tissue (Vranjic 1997). Loss of sap through scale feeding reduces the nutrients available for plant function, reducing plant growth and affecting the plant's ability to respond to environmental stresses (Vranjic 1997).</p> <p>Soft scales expel honeydew (mostly excess carbohydrates) over the foliage, which provides a favourable substrate for sooty mould growth (Vranjic 1997). Sooty moulds are saprophytic and, while not directly harming the host plant, they block light transmission, which interferes with photosynthesis. Fruit can also be covered in sooty mould, making them unsaleable without washing (Vranjic 1997).</p>
Other aspects of the environment	<p>Impact score: A — indiscernible at the local level</p> <p>Direct impacts are limited to effects on plant health. No other direct impacts on the environment associated with <i>Saissetia neglecta</i> have been reported.</p>
<b>Indirect</b>	
Eradication, control	<p>Impact score: B — minor significance at the local level</p> <p>Additional pest management in commercial orchards may not be required, as existing measures against other common scale pests on citrus in Western Australia (Broughton 2007) would typically be effective against Caribbean black scale.</p>
Domestic trade	<p>Impact score: A — indiscernible at the local level</p> <p>Additional restrictions on interstate movement of fresh produce are unlikely, as produce is already regulated for other coccid pests.</p>
International trade	<p>Impact score: B — minor significance at the local level</p> <p>Establishment of this pest in Western Australia could potentially result in additional measures on exports to international markets where the pest is absent. However, the presence of this scale does not impede the export of host commodities such as citrus and mangoes from the eastern states to international markets.</p>
Environmental and non-commercial	<p>Impact score: A — indiscernible at the local level</p> <p>The potential impacts to plant health described above are unlikely to result in discernible changes to plant communities, ecological processes, the natural environment or human recreational uses.</p>

#### 4.1.6 Unrestricted risk estimate

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

Unrestricted risk estimate for <i>Saissetia neglecta</i>	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very low

As indicated, the unrestricted risk of *Saissetia neglecta* has been assessed as Very low, which achieves the ALOP for Australia. Therefore, specific risk management measures are not required for *Saissetia neglecta*.

## 4.2 Armoured scales

***Chrysomphalus dictyospermi* (EP, WA), *Hemiberlesia cyanophylli* (EP, WA), *Morganella longispina* (EP, WA), *Parlatoria cinerea* (EP), *Parlatoria pergandii* (EP, WA), *Pinnaspis aspidistrae* (EP, WA), *Unaspis citri* (EP, WA)**

*Chrysomphalus dictyospermi*, *Hemiberlesia cyanophylli*, *Morganella longispina*, *Parlatoria pergandii*, *Pinnaspis aspidistrae* and *Unaspis citri* are not present in Western Australia and are pests of regional quarantine concern for that state.

The biological characteristics and behaviours on the importation pathway of these species are considered sufficiently similar to justify combining them into a single assessment. In this assessment, the term ‘armoured scales’ is used to refer to these seven species unless otherwise specified.

*Morganella longispina*, *Parlatoria cinerea*, *Pinnaspis aspidistrae* and *Unaspis citri* have previously been assessed in the policy for Tahitian limes from New Caledonia (BA 2006a). *Hemiberlesia cyanophylli* was previously assessed (as *Abgrallaspis cyanophylli*) for mangoes from India (BA 2008). *Chrysomphalus dictyospermi* and *Parlatoria pergandii* were previously assessed in policy for sweet oranges from Italy (BA 2005).

The department has reviewed the literature available since the previous assessments, including Miller *et al.* (2014), Malumphy (2014), Kondo and Munoz (2016), Masten Milek *et al.* (2009), Aguiar (2009) and García Morales *et al.* (2016). The available information suggests the likelihoods of importation, distribution, establishment and spread, and the potential consequences are unlikely to significantly differ from the previous assessments, so the department considers that reassessment of these armoured scales is not required. The outcomes of the previous assessments will therefore be adopted.

Armoured scales have a history of being intercepted in international trade of citrus fruit (Masten Milek *et al.* 2009; Stout 1982; Aguiar 2009), and could be present on imported Tahitian limes. *Parlatoria pergandii* has previously been intercepted at the Australian border on mandarins imported from Israel and oranges from Egypt (DAWR interception records).

The horticultural practices, climatic conditions and pest prevalence in the Cook Islands, Niue, Samoa, Tonga and Vanuatu are considered to be similar to those in New Caledonia. Therefore the likelihood that *Morganella longispina*, *Parlatoria cinerea*, *Pinnaspis aspidistrae* and *Unaspis citri* will be imported into Australia with fresh Tahitian lime fruit from those nations is expected to be the same as previously assessed for New Caledonia. The likelihoods of importation for *Chrysomphalus dictyospermi*, *Parlatoria pergandii* and *Hemiberlesia cyanophylli* are expected to be the same as previously assessed for oranges from Italy and mangoes from Taiwan.

After importation, Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu will also be distributed throughout Australia for retail sale in a similar way to Tahitian limes from New Caledonia, oranges from Italy and mangoes from Taiwan. Therefore, the likelihood of distribution for these armoured scales for Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu would be comparable to that assessed previously.

The likelihoods of establishment and spread of armoured scales in Australia and the consequences they may cause will be comparable to those previously assessed for Tahitian limes

from New Caledonia, oranges from Italy and mangoes from Taiwan. These likelihoods relate specifically to events that occur subsequent to arrival in Australia and are largely independent of the commodity importation pathway. Accordingly, there is no need to reassess these components, so the outcome of the previous assessments will be adopted for these armoured scales.

**Unrestricted risk outcome**

The unrestricted risk for armoured scales on Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu will be comparable to that determined in previous assessments, which achieves the ALOP for Australia. Therefore, specific risk management measures are not required for these pests.

### 4.3 Mealybugs

#### ***Dysmicoccus neobrevipes* (EP), *Planococcus minor* (EP, WA), *Pseudococcus cryptus* (EP, WA)**

*Planococcus minor* and *Pseudococcus cryptus* are not present in Western Australia and are pests of regional quarantine concern for that state.

The biological characteristics and behaviours on the importation pathway of these species are considered sufficiently similar to justify combining them into a single assessment. In this assessment, the term ‘mealybugs’ is used to refer to these three species unless otherwise specified.

*Dysmicoccus neobrevipes* has previously been assessed in the policies for mangosteens from Thailand (DAFF 2004) and pineapples from Malaysia (DAFF 2012). *Planococcus minor* was previously assessed for pineapples from Malaysia (DAFF 2012). *Pseudococcus cryptus* was previously assessed for mangoes from Taiwan (BA 2006b).

The department has reviewed the literature available since the previous assessments, including Miller *et al.* (2014), Holat *et al.* (2014), Stocks and Roda (2011), Kim *et al.* (2008) and García Morales *et al.* (2016). The available information suggests the likelihoods of importation, distribution, establishment and spread, and the potential consequences are unlikely to significantly differ from the previous assessments, so the department considers that reassessment of these mealybugs is not required. The outcomes of the previous assessments will therefore be adopted.

While the previous assessments were for different commodities (mangoes, mangosteens and pineapples), there are a number of biological and behavioural factors for these species that suggest the likelihood that *Dysmicoccus neobrevipes*, *Planococcus minor* and *Pseudococcus cryptus* will be imported into Australia with fresh Tahitian lime fruit from the Cook Islands, Niue, Samoa, Tonga and Vanuatu would be comparable to the previously assessed commodities. As further evaluated in Appendix A, these species are polyphagous pests associated with the fruit of many plant hosts. They are commonly intercepted on tropical fruit and plants entering the United States from the Pacific and southern Asia (Miller *et al.* 2014). *Dysmicoccus neobrevipes* is known to attack citrus fruit and has a history of being introduced to new localities via human activities (Williams and Watson 1988b). *Planococcus minor* has previously been intercepted at the Australian border on grapefruit imported from Israel and mangosteen fruit from Thailand.

After importation, Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu will be distributed throughout Australia for retail sale in a similar way to mangoes, mangosteens and pineapples. Opportunities for the pest to leave the imported limes and locate a suitable host plant are likely to be similar to those previously assessed for mangoes, mangosteens and pineapples. Therefore, the likelihood of distribution for these mealybugs on Tahitian limes would be comparable to that assessed previously.

The likelihood of establishment and spread of mealybugs, and the potential consequences they may cause, will also be comparable for any commodity on which these species potentially enter Australia. These likelihoods relate specifically to events that occur subsequent to their arrival in Australia and are largely independent of the commodity importation pathway. Accordingly,

there is no need to reassess these components, so the outcome of the previous assessments will be adopted for these mealybugs.

The risk scenario of concern for mealybugs is the presence of eggs, nymphs or adult females on imported Tahitian lime fruit.

**Unrestricted risk outcome**

The unrestricted risk for mealybugs on Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu will be comparable to that determined in previous assessments, which has been assessed as not achieving the ALOP for Australia. Therefore, specific risk management measures are required for these pests.



## 4.4 Citrus scab

### *Elsinoë fawcettii*

*Elsinoë fawcettii* has previously been assessed (as *Sphaceloma fawcettii*) in the policy for Tahitian limes from New Caledonia (BA 2006a). Reappraisal of the available literature (for example, Meister (1973), Timmer (2000), Hyun *et al.* (2009)), suggested a review of the previous assessment needed to be undertaken.

Two scab diseases of citrus are currently recognised: citrus scab, caused by *Elsinoë fawcettii* (anamorph *Sphaceloma fawcettii*), and sweet orange scab, caused by *Elsinoë australis* (anamorph *Sphaceloma australis*) (Hyun *et al.* 2009; Timmer 2000). The previously described *Sphaceloma fawcettii* var. *scabiosa*, responsible for Tryon's scab, is now considered to be a pathotype of *Elsinoë fawcettii* and is no longer a valid name (Timmer 2000).

A number of citrus scab pathotypes have been identified worldwide (Hyun *et al.* 2009; Hou *et al.* 2014). The Tryon's and lemon pathotypes are known to be present in Australia (Miles *et al.* 2015), but it is possible that additional pathotypes could be discovered in Australia with more extensive sampling (Hyun *et al.* 2009). Pathotypes exotic to Australia have not been reported in the Pacific Islands, but are also likely poorly researched.

The risk scenario of concern for *Elsinoë fawcettii* is that exotic pathotypes of the fungus may be present on imported fresh Tahitian lime fruit, and establishment could affect fruit production and nursery stock quality.

#### 4.4.1 Likelihood of entry

The likelihood of entry is considered in two parts, the likelihood of importation and the likelihood of distribution, which consider pre-border and post-border issues, respectively.

##### Likelihood of importation

The likelihood that exotic pathotypes of *Elsinoë fawcettii*, if present, will arrive in Australia with the importation of Tahitian limes from any country where this pest is present is assessed as Moderate.

The following information provides supporting evidence for this assessment.

- Tahitian limes are considered to be a host of *Elsinoë fawcettii* (Meister 1973; Hyun *et al.* 2009), although limes are reported to be rarely attacked (Smith IM *et al.* 1997). However, susceptibility may vary depending on the citrus scab pathotype present, as Nelson (2008) observed Tahitian limes to be highly susceptible in Hawaii.
- Citrus scab infection produces exterior blemishes on citrus fruit (Timmer 2000). Scab pustules on the fruit skin consist of a mixture of fungal and host tissues (Timmer 2000). Infected fruit could feasibly be imported, although the affected fruit would typically be deemed unsuitable for export.
- It would be expected that Tahitian lime trees in managed orchards would have a low incidence of citrus scab infection, but importation of infected fruit cannot be entirely ruled out.

- The fruit (as well as leaves and twigs) are infected when they are young, and are resistant to infection when full size (Tsatsia and Jackson 2017). Any infected fruit would have raised pustules evident on the skin by the time the fruit was ready for harvest. It is considered unlikely that asymptomatic unblemished fruit would be infected with citrus scab.
- The fruit is manually harvested, and washed, graded and packed by hand, so it is likely that visibly infected fruit, if present, would be removed from the pathway. Blemished fruit is usually eliminated in the packing line for commercial sales (Hyun *et al.* 2009). However, it is feasible that fruit with citrus scab could escape detection during commercial grading operations and be imported into Australia.

The low susceptibility of Tahitian limes to citrus scab infection, and the visible symptoms of infection and consequent likely removal of blemished fruit from the export pathway, support a likelihood estimate for importation of Moderate.

#### **Likelihood of distribution (transfer to a suitable host)**

The likelihood that exotic pathotypes of *Elsinoë fawcettii*, if present, will be distributed in Australia, in a viable state, as a result of the processing, sale or disposal of fresh Tahitian limes is assessed as Low.

The following information provides supporting evidence for this assessment.

- Tahitian lime fruit could be distributed for sale to various destinations in Australia, although predominantly to the larger population centres. They may be distributed through large fresh produce wholesale markets and then to supermarkets or other sellers, or directly to smaller retailers, and thence to consumers.
- Although Tahitian lime fruit would be imported for human consumption, the fruit peel and waste fruit would be discarded. Most fruit waste discarded in urban areas is likely to be disposed of via municipal waste management systems and likely buried amongst other waste, minimising opportunities for dispersal of spores.
- *Elsinoë fawcettii* only affects citrus species (including cumquats), but the range of hosts susceptible to the pathogen depends on the pathotype involved. Many, but not all, identified pathotypes have narrow host ranges (Timmer 2000; Hou *et al.* 2014).
- For transmission to a susceptible host to occur, the fruit would need to be placed in close proximity to growing plants under conditions conducive for spore production and infection.
- Hyaline conidia (asexual spores) are produced in acervuli on the surface of the pustules. These spores are dispersed to the young leaves and fruit of susceptible hosts by rain splash (Timmer 2000). These conidia are fragile and die quickly if they are exposed to sunlight or dry conditions (Timmer 2000).
- After a period of exposure to high humidity, spindle-shaped conidia may also be produced on the scab lesions (Timmer 2000). These spindle-shaped conidia can be liberated and aerially dispersed by wind without requiring moisture. They can survive at least until the following night, when dew initiates germination (Whiteside 1975).
- Fruit in the distribution chain are unlikely to be exposed to sufficient moisture to stimulate conidia production and release, unless discarded in the environment.

- Information on the ability of the pathogen to survive in the pustules on the peel after harvest is not available. However, discarded waste containing the fungus would be rapidly colonised by saprophytic microorganisms, reducing the likelihood that conidia would be produced on, and dispersed from, any infected fruit.

The narrow host range, fragile conidia with poor survival in adverse conditions, and specific requirements for dispersal to susceptible parts of a new host plant reduce the likelihood that viable conidia on imported Tahitian lime fruit would be dispersed to a susceptible host, which supports a likelihood estimate for distribution of Low.

#### **Overall likelihood of entry (importation x distribution)**

The likelihood that *Elsinoë fawcettii* will enter Australia and be distributed in a viable state to a suitable host, as a result of trade in Tahitian limes from any country where this pest is present, is assessed as Low.

#### **4.4.2 Likelihood of establishment**

The likelihood that exotic pathotypes of *Elsinoë fawcettii* will establish in Australia, based on a comparison of factors in the source and destination areas that affect pest survival and reproduction, is assessed as Moderate.

The following information provides supporting evidence for this assessment.

- Only young leaves and fruit are susceptible to infection. Leaves are most susceptible just after emergence, while young fruit are susceptible to infection for 6–8 weeks after petal fall (Timmer 2000).
- Plants are only susceptible to infection under specific conditions. Infection requires at least 2–3 hours of exposure to high humidity (including dew or fog), but the amount of infection will increase with longer periods of wetness (Timmer 2000; Agostini *et al.* 2003).
- The optimal range for infection and development of citrus scab has been reported as 23.5 to 27 °C (Agostini *et al.* 2003), although infection can occur at temperatures between 16 °C and 32 °C (Whiteside 1975). Conidia production and germination markedly declined at temperatures above 30 °C (Whiteside 1975).
- Conidia are fragile and susceptible to desiccation. If the conditions are not suitable for infection, the conidia are unlikely to persist in the environment and will die.
- Citrus scab usually does not establish in areas of low rainfall (less than 1300 millimetres) and hot long summers (mean monthly temperature above 24 °C) (Smith IM *et al.* 1997), so establishment is unlikely to occur in many parts of Australia.
- Establishment of exotic pathotypes may be possible in some areas of Australia where suitable temperature and humidity conditions prevail (wet subtropics, cooler tropics).

The limited developmental stages in which hosts are most susceptible, and the specific weather conditions required for infection to occur support a likelihood estimate for establishment of Moderate.

#### 4.4.3 Likelihood of spread

The likelihood that exotic pathotypes of *Elsinoë fawcettii* will spread in Australia, based on a comparison of factors in the area of origin and in Australia that affect the expansion of the geographic distribution of this pest, is assessed as Moderate.

The following information provides supporting evidence for this assessment.

- Long distance dispersal could occur via movement of infected nursery stock (Timmer 2000). Infected citrus nursery stock could be widely distributed in Australia, thereby introducing citrus scab to new areas.
- Natural spread would be slow and localised. Plants in the Rutaceae family (mostly *Citrus* spp.) are the only known hosts. Citrus scab tends to be localised, with disease incidence varying considerably between neighbouring trees (Whiteside 1975).
- Dissemination mostly occurs by conidia in rain splash (Whiteside 1975). Air-borne water droplets carrying splash-liberated inoculum can be carried by the wind for short distances (Whiteside 1975).
- Dry airborne dispersal of spindle-shaped conidia may be responsible for more distant dispersal than airborne water droplets, but it is not clear if this is epidemiologically significant in causing scab epidemics (Whiteside 1975).
- The disease does not establish, or is of little importance, in citrus growing areas with a dry climate (Smith IM *et al.* 1997), which suggests spread would be moderated by climatic factors.
- *Elsinoë fawcettii* already has a wide distribution in coastal regions of eastern Australia, so similar spread could be anticipated for exotic pathotypes.

While natural spread of citrus scab will be limited, it could potentially be spread widely by movement of infected nursery stock to new localities; conversely, spread will be moderated by local climatic conditions that will affect survival of the pathogen. This supports a likelihood estimate for spread of Moderate.

#### 4.4.4 Overall likelihood of entry, establishment and spread

The likelihood that exotic pathotypes of *Elsinoë fawcettii* will enter Australia as a result of trade in Tahitian limes from any country where this pest is present, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within Australia, is assessed as Low.

#### 4.4.5 Consequences

The potential consequences of the establishment of *Elsinoë fawcettii* in Australia have been estimated according to the methods described in Table 2.3.

Based on the decision rules described in Table 2.4, the overall consequences are estimated to be Low.

Criterion	Estimate and rationale
<b>Direct impacts</b>	
Plant life or health	<p>Impact score: D — major significance at the local level</p> <p>Citrus scab only attacks <i>Citrus</i> species, but impacts on hosts may vary depending on the pathotype involved. Introduction of new pathotypes in Australia could potentially result in impacts on some <i>Citrus</i> spp. that are presently unaffected by citrus scab. Other plants are unaffected by citrus scab.</p> <p>Citrus scab infection results in fruit blemishes that reduce the value of citrus fruit for the fresh market (Hyun <i>et al.</i> 2009). Losses largely depend on local and seasonal variations in the weather (Smith IM <i>et al.</i> 1997). The disease can affect susceptible rootstock in the nursery, stunting seedlings or making them bushy and difficult to bud (Smith IM <i>et al.</i> 1997).</p> <p>The disease does not establish, or is of little importance, in citrus growing areas with a dry climate (Smith IM <i>et al.</i> 1997). However, impacts may be significant in some other districts.</p>
Other aspects of the environment	<p>Impact score: A — indiscernible at the local level</p> <p>Direct impacts are limited to effects on plant health (see above). No other direct impacts on the environment associated with <i>Elsinoë fawcettii</i> have been reported.</p>
<b>Indirect impacts</b>	
Eradication, control	<p>Impact score: D — major significance at the local level</p> <p><i>Elsinoë fawcettii</i> can be controlled by using resistant cultivars and application of fungicides (Smith IM <i>et al.</i> 1997). Copper fungicides are commonly used for control of scab (Timmer 2000). Once established the pathogen can be persistent and is unlikely to be eradicated.</p>
Domestic trade	<p>Impact score: A — indiscernible at the local level</p> <p>Citrus scab is already present in citrus-growing areas of eastern and northern Australia, so additional impacts on domestic trade would not be expected.</p>
International trade	<p>Impact score: A — indiscernible at the local level</p> <p>Citrus scab is already present in citrus-growing areas of eastern and northern Australia, so significant additional impacts on international trade would not be expected. <i>Elsinoë fawcettii</i> is not recognised as a quarantine pest by regional plant protection organisations (Smith IM <i>et al.</i> 1997; CABI 2016) so additional restrictions on international trade are unlikely.</p>
Indirect environmental and non-commercial impacts	<p>Impact score: A — indiscernible at the local level</p> <p>The potential impacts to plant health described above are unlikely to result in discernible changes to plant communities, ecological processes, the natural environment or human recreational uses.</p>

#### 4.4.6 Unrestricted risk estimate

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

<b>Unrestricted risk estimate for <i>Elsinoë fawcettii</i></b>	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very low

As indicated, the unrestricted risk of *Elsinoë fawcettii* has been assessed as Very Low, which achieves the ALOP for Australia. Therefore, specific risk management measures are not required for *Elsinoë fawcettii*.

## 4.5 Summary of the assessment of pests of Tahitian limes

This section provides an overview of the assessment process for the pests of Tahitian limes considered in this report. This is summarised in Figure 3.

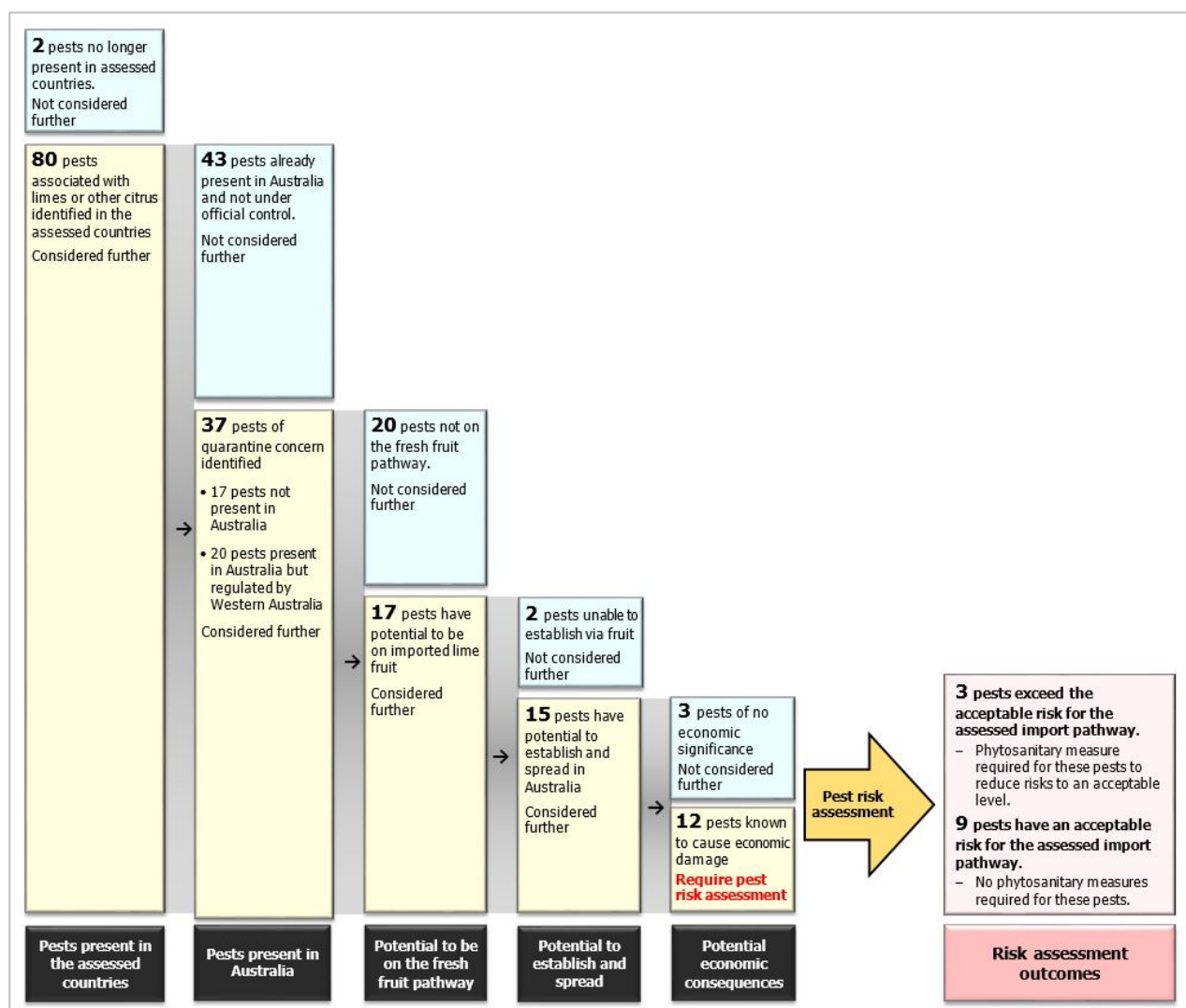
The pest categorisation process (Appendix A) identified 82 pests of Tahitian limes and related citrus species recorded in the Cook Islands, Niue, Samoa, Tonga and Vanuatu. Of these 82 pests:

- Two pests have been eradicated or are no longer known to be present in the countries considered in this report, so were not considered further;
- 43 pests are already present in Australia, and not under official control, and therefore were not considered further;
- 20 of the remaining 37 pests were assessed as not likely to be present on mature, commercially produced and harvested Tahitian lime fruit, and therefore were not considered further;
- Two of the remaining 17 pests were assessed as being unable to establish in Australia via imported fruit due to the lack of a transmission pathway, and were therefore not considered further; and
- Three of the remaining 15 pests were assessed to have minimal economic consequences, and therefore were not considered further.

The outcome of this pest categorisation process was the identification of twelve pests that require pest risk assessments to ascertain whether phytosanitary measures are needed to manage the biosecurity risks to an acceptable level.

Pest risk assessments were undertaken for these twelve pests:

- Nine pests were assessed as having an acceptable risk for the assessed pathway, meeting Australia's appropriate level of protection without specific risk management measures. These pests were:
  - Caribbean black scale (*Saissetia neglecta*);
  - Armoured scales (*Chrysomphalus dictyospermi*, *Hemiberlesia cyanophylli*, *Morganella longispina*, *Parlatoria cinerea*, *Parlatoria pergandii*, *Pinnaspis aspidistrae* and *Unaspis citri*); and
  - Citrus scab (*Elsinoë fawcettii*);
- Three pests were assessed as exceeding the acceptable risk for the assessed pathway, and not achieving Australia's appropriate level of protection. Specific risk management measures are therefore required to reduce the risks to an acceptable level. These pests were:
  - Grey pineapple mealybug (*Dysmicoccus neobrevipes*);
  - Pacific mealybug (*Planococcus minor*); and
  - Cryptic mealybug (*Pseudococcus cryptus*).

**Figure 3 Summary of pest categorisation and pest risk assessment outcomes**

## 4.6 Pest risk assessment conclusions

Table 4.2 summarises the unrestricted risk estimates and outcomes for the quarantine pests associated with fresh Tahitian lime fruit for human consumption from the Cook Islands, Niue, Samoa, Tonga and Vanuatu.

The recommended risk management measures are discussed in Chapter 5.



Table 4.2 Summary of unrestricted risk estimates for pests associated with Tahitian limes

Pest name	Likelihood of					[EES]	Consequences	Unrestricted Risk Estimate	Outcome
	Importation	Distribution	Entry	Establishment	Spread				
Soft scales [Hemiptera: Coccidae]									
<i>Saissetia neglecta</i> [WA]	High	Low	Low	High	Moderate	Low	Low	Very low	Achieves ALOP
Armoured scales [Hemiptera: Diaspididae]									
<i>Chrysomphalus dictyospermi</i> [EP, WA]	Outcome of previous assessments has been adopted for these pests								Achieves ALOP
<i>Hemiberlesia cyanophylli</i> [EP, WA]									
<i>Morganella longispina</i> [EP, WA]									
<i>Parlatoria cinerea</i> [EP]									
<i>Parlatoria pergandii</i> [EP, WA]									
<i>Pinnaspis aspidistrae</i> [EP, WA]									
<i>Unaspis citri</i> [EP, WA]									
Mealybugs [Hemiptera: Pseudococcidae]									
	Estimates are based on evaluations provided in Appendix A, and prior assessments as referenced.								
<i>Dysmicoccus neobrevipes</i> [EP] (DAFF 2012)	High	Moderate	Moderate	High	High	Moderate	Low	Low	Does not achieve ALOP
<i>Planococcus minor</i> [EP, WA] (DAFF 2012)	High	Moderate	Moderate	High	High	Moderate	Low	Low	Does not achieve ALOP
<i>Pseudococcus cryptus</i> [EP, WA] (BA 2006b)	High	Moderate	Moderate	High	High	Moderate	Low	Low	Does not achieve ALOP
Fungi									
<i>Elsinoë fawcettii</i>	Moderate	Low	Low	Moderate	Moderate	Low	Low	Very low	Achieves ALOP
[EP]	pest for which assessment from existing policy has been used								
[WA]	regional quarantine pest for Western Australia								
[EES]	overall likelihood of entry, establishment and spread								

## 5 Pest risk management

This chapter provides information on the management of quarantine pests identified with an unrestricted risk that does not achieve the appropriate level of protection (ALOP) for Australia. The recommended phytosanitary measures are described in this chapter.

### 5.1 Pest risk management measures and phytosanitary procedures

The pest risk assessment process (Chapter 4) identified three pests that have an unrestricted risk level that does not achieve the ALOP for Australia. Specific pest risk management measures and a system of operational procedures are recommended for fresh Tahitian lime fruit imported from the Cook Islands, Niue, Samoa, Tonga and Vanuatu to reduce the risk to a level that achieves ALOP for Australia.

#### 5.1.1 Analysis of pest interception data 2005 to 2015

As indicated, pest risk assessment identified three quarantine pests for Australia, and a further nine pests potentially of regional concern to Western Australia. Examination of import records across all commodities and pathways indicates few interceptions of these particular pests in regulated commercial trade, although they have been encountered more frequently in non-commercial/illegal imports. The detection of some of these pests on fruit in passenger baggage indicates the pests do have an association with limes (or other citrus), but risks can be managed in commercial trade, through commercial production practices and measures which include pre-export phytosanitary inspection.

Since 2005, the majority of lime consignments imported into Australia have come from the USA (California). There have also been limes imported from Egypt, New Zealand, New Caledonia and Spain. Data for imports indicated presence of small numbers of mealybugs (Pseudococcidae), armoured scales (Diaspididae), spider mites (Tetranychidae) and yellow mites (Tydeidae). Other arthropods typically considered to be contaminant organisms were also found, including fungus gnats (Sciaridae), gall midges (Cecidomyiidae), brine flies (Ephydriidae) and mites (Cheyletidae). Asian citrus psyllid, glassy winged sharpshooter and fruit flies have not been detected in commercial imports of limes, or other goods imported from Pacific Island countries where these pests are present.

*Parlatoria pergandii* and *Planococcus minor* have been intercepted in commercial consignments of other citrus imported into Australia. A brief summary of interceptions of the pests assessed in this report, across all commodities for the period 2005–2015, is discussed here.

#### Soft scales

- *Saissetia neglecta* – no interceptions on any commodity.

#### Armoured scales

- *Chrysomphalus dictyospermi* – no interceptions on any commodity (an unidentified *Chrysomphalus* species was intercepted on oranges in passenger baggage).
- *Hemiberlesia (Aonidiella) cyanophylli* – no interceptions on any commodity (unidentified *Aonidiella* species have been intercepted on citrus and kiwifruit).

- *Morganella longispina* – no interceptions reported on any commodity.
- *Parlatoria cinerea* – no interceptions reported on any commodity.
- *Parlatoria pergandii* – no interceptions on limes (this species has been intercepted on mandarins in passenger baggage, and commercial consignments of mandarins and oranges).
- *Pinnaspis aspidistrae* – no interceptions on limes (this species has been intercepted on oranges in passenger baggage).
- *Unaspis citri* – no interceptions on limes (this species has been intercepted on oranges in passenger baggage).

### Mealybugs

- *Dysmicoccus neobrevipes* – no interceptions on limes (an unidentified *Dysmicoccus* species was detected on a commercial consignment of limes).
- *Planococcus minor* – no interceptions on limes (there have been interceptions on commercial consignments of betel leaves, mangosteens and grapefruit, as well as longan fruit in passenger baggage).
- *Pseudococcus cryptus* – no interceptions reported on any commodity.

### Fungi

- *Elsinoë fawcettii* – intercepted on limes in passenger baggage.

#### 5.1.2 Pest risk management for quarantine pests

*Dysmicoccus neobrevipes*, *Planococcus minor* and *Pseudococcus cryptus* have been assessed as having an unrestricted risk that does not achieve the ALOP for Australia, so measures are therefore required to manage this risk to an acceptable level.

The recommended risk management measure is a pre-export phytosanitary inspection by the NPPO to ensure that the Tahitian limes are free of *Dysmicoccus neobrevipes*, *Planococcus minor* and *Pseudococcus cryptus*, and any infested consignments are identified and removed from the export pathway, or subjected to appropriate remedial action prior to export.

Export consignments found to contain any of these pests must be subject to remedial action, which may include withdrawing the consignment from export to Australia or application of an approved treatment to ensure that the pest is no longer viable. Adoption of these measures, which are further described in Section 5.2, is expected to reduce the risk of entry, establishment and spread of the pests to a level that achieves the ALOP for Australia.

#### 5.1.3 Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013), the department will consider any alternative measure proposed by an exporting country's NPPO, providing that it achieves Australia's ALOP. Evaluation of such measures or treatments will require a technical submission from the NPPO that details the proposed treatment and includes data from suitable treatment trials to demonstrate efficacy.

## 5.2 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 Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu. This is to ensure that the recommended risk management measures have been met and are maintained.

### 5.2.1 A system of traceability to source orchards

The objectives of this recommended procedure are to ensure that:

- Tahitian limes are sourced only from commercial orchards
- orchards from which limes are sourced can be identified so investigation and corrective action can be targeted rather than applied to all contributing export orchards in the event that live pests are intercepted.

The exporting country's NPPO is required to establish and maintain a system to enable traceability back to the orchard where Tahitian limes for export to Australia are sourced. The NPPO will be responsible for ensuring that export lime growers are aware of pests of quarantine concern to Australia.

### 5.2.2 Packaging and labelling

The objective of this requirement for packaging and labelling is to ensure that Tahitian limes exported to Australia are not contaminated by quarantine pests or other regulated articles such as trash, soil and weed seeds.

Each consignment must be securely packed in new, clean packaging. All boxes must be labelled with details of the source orchard and packing house for the purpose of traceback.

### 5.2.3 Specific conditions for storage and movement

The objective of this recommended procedure is to ensure that the quarantine integrity of the commodity during storage and movement is maintained.

Tahitian limes for export to Australia that have been inspected by the NPPO must be kept secure and segregated at all times from any fruit for domestic or other markets, or fruit that has not been inspected, to prevent mixing or cross-contamination.

### 5.2.4 Freedom from trash

Freedom from trash will be confirmed by the inspection procedures. Export consignments found to contain trash or foreign matter must be withdrawn from export unless approved remedial action is available and applied to the consignment, which must then be re-inspected.

All Tahitian limes for export must be free from trash (stem and leaf material, weed seeds, soil or other extraneous material) and foreign matter.

### 5.2.5 Pre-export phytosanitary inspection and certification by a NPPO

Every consignment must be accompanied by an International Phytosanitary Certificate (IPC) providing formal documentation to the department verifying that any required measures have been undertaken, and identifying the product and country of origin.

The exporting country's NPPO, or other relevant agency nominated by the NPPO, must undertake a 600-unit phytosanitary inspection for each consignment prior to export.

### 5.2.6 On-arrival verification inspection

On arrival in Australia, the Australian Government Department of Agriculture and Water Resources will:

- assess documentation to verify that the consignment is as described on the phytosanitary certificate and that product security has been maintained
- complete an inspection of a random sample of 600 units of Tahitian lime fruit per consignment to verify that the biosecurity status of the consignment meets Australia's import conditions.

Consignments will be released from quarantine if found free of live quarantine pests and other regulated articles.

### 5.2.7 Remedial action(s) for non-compliance

The objectives of remedial action(s) for non-compliance are to ensure that:

- any quarantine pest or regulated article is addressed by remedial action, as appropriate
- non-compliance with import requirements is addressed, as appropriate.

Any consignment that fails to meet Australia's import conditions must be subject to a suitable remedial action (if one is available), or otherwise destroyed or re-exported.

Other actions may be taken depending on the specific pest intercepted and the risk management strategy put in place against that pest.

If consignments are repeatedly non-compliant, the department reserves the right to suspend imports (either all imports or imports from specific sources) and conduct an audit of the risk management systems. Imports will recommence only when the department is satisfied that appropriate corrective action has been undertaken.

## 5.3 Uncategorized pests

If an organism that has not been categorised (Appendix A) is detected on Tahitian lime fruit during inspection, assessment may be required to determine its quarantine status and whether phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis will result in remedial action, as appropriate. This could include temporary suspension of trade while a review is conducted to ensure that existing measures continue to provide the ALOP for Australia.

## 5.4 Review of policy

The Australian Government Department of Agriculture and Water Resources will review the import policy after the first year of trade. In addition, the department reserves the right to review the import policy as deemed necessary, for example, if there is reason to believe that the pest or phytosanitary status in the Cook Islands, Niue, Samoa, Tonga or Vanuatu has changed.

The NPPO of the exporting country must inform the Australian Government Department of Agriculture and Water Resources immediately on detection in the exporting country of any new pests of limes that are of potential quarantine concern to Australia.

## 5.5 Meeting Australia's food laws

Imported food for human consumption must comply with the requirements of the *Imported Food Control Act 1992*, as well as Australian state and territory food laws. Among other things, these laws require all food, including imported food, to meet the standards set out in the Australia New Zealand Food Standards Code (the Code).

The Australian Government Department of Agriculture and Water Resources administers the *Imported Food Control Act 1992*. This legislation provides for the inspection and control of imported food using a risk-based border inspection program, the Imported Food Inspection Scheme. More information on this inspection scheme, including the testing of imported food, is available from the department's [website](#).

Food Standards Australia New Zealand (FSANZ) is responsible for developing and maintaining the Code, including Standard 1.4.2 for agricultural and veterinary chemicals. This standard is available on the [Federal Register of Legislation](#) or through the [FSANZ website](#).

Standard 1.4.2 and Schedules 20 and 21 of the Code set out the maximum residue limits (MRLs) and extraneous residue limits (ERLs) for agricultural or veterinary chemicals that are permitted in food, including imported food.

Standard 1.1.1 of the Code specifies that a food must not contain, as an ingredient or a component, a detectable amount of an agricultural or veterinary chemical or a metabolite or a degradation product of an agricultural or veterinary chemical, unless expressly permitted by the Code.

## 6 Conclusion

The findings of this draft report are based on a comprehensive analysis of relevant scientific literature, as well as observations of orchards and export procedures in Vanuatu, and other information from previous department activities in the exporting countries.

The department considers that the risk management measures and operational procedures proposed in this report will provide an appropriate level of protection against the pests identified as being associated with trade of Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu. Alternative risk management measures may be suitable to manage the risks, and the department will consider any other measures suggested by stakeholders that provide an equivalent level of phytosanitary protection.



## Appendix A      Categorisation of pests of fresh Tahitian limes from the Cook Islands, Niue, Samoa, Tonga and Vanuatu

This table identifies the pests that have the potential to be present on fresh Tahitian lime fruit grown in the Cook Islands, Niue, Samoa, Tonga and Vanuatu, using typical commercial production and packing procedures, and imported into Australia.

The purpose of pest categorisation is to ascertain which of these pests require detailed assessment to determine whether phytosanitary measures are appropriate. The steps in the pest categorisation process are considered sequentially, with the assessment terminating at 'Yes' for column 3 (except for pests that are present, but under official control and/or pests of regional concern) or the first 'No' for columns 4, 5 or 6.

This is not a comprehensive list of all pests associated with Tahitian lime trees, and it does not include soil-borne pests and pathogens, or wood-borers and root pests, as these are not directly related to the export pathway of fresh lime fruit. Other pests that may occasionally be detected in trade, which are not specifically associated with limes, are not categorised here. Any such contaminant pests detected at the border are managed under existing standard operational procedures. It is important to note that any quarantine pests detected on arrival at quarantine inspection will be actioned as appropriate, even if they have not been assessed in this report.

The department is aware of recent changes in fungal nomenclature that ended the separate naming of different states of fungi with a pleomorphic life cycle. However, as the nomenclature for these fungi is in a phase of transition and many priorities of names are still to be resolved, this report uses the generally accepted names and provides alternatively used names as synonyms, where required. As official lists of accepted and rejected fungal names become available, these accepted names will be adopted.

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>ARTHROPODS</b>						
<b>Acari (mites)</b>						
<b><i>Brevipalpus phoenicis</i></b> (Geijskes, 1936) [Tenuipalpidae] Red crevice mite The taxonomy of the <i>Brevipalpus phoenicis</i> complex has recently been revised (Beard <i>et al.</i> 2015). Further identification of specimens is being undertaken to verify the species present in these Pacific Island countries.	Cook Islands, Samoa, Tonga (SPC 2016; Stout 1982).	Yes. NSW, NT, Qld and WA (CSIRO 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Phyllocoptruta oleivora</i></b> (Ashmead, 1879) [Eriophyidae] Citrus rust mite	Cook Islands, Vanuatu (SPC 2016).	Yes. NSW, Qld and WA (CABI 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Polyphagotarsonemus latus</i></b> (Banks, 1904) [Tarsonemidae] Broad mite	Cook Islands, Samoa (Stout 1982; SPC 2016).	Yes. NSW, Qld and WA (CABI 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Tetranychus neocaledonicus</i></b> (André, 1933) [Tetranychidae] Vegetable spider mite	Cook Islands, Niue, Samoa, Vanuatu (SPC 2016; Stout 1982).	Yes. NSW, Qld and WA (Gutierrez and Schicha 1983), NT (Zhang 2008), WA (Botha <i>et al.</i> 2014).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b>Coleoptera (beetles, weevils)</b>						
<b><i>Bradymerus amicornum</i></b> (Fairmaire, 1849) [Tenebrionidae] Tenebrionid beetle	Samoa, Tonga (Kaszab 1955).	No record found.	No. This beetle is associated with dead bark (Kaszab 1955). Unlikely to be present on fruit.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>Diptera (flies)</b>						
<b><i>Bactrocera curvipennis</i></b> (Froggatt, 1909) [Tephritidae] Banana fruit fly	No. Previously reported from the island of Aneityum in southern Vanuatu in 1930 (Allwood <i>et al.</i> 1997) but it is no longer considered to be present (Drew and Romig 2001).	No record found.	Assessment not required. Not present in assessed countries.	Assessment not required.	Assessment not required.	No
<b><i>Bactrocera dorsalis</i></b> (Hendel, 1912) [Tephritidae] Oriental fruit fly	No. Incursion in the Cook Islands (SPC 2013) has been eradicated (Vargas <i>et al.</i> 2015; CABI 2016).	No. An incursion in Far North Queensland was eradicated in 1999 (under the name of <i>Bactrocera papayae</i> ) and has been detected and eradicated from Torres Strait islands a number of times (Cantrell <i>et al.</i> 2002).	Assessment not required. Not present in assessed countries.	Assessment not required.	Assessment not required.	No
<b><i>Bactrocera kirki</i></b> (Froggatt, 1911) [Tephritidae] Fruit fly	Niue, Samoa, Tonga (White and Elson-Harris 1994).	No record found.	No. <i>Bactrocera kirki</i> was bred from damaged fruit exposed to gravid females in laboratory cage trials in Samoa (Heimoana <i>et al.</i> 1997a), but there is no evidence of field infestation. Tahitian limes are not considered a host.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Bactrocera passiflorae</i></b> (Froggatt, 1911) [Tephritidae] Fijian fruit fly	Niue, Tonga (Niuatoputapu and Niuafoou islands) (White and Elson-Harris 1994; Heimoana <i>et al.</i> 1997b).	No record found.	No. This species has been recorded on some other citrus hosts in the Pacific (Leblanc <i>et al.</i> 2012), but is not reported as a pest of limes. Tahitian limes are not considered a host.	Assessment not required.	Assessment not required.	No
<b><i>Bactrocera trilineola</i></b> Drew, 1989 [Tephritidae] Fruit fly	Vanuatu (Leblanc <i>et al.</i> 2012).	No record found.	No. Host testing has determined that Tahitian limes are not a host of this species (Tau and Berukilukilu 2000).	Assessment not required.	Assessment not required.	No
<b><i>Bactrocera umbrosa</i></b> (Fabricius, 1805) [Tephritidae] Breadfruit fly	Vanuatu (Leblanc <i>et al.</i> 2012).	No record found.	No. This species mainly attacks <i>Artocarpus</i> spp. (Drew and Romig 2001), but there are some old reports on citrus (White and Elson-Harris 1994). Tahitian limes are not known to be hosts of this pest (Leblanc <i>et al.</i> 2012). It has only ever been recorded in breadfruit in Vanuatu (Allwood <i>et al.</i> 1997).	Assessment not required.	Assessment not required.	No
<b><i>Bactrocera xanthodes</i></b> (Broun, 1904) [Tephritidae] Pacific fruit fly	Cook Islands, Niue, Samoa, Tonga (Leblanc <i>et al.</i> 2012).	No record found.	No. <i>Bactrocera xanthodes</i> was bred from damaged fruit exposed to gravid females in laboratory cage trials in Samoa (Heimoana <i>et al.</i> 1997a), but no evidence of field infestation has been reported. Tahitian limes are not considered a host.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>Hemiptera (aphids, leafhoppers, mealybugs, scales, true bugs, whiteflies)</b>						
<b><i>Aonidiella aurantii</i></b> (Maskell, 1879) [Diaspididae] Red scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Watson 2016; SPC 2016).	Yes. NSW, NT, Qld, SA, Vic. and WA (Poole 2010; Donaldson and Tsang 2002).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Aonidiella inornata</i></b> McKenzie, 1938 [Diaspididae] Papaya red scale	Samoa, Vanuatu (García Morales <i>et al.</i> 2016; Williams and Butcher 1987).	Yes. NT, Qld and WA (Poole 2010; Donaldson and Tsang 2002).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Aphis craccivora</i></b> Koch, 1854 [Aphididae] Cowpea aphid	Cook Islands, Samoa, Tonga (SPC 2016; CABI 2016).	Yes. NSW, Qld, Tas., Vic. and WA (Hollis and Eastop 2005).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Aphis gossypii</i></b> Glover, 1877 [Aphididae] Cotton aphid	Cook Islands, Niue, Samoa, Tonga, Vanuatu (SPC 2016).	Yes. NSW, Qld, SA, Tas., Vic. and WA (Hollis and Eastop 2005).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Aspidiotus destructor</i></b> Signoret, 1869 [Diaspididae] Coconut scale	Samoa, Vanuatu, (Miller and Davidson 2005), Tonga (SPC 2016).	Yes. NSW, NT, Qld and WA (Poole 2010; Donaldson and Tsang 2002).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Bemisia tabaci</i></b> (Gennadius, 1889) [Aleyrodidae] Whitefly	Cook Islands, Niue, Samoa, Vanuatu (De Barro <i>et al.</i> 1998).	Yes. NSW, NT, Qld, SA, Vic. and WA (Martin and Gillespie 2001). 'Nauru' biotype not known to be present in Australia (DeBarro <i>et al.</i> 2011), and is a Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. Not associated with the fruit. Adults and nymphs feed on the leaves of host plants (EPPO 1997). The 'Nauru' biotype, which is not known to be present in Australia, but the most widely distributed biotype in the Pacific, has not been recorded on citrus (De Barro <i>et al.</i> 1998).	Assessment not required.	Assessment not required.	No
<b><i>Ceroplastes ceriferus</i></b> (Fabricius, 1798) [Coccidae] Indian wax scale	Cook Islands, Tonga, Vanuatu (Garcia Morales <i>et al.</i> 2016).	Yes. NSW, Qld and WA (Qin and Gullan 1994).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Ceroplastes rubens</i></b> Maskell, 1893 [Coccidae] Pink wax scale	Cook Islands, Samoa, Vanuatu (Garcia Morales <i>et al.</i> 2016), Niue (Williams and Watson 1990), Tonga (SPC 2016).	Yes. ACT, NSW, NT, Qld, Vic. and WA (Qin and Gullan 1994).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Chrysomphalus aonidum</i></b> (L., 1758) [Diaspididae] Florida red scale	Cook Islands, Niue, Samoa, Tonga (Garcia Morales <i>et al.</i> 2016; Watson 2016).	Yes. NSW, NT, Qld and WA (Poole 2010; Donaldson and Tsang 2002).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Chrysomphalus dictyospermi</i></b> (Morgan, 1889) [Diaspididae] Spanish red scale	Cook Islands, Niue, Samoa, Tonga (Watson 2016).	Yes. Qld (Donaldson and Tsang 2002). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Highly polyphagous pest associated with a number of citrus species. Typically found on the upper surface of the leaves but can also infest fruit (Stout 1982; Miller and Davidson 2005).	Yes. This species has already established in Qld and has a wide distribution globally. It is highly polyphagous (Garcia Morales <i>et al.</i> 2016) and feeds on many plants that are common in Australia.	Yes. This species is a serious pest of citrus in the western Mediterranean, Greece and Iran (Garcia Morales <i>et al.</i> 2016).	<b>Yes (WA)</b>
<b><i>Coccus hesperidum</i></b> L., 1758 [Coccidae] Soft scale	Cook Islands, Niue, Samoa, Tonga (Williams and Watson 1990), Vanuatu (Williams and Butcher 1987).	Yes. NT, Qld, SA, Vic. and WA (Smith D <i>et al.</i> 1997), NSW, Tas. (CSIRO 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Coccus longulus</i></b> (Douglas, 1887) [Coccidae] Long brown scale	Cook Islands, Niue, Samoa, Vanuatu (Williams and Watson 1990; Garcia Morales <i>et al.</i> 2016).	Yes. NSW, NT, Qld, SA and WA (Garcia Morales <i>et al.</i> 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Coccus viridis</i></b> (Green, 1889) [Coccidae] Soft green scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1990; Garcia Morales <i>et al.</i> 2016).	Yes. NSW, NT, Qld and WA (Poole 2005; Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Dysmicoccus brevipes</i></b> (Cockerell, 1893) [Pseudococcidae] Pineapple mealybug	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1988b).	Yes. NSW, NT, Qld, Tas. and WA (Garcia Morales <i>et al.</i> 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Dysmicoccus neobrevipes</i></b> Beardsley, 1959 [Pseudococcidae] Grey pineapple mealybug	Cook Islands, Samoa (Williams and Watson 1988b).	No record found.	Yes. Lime is a host (Williams and Watson 1988b). This mealybug is normally found on the aerial parts of host plants including the fruit (Martin Kessing <i>et al.</i> 2007c).	Yes. This species could potentially establish in tropical regions of Australia, and possibly subtropical areas as well, especially where pineapples are grown (Martin Kessing <i>et al.</i> 2007c). Other hosts include bananas, taro and coffee (Garcia Morales <i>et al.</i> 2016).	Yes. This species is one of the most serious mealybug pests in Hawaii. It is implicated in vectoring mealybug wilt and green spot disease in pineapples (Martin Kessing <i>et al.</i> 2007c).	<b>Yes</b>
<b><i>Ferrisia virgata</i></b> (Cockerell, 1893) [Pseudococcidae] Striped mealybug	Cook Islands, Samoa, Tonga, Vanuatu (Williams and Watson 1988b).	Yes. NSW, NT, Qld and WA (Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Fiorinia proboscidea</i></b> Green, 1900 [Diaspididae] Armoured scale	Tonga (Beardsley 2001).	No record found.	Yes. This scale feeds on a number of citrus species (Williams and Watson 1988a). Mainly found on the underside of the leaves (Beardsley 2001), but has been reported on citrus fruit in Florida (Stocks 2015) and the Caribbean (Malumphy 2014). Scales are often clustered together on the host, and feeding results in chlorosis of the fruit (Malumphy 2014), so infestations are readily detectable and affected fruit would be removed from the pathway.	Yes. This scale has a broad geographic range, and feeds on plants that are common in Australia including rose, citrus and mango (Garcia Morales <i>et al.</i> 2016). However, due to the immobility of most life stages of the scale, fresh lime fruit are unlikely to provide a suitable pathway to enable establishment to occur.	No. This scale is not reported as a pest (Evans and Dooley 2013). There are no reports that indicate impacts of any economic significance, but potentially a nuisance pest.	No



Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Hemiberlesia cyanophylli</i></b> (Signoret, 1869) [syn.: <i>Abgrallaspis cyanophylli</i> (Signoret, 1869)] [Diaspididae] Cyanophyllum scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Watson 2016; SPC 2016).	Yes. NSW and Qld (Donaldson and Tsang 2002). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Not commonly associated with citrus, but this species has been recorded on limes in Samoa (Stout 1982). It may be present on fruit, leaves and bark of host plants, but prefers the undersides of the leaves (Miller and Davidson 2005).	Yes. Widespread in tropical and subtropical regions, and already present in eastern Australia. It is a polyphagous species with a wide host range (Garcia Morales <i>et al.</i> 2016; Watson 2016).	Yes. This species is highly polyphagous, causing damage to various ornamentals, palms, banana, avocado, cocoa, mango, guava and tea (Miller and Davidson 2005; Garcia Morales <i>et al.</i> 2016; Watson 2016).	<b>Yes (WA)</b>
<b><i>Hemiberlesia lataniae</i></b> (Signoret, 1869) [Diaspididae] Latania scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1988a).	Yes. NSW, Qld and WA (Donaldson and Tsang 2002; Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Homalodisca vitripennis</i></b> (Germar, 1821) [Cicadellidae] Glassy winged sharpshooter	Cook Islands (CABI 2016)	No record found.	No. Feeds on the xylem of host plants, so typically found on stems and leaves. Oviposition is generally into the leaves of plants, forming blister-like patches. In heavy infestations, egg masses can be laid into the rind of immature fruit. The eggs hatch in one to two weeks (Blua <i>et al.</i> 1999), so viable eggs are unlikely to be present on mature fruit at harvest (Phillips 2000). Old hatched egg masses appear as grey or tan scars on surface of the rind (Blua <i>et al.</i> 1999). Scarred fruit are typically unmarketable, so would be discarded at harvest or in pre-export sorting and handling.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Howardia biclavis</i></b> (Comstock, 1883) [Diaspididae] Mining scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1988a).	Yes. Qld (Donaldson and Tsang 2002). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. Lime trees are a host, but this scale is usually found on twigs and branches, where it settles in the bark tissue (Garcia Morales <i>et al.</i> 2016). Rarely found on leaves and fruit of hosts (Miller and Davidson 2005).	Assessment not required.	Assessment not required.	No
<b><i>Icerya purchasi</i></b> Maskell, 1879 [Monophlebidae] Cottony cushion scale	Tonga (Williams and Watson 1990).	Yes. NSW, Qld, SA, Tas., WA (Houston 2002).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Icerya seychellarum</i></b> (Westwood, 1855) [Monophlebidae] Seychelles fluted scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1990).	Yes. NT, Qld (AFD 2016), WA (Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Ischnopsis longirostris</i></b> (Signoret, 1882) [Diapidae] Black thread scale	Cook Islands, Samoa, Tonga, Vanuatu (Williams and Watson 1988a).	Yes. NT, Qld, SA (Watson 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Lepidosaphes beckii</i></b> (Newman, 1869) [Diaspididae] Mussel scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Garcia Morales <i>et al.</i> 2016).	Yes. NSW, Qld, SA, Tas., Vic. (Garcia Morales <i>et al.</i> 2016) and WA (Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Lepidosaphes gloverii</i></b> (Packard, 1869) [Diaspididae] Glover scale	Cook Islands, Niue, Samoa, Tonga (Williams and Watson 1988a).	Yes. NSW, Qld, Vic and WA (Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Leptoglossus gonagra</i></b> (Fabricius, 1775) [Coreidae] Passionvine bug	Cook Islands, Samoa, Tonga, Vanuatu (SPC 2016, as <i>Leptoglossus australis</i> ).	Yes. NSW, NT, Qld (Cassis <i>et al.</i> 2012) and WA (APPD 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<i>Lopholeucaspis cockerelli</i> (Grandpré and Charmoy, 1899) [Diaspididae] Diaspine scale	Cook Islands, Samoa, Tonga, Vanuatu (Williams and Watson 1988a; Watson 2016).	No record found.	No. Reported from a number of citrus species including limes, but is associated with the leaves (Stout 1982; Watson 2016).	Assessment not required.	Assessment not required.	No
<i>Mictis profana</i> (Fabricius, 1803) [Coreidae] Crusader bug	Samoa, Tonga (Stout 1982).	Yes. ACT, NSW, NT, Qld, SA, Vic. and WA (Cassis <i>et al.</i> 2012).	Assessment not required.	Assessment not required.	Assessment not required.	No
<i>Milviscutulus mangiferae</i> (Green, 1889) [Coccidae] Mango shield scale	Samoa, Tonga (Williams and Watson 1990).	Yes. Qld (Grimshaw and Donaldson 2007). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. This species is found on the leaves and stems of host plants, and is not usually associated with the fruit (Anderson and MacLeod 2008).	Assessment not required.	Assessment not required.	No
<i>Morganella longispina</i> (Morgan, 1889) [Diaspididae] Plumose scale	Cook Islands, Samoa, Tonga (Williams and Watson 1988a).	Yes. Qld (Donaldson and Tsang 2002). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. This polyphagous species attacks citrus, and is normally present on the fruit and branches of hosts (Miller and Davidson 2005).	Yes. This is a cosmopolitan species that has already established in eastern Australia (Donaldson and Tsang 2002). It could possibly establish in northern parts of Western Australia.	Yes. This species causes damage to citrus, tea, avocado, fig, mango and papaya, but is usually only a minor or occasional pest (Miller and Davidson 2005).	Yes (WA)
<i>Myzus persicae</i> (Sulzer, 1776) [Aphididae] Green peach aphid	Cook Islands, Samoa (SPC 2016), Tonga (Carver <i>et al.</i> 1993).	Yes. NSW, NT, Qld, SA, Tas., Vic. and WA (Hollis and Eastop 2005).	Assessment not required.	Assessment not required.	Assessment not required.	No
<i>Nezara viridula</i> (L., 1758) [Pentatomidae] Green vegetable bug	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Waterhouse and Norris 1987).	Yes. NSW, NT, Qld, SA, Tas., Vic. and WA (Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Parabemisia myricae</i></b> (Kuwana, 1927) [Aleyrodidae] Japanese bayberry whitefly	Samoa (De Barro <i>et al.</i> 1998)	Yes. Qld (CSIRO 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. This is a pest of citrus in California, but primarily associated with young foliage (Hamon <i>et al.</i> 1990). Adults may feed and lay eggs on fruit of some hosts (EPPO 1988), but honeydew, sooty mould and feeding damage are likely to be evident, and the pests and affected fruit removed from the pathway during pre-export handling. Reported on <i>Gardenia</i> sp. and <i>Rollinia</i> sp. in Samoa (De Barro <i>et al.</i> 1998).	Assessment not required.	Assessment not required.	No
<b><i>Parasaissetia nigra</i></b> (Nietner, 1861) [Coccidae] Nigra scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (SPC 2016).	Yes. NSW, NT, Qld, Vic. and WA (Garcia Morales <i>et al.</i> 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Parlatoria cinerea</i></b> Hadden, 1909 [Diaspididae] Tropical grey chaff scale	Cook Islands, Niue, Samoa, Vanuatu (Williams and Watson 1988a).	No record found	Yes. Recorded on lime in Niue, and a common pest on citrus in the Pacific (Williams and Watson 1988a). Mainly found on stems and branches, but sometimes on leaves and fruit (Watson 2016).	Yes. This is a polyphagous species, and hosts such as citrus, mango, grape, gardenia, bougainvillea and jasmine (Watson 2016) are common in parts of Australia. It has a wide distribution in the warmer parts of the world, so it could potentially establish in Australia.	Yes. <i>Parlatoria cinerea</i> has been recorded as a pest of citrus in several countries in the South Pacific region (Williams and Watson 1988a). Heavy infestations can cause significant damage to citrus plantations (Watson 2016).	<b>Yes</b>

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<b><i>Parlatoria pergandii</i></b> Comstock, 1881 [Diaspididae] Chaff scale	Cook Islands, Niue, Samoa (Williams and Watson 1988a).	Yes. NSW (Watson 2016) and Qld (Donaldson and Tsang 2002). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. This species may be present on lime fruit (Stout 1982; Watson 2016).	Yes. This species has already established in eastern Australia. It is highly polyphagous, and crawlers can be dispersed by wind or animals. Sessile adults and eggs can be distributed via human assisted movement of infested plant materials (Watson 2016).	Yes. This species is widely known as a pest of citrus, with heavy infestations resulting in dieback of whole branches and sometimes killing the tree (Watson 2016). Also damaging to ornamentals and mango (Watson 2016).	<b>Yes (WA)</b>
<b><i>Pinnaspis aspidistrae</i></b> (Signoret, 1869) [Diaspididae] Fern scale	Cook Islands, Niue, Samoa (Williams and Watson 1988a), Tonga, Vanuatu (Watson 2016).	Yes. NSW, Qld (Donaldson and Tsang 2002), SA (Brookes 1964) and Tas. (Garcia Morales <i>et al.</i> 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Commonly infests citrus. Mainly found on leaves, but occasionally present on the fruit (Miller and Davidson 2005).	Yes. This is a polyphagous species recorded from at least 60 genera (Miller and Davidson 2005). Probably native to the Oriental region (Miller and Davidson 2005) but has spread widely.	Yes. Considered to be a serious pest of ferns and other foliage plants, as well as citrus, palms and bananas (Miller and Davidson 2005).	<b>Yes (WA)</b>
<b><i>Pinnaspis strachani</i></b> (Cooley, 1899) [Diaspididae] Hibiscus snow scale	Cook Islands, Niue, Samoa, Tonga (Williams and Watson 1988a).	Yes. SA (Brookes 1964) and WA (Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Planococcus citri</i></b> (Risso, 1813) [Pseudococcidae] Citrus mealybug	Cook Islands, Niue, Samoa, Tonga (Williams and Watson 1988b).	Yes. NSW, NT, Qld, SA, Tas. and WA (Smith D <i>et al.</i> 1997; Poole 2010).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b><i>Planococcus minor</i></b> (Maskell, 1897) [syn.: <i>Planococcus pacificus</i> Cox, 1981] [Pseudococcidae] Pacific mealybug	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1988b).	Yes. NSW, NT, Qld and SA (Cox 1989). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Recorded on limes in Vanuatu (Williams and Butcher 1987). This species can be spread via trade in fruit (Venette and Davis 2004; Francis <i>et al.</i> 2012).	Yes. This species is polyphagous and has a high reproductive rate, and has successfully established in a number of countries following its introduction (Francis <i>et al.</i> 2012).	Yes. This species is a serious pest in some countries. It can affect crops such as banana, citrus, cocoa, coffee, corn, grape, mango, potato and soybean (Venette and Davis 2004).	<b>Yes (WA)</b>
<b><i>Pseudaonidia trilobitiformis</i></b> (Green, 1896) [Diaspididae] Trilobite scale	Samoa (SPC 2016), Vanuatu (Williams and Butcher 1987).	Yes. NT, Qld (Donaldson and Tsang 2002; Garcia Morales <i>et al.</i> 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. Recorded on citrus, but found on the leaves (Watson 2016; Hill 2008). On other hosts it may be found on bark, leaves or fruit (Miller and Davidson 2005).	Assessment not required.	Assessment not required.	No
<b><i>Pseudococcus cryptus</i></b> Hempel, 1918 [Pseudococcidae] Cryptic mealybug	Samoa (Williams and Watson 1988b).	Yes. Present in northern Queensland (QDAF 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Commonly found on citrus, including limes. Concealed fruit is heavily attacked (Williams and Watson 1988b).	Yes. This species is polyphagous and has a wide distribution globally, indicating a potential to establish and spread (Garcia Morales <i>et al.</i> 2016).	Yes. This species is an important citrus pest in Japan (Arai 2002), and was a serious pest in Israel following its introduction there (Garcia Morales <i>et al.</i> 2016).	<b>Yes (WA)</b>

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<b><i>Pulvinaria polygonata</i></b> Cockerell, 1905 [Coccidae] Cottony citrus scale	Cook Islands (Williams and Watson 1990).	Yes. Qld (Garcia Morales <i>et al.</i> 2016).  Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. Associated with the leaves and twigs of citrus (Smith D <i>et al.</i> 1997).	Assessment not required.	Assessment not required.	No
<b><i>Pulvinaria psidii</i></b> Maskell, 1893 [Coccidae] Soft scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1990).	Yes. ACT, NSW, NT, Qld (Garcia Morales <i>et al.</i> 2016) and WA (APPD 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Saissetia coffeae</i></b> (Walker, 1852) [Coccidae] Brown scale	Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1990).	Yes. NSW, NT, Qld, SA, Vic. and WA (Garcia Morales <i>et al.</i> 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Saissetia neglecta</i></b> De Lotto, 1969 [Coccidae] Caribbean black scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Williams and Watson 1990).	Yes. Records from South East Qld (APPD 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. The scales can be found on small twigs, particularly the fruit stems (Bullock 1976; Fasulo and Brooks 2013).	Yes. This species has been reported from many plant hosts (Garcia Morales <i>et al.</i> 2016). The female lays an average of 2,000 eggs and reproduction is usually by parthenogenesis (Fasulo and Brooks 2013).	Yes. This species is the main scale infesting citrus in Florida (Fasulo and Brooks 2013). A number of other plants have been recorded as hosts including mango, coffee, guava, fig and cassava (Garcia Morales <i>et al.</i> 2016).	<b>Yes (WA)</b>
<b><i>Singhiella citrifolii</i></b> (Morgan, 1893) [Aleyrodidae] Citrus whitefly	Samoa (De Barro 1998, as <i>Dialeurodes citrifolii</i> ).	No record found.	No. This whitefly almost exclusively colonises the underside of host-plant leaves. Unlikely to be on fruit subject to typical production and import procedures (Naumann 2002).	Assessment not required.	Assessment not required.	No

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<b><i>Toxoptera aurantii</i></b> (Boyer de Fonscolombe, 1841) [Aphididae] Black citrus aphid	Cook Islands, Samoa, Tonga, Vanuatu (SPC 2016).	Yes. Qld, Tas., Vic. (Hollis and Eastop 2005) and WA (APPD 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Toxoptera citricida</i></b> (Kirkaldy, 1907) [Aphididae] Brown citrus aphid	Cook Islands, Samoa (SPC 2016), Tonga (Carver <i>et al.</i> 1993), Vanuatu (CABI 2016).	Yes. NSW, Qld, SA, Vic. and WA (Hollis and Eastop 2005).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Unaspis citri</i></b> (Comstock, 1883) [Diaspididae] Citrus snow scale	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Waterhouse and Norris 1987).	Yes. NSW and Qld (Donaldson and Tsang 2002). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Citrus is a host. Usually found on the trunk and branches, but occasionally present on fruit and leaves (Miller and Davidson 2005).	Yes. This species has a broad host range including a number of citrus species (Garcia Morales <i>et al.</i> 2016). It is already present in eastern Australia, so could potentially establish if introduced to parts of Western Australia.	Yes. This species is a serious pest of major economic importance (Miller and Davidson 2005).	<b>Yes (WA)</b>
<b>Lepidoptera (butterflies, moths)</b>						
<b><i>Cleora samoana</i></b> Butler, 1886 [Geometridae] Forest looper caterpillar	Niue, Samoa, Tonga (Stout 1982).	No record found.	No. Lime is a host, but the larvae feed on leaves (Stout 1982). Not likely to be present on fruit.	Assessment not required.	Assessment not required.	No
<b><i>Cryptoblabes gnidiella</i></b> (Millière, 1867) [Pyralidae] False blossom moth	Cook Islands, Niue, Samoa, Tonga (Stout 1982).	No record found.	No. Lime is reported as a host (Stout 1982), but this pest is unlikely to be present on mature fruit harvested for export. Larvae may feed on rind of immature fruit, causing premature yellowing and fruit drop (Silva and Mexia 1999).	Assessment not required.	Assessment not required.	No



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<b><i>Eudocima phalonia</i></b> (L., 1763) [syn.: <i>Othreis fullonica</i> (L., 1767); <i>Eudocima fullonia</i> (Clerck, 1764)] [Noctuidae] Fruit piercing moth	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Stout 1982).	Yes. NSW, NT, Qld (CSIRO 2016) and WA (APPD 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Eudocima salaminia</i></b> (Cramer, 1777) [Noctuidae] Fruit piercing moth	Samoa, Tonga (Stout 1982), Vanuatu (Muniappan <i>et al.</i> 2002).	Yes. NSW, NT and Qld (CSIRO 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. Adults feed on citrus, but only at night, so will not be present when fruit is harvested. Eggs are laid on the leaves of <i>Stephania japonica</i> and other Menispermaceae plants on which the larvae feed (Muniappan <i>et al.</i> 2002).	Assessment not required.	Assessment not required.	No
<b>CHLOROPHYTA: Ulvophyceae</b>						
<b>Trentepohliales (green algae)</b>						
<b><i>Cephaleuros virescens</i></b> Künze ex E.M.Fries 1832 [Trentepohliales: Trentepohliaceae] Algal leafspot	Cook Islands, Niue, Samoa, Tonga (Dingley <i>et al.</i> 1981), Vanuatu (SPC 2016).	Yes. WA (APPD 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b>CHROMALVEOLATA: Oomycota</b>						
<b>Peronosporales (water moulds)</b>						
<b><i>Phytophthora nicotianae</i></b> Breda de Haan 1896 [Peronosporaceae] Brown rot	Cook Islands (Dingley <i>et al.</i> 1981), Samoa, Tonga (SPC 2016).	Yes. Qld (Simmonds 1966), SA (Cook and Dube 1989), Tas. (Sampson and Walker 1982) and WA (Shivas 1989).	Assessment not required.	Assessment not required.	Assessment not required.	No

Pest	Present in Cook Islands, Niue, Samoa, Tonga or Vanuatu	Present in Australia	Potential to be on fresh Tahitian lime fruit pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
<b>FUNGI</b>						
<b><i>Chaetothyrium javanicum</i></b> (Zimm.) Boedijn 1931 [Chaetothyriaceae] Sooty mould	Samoa, Tonga (Dingley <i>et al.</i> 1981, as <i>Phaeosaccardinula javanica</i> ).	No record found	No. Sooty moulds are superficial fungi found on the leaves, stems and fruit of trees that have been infested with honeydew excreting insects (Timmer 2000). Affected fruit would be removed from the pathway prior to export.	Assessment not required.	Assessment not required.	No
<b><i>Cryptosporiopsis citri</i></b> P.R.Johnst. & Full. 1988 [Dermateaceae] Leaf spot	Cook Islands, Niue, Samoa, Tonga, Vanuatu (Johnston and Fullerton 1988).	Yes. NT (Ray <i>et al.</i> 2008), Qld (Johnston and Fullerton 1988).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Diaporthe citri</i></b> (H.S.Fawc.) F.A.Wolf 1926 [Diaporthaceae] Melanose	Cook Islands, Niue, Samoa, Tonga (Dingley <i>et al.</i> 1981; Stout 1982, as <i>Diaporthe citri</i> ).	Yes. NSW (Letham 1995), Qld (Simmonds 1966) and WA (ALA 2016).	Assessment not required.	Assessment not required.	Assessment not required.	No

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<b><i>Elsinoë fawcettii</i></b> Bitanc. & Jenkins 1936 [Elsinoaceae] Citrus scab	Cook Islands, Niue, Samoa, Tonga (Dingley <i>et al.</i> 1981, as <i>Sphaceloma fawcettii</i> ), Vanuatu (McKenzie 1989). Information on the scab pathotypes present in these countries is not available.	Yes. NSW, NT and Qld (Timmer <i>et al.</i> 1996). At least two pathotypes are present in Australia (Tryon's and lemon) (Timmer <i>et al.</i> 1996). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. Could potentially be on Tahitian lime fruit, but infrequently. Most cultivars of Tahitian limes are rarely attacked (Smith IM <i>et al.</i> 1997). Affected trees in an abandoned orchard in Fiji had scabs on less than one percent of old leaves (Meister 1973), but no indication of fruit infection was noted. Additionally, blemished fruit is usually removed from the packing line prior to export (Hyun <i>et al.</i> 2009).	Yes. Possible, but trade in commercial fruit is an unlikely pathway for establishment of citrus scab (Hyun <i>et al.</i> 2009). Scab is only spread by splash dispersal of conidia to young leaves and fruit (Timmer 2000). It can survive for periods in pustules on old leaves and fruit (Timmer 2000) but is difficult to isolate from mature fruit in the field (Hyun <i>et al.</i> 2009). Blemished fruit is usually removed from the packing line prior to export (Hyun <i>et al.</i> 2009).	Yes. Infection produces exterior blemishes on a range of citrus fruit, affecting the value of fruit grown for the fresh market (Timmer 2000).	<b>Yes</b>
<b><i>Geotrichum candidum</i></b> Link 1809 [Dipodascaceae] Sour rot	Cook Islands (Dingley <i>et al.</i> 1981, as <i>Endomyces geotrichum</i> ), Vanuatu (McKenzie 1989, as <i>Dipodascus geotrichum</i> ).	Yes. NSW (Letham 1995), SA (Cook and Dube 1989), Tas. (Sampson and Walker 1982) and WA (Shivas 1989).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Lasiodiplodia theobromae</i></b> (Pat.) Griffon & Maubl. 1909 [Botryosphaeriaceae] Diplodia stem-end rot	Cook Islands, Niue, Samoa, Tonga (Dingley <i>et al.</i> 1981), Vanuatu (McKenzie 1989).	Yes. Qld (Simmonds 1966) and WA (Shivas 1989).	Assessment not required.	Assessment not required.	Assessment not required.	No

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<b><i>Meliola citricola</i></b> Syd. & P.Syd. 1917 [Meliolaceae] Black mildew	Samoa (Dingley <i>et al.</i> 1981), Vanuatu	No record found	Yes. Recorded on key lime and other citrus in Samoa. Usually on the underside of the leaves (Dingley <i>et al.</i> 1981), but can colonise the fruit (Minter 2006).	Yes. This species could potentially establish in tropical parts of Australia where citrus is grown.	No. Severe infestations could conceivably result in plants having reduced photosynthetic capability, but there are no reports of economic loss as a result. Appearance of fruit could be unsightly (Minter 2006).	No
<b><i>Penicillium digitatum</i></b> (Pers.:Fr.) Sacc. 1881 [Trichocomaceae] Green mould	Cook Islands, Niue (Dingley <i>et al.</i> 1981).	Yes. NSW (Letham 1995), Qld (Simmonds 1966), SA (Cook and Dube 1989) and WA (Shivas 1989).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Penicillium italicum</i></b> Wehmer 1894 [Trichocomaceae] Blue mould	Cook Islands (Dingley <i>et al.</i> 1981), Samoa (SPC 2016).	Yes. NSW (Letham 1995), Qld (Simmonds 1966), SA (Cook and Dube 1989) and WA (Shivas 1989).	Assessment not required.	Assessment not required.	Assessment not required.	No
<b><i>Seurattia millardetii</i></b> (Racib.) Meeker 1975 [Seuratiaceae] Sooty mould	Cook Islands (as <i>Atichia millardetii</i> Raciborski) (Dingley <i>et al.</i> 1981), Samoa (as <i>Atichia glomerulosa</i> (Ach. ex H. Mann) Stein) (Dingley <i>et al.</i> 1981).	No record found.	Yes. Saprobiic and epiphytic on leaves (Cannon and Kirk 2007). Usually on the upper surface of the leaves, growing on insect honey dew (Dingley <i>et al.</i> 1981). Could potentially be present on surface of lime fruit.	Yes. Has a wide global distribution from warm temperate to tropical regions (Farr and Rossman 2016). Some hosts are present in Australia.	No. Not of economic importance (Dingley <i>et al.</i> 1981). Fungi of the Seuratiaceae family are not known to have economic consequences (Cannon and Kirk 2007).	No

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<b>VIROIDS</b>						
<b>Citrus exocortis viroid</b> (CEVd) [Pospiviroidae]	Cook Islands (Davis <i>et al.</i> 2005), Samoa (Davis <i>et al.</i> 2006a).	Yes. NSW, NT and Qld (CABI 2016). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	Yes. All citrus species are susceptible to infection, but may remain symptomless. Infection is systemic, so some viroids could be present in the fruit.	No. Not known to be transmitted from citrus fruit or seed (CABI 2016). Fresh lime fruit will not provide a pathway for transmission to a susceptible host, so the viroid is unlikely to be able to establish.	Assessment not required.	No
<b>VIRUSES</b>						
<b>Citrus psorosis virus</b> (CPsV) [Ophioviridae] Psorosis Note: Psorosis is thought to be caused by a complex of several viruses	Samoa (Davis <i>et al.</i> 2006a), Tonga (Davis <i>et al.</i> 2006b).	Yes. NSW (Letham 1995), Qld (Simmonds 1966), SA (Cook and Dube 1989) and Vic. (Washington and Nancarrow 1980). Declared Organism (Prohibited - section 12) for WA (Government of Western Australia 2017).	No. Fruit may have chlorotic ring-shaped symptoms on the surface. Infected trees have low yields and produce poor quality fruit (Sofy <i>et al.</i> 2007), which are unlikely to be suitable for export.	Assessment not required.	Assessment not required.	No
<b>Citrus tristeza virus</b> (CTV) [Closteroviridae] Tristeza, lime dieback	Cook Islands, Niue, Samoa, Tonga (Davis <i>et al.</i> 2010).	Yes. NSW (Letham 1995), Qld (Simmonds 1966), SA (Cook and Dube 1989) and Vic. (Washington and Nancarrow 1980). Several strains, but not all, are present in Australia (PHA 2016).	Yes. <i>Citrus aurantifolia</i> (key lime) is reported as a host in the Pacific Islands (Davis <i>et al.</i> 2010), and Tahitian lime is also a likely host. Virus is present in the phloem, so presence in fruit cannot be excluded; affected trees are unlikely to yield export quality fruit.	No. Not known to be seed-borne (CABI 2016). Fresh lime fruit will not provide a pathway for transmission to a susceptible host, so the virus will not be able to establish and spread.	Assessment not required.	No

## Appendix B Issues raised in stakeholder comments

This section summarises the key stakeholder comments raised in consultation on the draft report, and the department's responses. Additional information on other issues commonly raised by stakeholders, which may be outside the scope of this technical report, is available on the department's website.

**Comment 1: It was queried why citrus canker (*Xanthomonas citri*) and huanglongbing (*Candidatus Liberibacter asiaticus*) were not assessed, given they are significant pathogens of citrus of concern to Australian producers.**

Response: These pathogens are not present in the countries assessed in this review, and so are not within the scope of this assessment, consistent with ISPM 11 (FAO 2013).

**Comment 2: Concerns were raised over the methodology used in the pest categorisation process, which resulted in many pests (for example, fruit flies, glassy winged sharpshooter, citrus tristeza virus) not being assessed further.**

Response: As indicated in Chapter 2 of this report, phytosanitary measures cannot be imposed for pests that are not directly associated with, and transmissible from, the actual commodity being imported (fresh Tahitian lime fruit), or if they are already present in the importing country (Australia) and are not under official control. Pest categorisation also considers whether the pests could establish and spread in Australia, and whether they are likely to have an unacceptable economic impact (including impacts on the environment). The majority of the 82 pests considered in the pest categorisation process did not meet those criteria, and hence were not considered further. Conversely, all twelve pests that did fulfil the criteria were assessed in detail, with three mealybug species ultimately requiring import risk management measures.

While specific measures may not be required for all pests, goods are imported through a formal operational system, as outlined in section 5.2 of this report. In addition to the quality assurance checks done in the packing house by the exporter, every consignment will be subject to a pre-export phytosanitary inspection by the NPPPO or relevant agency to ensure no quarantine pests or other regulated articles (leaves or soil, for example) are present in the exported goods. An additional inspection will be done on arrival in Australia to verify that the consignment is free of pests before it is released from quarantine. These checks provide assurance that goods imported into Australia are free of quarantine pests.

**Comment 3: It was queried why citrus tristeza virus was not assessed further, as a number of potentially exotic strains of the virus have been identified in the Pacific Islands.**

Response: The citrus tristeza virus (CTV) was not assessed further because fresh Tahitian lime fruit does not provide a transmission pathway – while the virus could feasibly be carried in the fruit, as indicated in the pest categorisation table (page 64), there is no means for the virus to be transmitted from the fruit to infect new hosts and establish in Australia. CTV is mainly vectored by aphids, which acquire the virus by feeding on the sap of infected trees, but CTV can also be transmitted by using infected budwood for grafting.

Furthermore, there is no information to suggest the 'stem pitting' strains of citrus tristeza virus, which are either regulated as quarantine pests by Australia, or are under official control in Queensland, are present in the countries assessed in this review.

**Comment 4: It was queried why fruit flies were not assessed further, given they are significant pests of concern to Australian producers.**

Response: Seven fruit fly species were considered in the pest categorisation process. These species were selected because published distribution records indicated they are (or were previously) present in the Cook Islands, Niue, Samoa, Tonga or Vanuatu, and they are either a known pest of limes (*Bactrocera dorsalis*) or a pest of other citrus fruit (*Bactrocera curvipennis*, *Bactrocera kirki*, *Bactrocera passiflorae*, *Bactrocera trilineola*, *Bactrocera umbrosa* and *Bactrocera xanthodes*) that therefore warranted careful scrutiny.

The first step in the pest categorisation process was to consider whether each species is currently present in the Cook Islands, Niue, Samoa, Tonga, or Vanuatu.

*Bactrocera curvipennis* was not assessed further as it is no longer considered to be present in Vanuatu, and is absent from the other countries. It has not been reported in Vanuatu since 1930, despite a number of fruit fly surveys since the 1970s, and the introduction of routine trap surveillance, which has operated since 1994.

*Bactrocera dorsalis* was not assessed further as it is no longer considered to be present in the Cook Islands, and is absent from the other countries. It was successfully eradicated from the Cook Islands following a brief incursion in 2013, and has not been detected since in subsequent surveillance trapping.

The other five fruit fly species (*Bactrocera kirki*, *Bactrocera passiflorae*, *Bactrocera trilineola*, *Bactrocera umbrosa* and *Bactrocera xanthodes*) are known to be present in one or more of the assessed countries, and were therefore considered further to examine their potential to be on the fresh Tahitian lime fruit import pathway.

As indicated in the report, there is no evidence to indicate that commercially produced Tahitian lime fruit are a host for these fruit flies. They have not been reported as pests of Tahitian limes in the field, and extensive host surveys and fruit sampling across the Pacific Islands over many years has not found these species in Tahitian limes. There is also no information to suggest host preferences have changed in recent years. Accordingly, these species were not considered further in the assessment.

There have been a number of regional fruit fly program initiatives over the last 25 years to improve the knowledge of the fruit fly fauna in Pacific Island countries, implement surveillance systems in each country, enhance the capacity of quarantine agencies to exclude or manage fruit flies, and undertake eradication activities. All Pacific Island countries now have permanent trapping stations for quarantine surveillance that are routinely monitored to ensure pests do not expand their range, and in the rare event of an incursion, these are quickly identified and eradicated. Trapping data has been routinely collated and reported, providing a reliable and accurate understanding of pest distribution across the region.

In addition to the quarantine surveillance, host fruit surveying across the Pacific Island countries, specifically targeting high-risk commodities such as citrus, has provided significant

information on the host range, comparative host susceptibility, and economic importance of each fruit fly species. Therefore our understanding of the current distribution and host range of the assessed fruit fly species is considered to be very good.

**Comment 5: It was queried why Asian citrus psyllid was not assessed further, given it is a significant pest of concern to Australian producers.**

Response: The Asian citrus psyllid (*Diaphorina citri*) has been introduced into some countries in the Pacific region, but is not present in the countries assessed in this report. The pest is known to be present in American Samoa, which is a different group of islands and a separate jurisdiction to the Independent State of Samoa (formerly known as Western Samoa) considered in this report. Samoa and American Samoa are physically separated by around 70 kilometres of open Pacific Ocean.

The adult Asian citrus psyllid is a weak flier, so flight between islands tens or hundreds of kilometres apart is unlikely. Chance dispersal during cyclones may be possible if the psyllids are lifted into higher altitudes, but this is not known to have thus far occurred.

The distribution of the Asian citrus psyllid in the Pacific is recognised as being restricted to Papua New Guinea (detected in 1992), Guam (2007), Hawaii (2006), American Samoa (2009) and the Commonwealth of the Northern Mariana Islands (2011).

**Comment 6: The host association of glassy winged sharpshooter was queried. Given that the draft report indicated eggs could occasionally be laid in the rind of citrus fruit, how could the department be confident the pests would not be imported in fruit?**

Response: The department considers commercially grown and exported citrus to be an unlikely pathway for introducing glassy winged sharpshooter (*Homalodisca vitripennis*). Wording in the pest categorisation table (page 52) has been revised to make the association with the fruit clearer.

Glassy winged sharpshooter is not associated with mature lime fruit. The adults and nymphs feed on xylem in the twigs, stems and leaf petioles of the host plant, so they would not be expected to be found on lime fruit. All life stages of the pest, including the eggs, are visible to the naked eye. The adults are relatively large insects (12 to 14 millimetres long) that will actively fly away if disturbed – they would not remain on a fruit when it was harvested, washed and packed. The nymphs are smaller and cannot fly, but are active crawlers that would attempt to flee if disturbed.

Generally eggs are laid on the leaves of citrus trees. However in heavy infestations, when space for oviposition is limited, eggs can be laid in the rind of immature fruit (CABI 2017). The eggs hatch in one to two weeks (Blua *et al.* 1999) so viable eggs are unlikely to still be present on mature fruit many months later when it is harvested. Old hatched egg masses appear as grey or tanned scars on the surface of the rind. Scarred fruit are typically unmarketable, so would be discarded at harvest or in pre-export sorting and handling.

There is no history of interceptions of this pest via imported citrus fruit despite considerable trade occurring. Australia does not impose measures against glassy winged sharpshooter for citrus (including limes) imported from California where this pest is present, as it is not considered to be associated with commercially-produced mature citrus fruit.



**Comment 7: Concerns were raised that countries should not be left to monitor their own agronomic and sanitation procedures, suggesting that Australian authorities should have some oversight of production, as well as undertake regular visits to ensure standards are upheld.**

Response: The risk assessment was based on the typical production and post-harvest systems used in the Pacific Islands. No pests were assessed as requiring additional in-field intervention or post-harvest treatments to mitigate their risks to an acceptable level. The department does undertake visits to production areas in exporting countries from time to time. All consignments will be inspected on arrival in Australia to verify that biosecurity standards have been met. The department reserves the right to review import requirements or suspend trade if there is repeated non-compliance of imports.

**Comment 8: The estimate of the likelihood of entry for exotic pathotypes of *Elsinoë fawcettii* ('low') was questioned, suggesting this would not be the case in the absence of specific in-field measures to control the pathogen.**

Response: The assessment in the draft report was based on available information, including the low susceptibility of Tahitian limes to scab infection in the countries assessed, and the visible symptoms of infection that would facilitate removal of blemished fruit from the export pathway. This assessment supports a likelihood estimate for importation of Low.

However, it is accepted that there may be unreported pathotypes present in the countries covered by this review, which may more readily infect limes, and therefore increase the likelihood of importation. The capacity to identify and remove all scabby fruit, if present on the pathway, has also been reconsidered. On these grounds, the estimate for likelihood of importation of exotic pathotypes of citrus scab has therefore been revised to Moderate in this final report. This raises the overall estimated unrestricted risk to Very Low.

**Comment 9: It was questioned why pressure washing and post-harvest fungicides are not mandated to control *Elsinoë fawcettii*.**

Response: The risk assessment for *Elsinoë fawcettii* was based on typical basic production and post-harvest systems used in the Pacific Islands, and did not factor in use of pressure washing or fungicidal dips. As the unrestricted risk estimate achieved the appropriate level of protection for Australia (that is, Very Low), additional measures for *Elsinoë fawcettii* are not required. Commercially produced fresh lime fruit imported from the Cook Islands, Niue, Samoa, Tonga and Vanuatu are considered an unlikely pathway for entry and establishment of new pathotypes of *Elsinoë fawcettii* in Australia.

**Comment 10: Likelihood of entry is supposedly based on a year's trade, but the expected volume is not stated. The risk assessment therefore lacks robust scientific credibility, and the indicative probabilities are meaningless.**

Response: The assessment was undertaken on the basis that there would be low annual volumes of trade (anticipated to be less than 20 tonnes per year). Additional information to support this assumption has been included in Section 3.1 of the report.

## 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 or regulated articles (FAO 2016).
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 2016).
Consignment	A quantity of plants, plant products 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 2016).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2016).
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 2016).
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 2016).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2016).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2016).
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2016).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2016).
Infection	The internal 'endophytic' colonisation of a plant, or plant organ, and is generally associated with the development of disease symptoms as the integrity of cells and/or biological processes are disrupted.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2016).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2016).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2016).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2016).
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 IPPC (FAO 2016).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2016).
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2016).
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 2016).
Pathway	Any means that allows the entry or spread of a pest (FAO 2016).

Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2016).
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 2016).
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 2016).
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 2016).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences (FAO 2016).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2016).
Phytosanitary certificate	An official paper document or its official electronic equivalent, consistent with the model of certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2016).
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 2016).
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 2016).
Polyphagous	Feeding on a relatively large number of hosts from different plant family and/or genera.
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2016).
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 2016).
Regulated article	Any plant, plant product, storage place, packaging, 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 2016).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2016).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
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.
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.

## References

- Agostini, JP, Bushong, PM, Bhatia, A & Timmer, LW 2003, 'Influence of environmental factors on severity of citrus scab and melanose', *Plant Disease*, 87, pp. 1102–1106.
- Aguiar, AMF 2009, 'Exotic arthropod fruit pests and parasitoids found in the Archipelago of Madeira, Portugal since 1990', *Actas do I Workshop de Fruticultura – Contributo para o seu desenvolvimento (Angra do Heroísmo 21–23 April 2005)*, pp. 89–100.
- Allwood, AJ, Tumukon, T, Tau, D & Kassim, A 1997, 'Fruit fly fauna in Vanuatu', in AJ Allwood & RAI Drew (eds) *Management of fruit flies in the Pacific. A regional symposium, Nadi, Fiji 28–31 October 1996*, pp. 77–80, Australian Centre for International Agricultural Research, Canberra.
- Allwood, AJ, Chinajariyawong, A, Drew, RAI, Hamacek, EL, Hancock, DL, Hengsawad, C, Jipanin, JC, Jirasurat, M, Kong Krong, C, Kritsaneepaiboon, S, Leong, CTS & Vijaysegaran, S 1999, 'Host plant records for fruit flies (Diptera: Tephritidae) in South East Asia', *The Raffles Bulletin of Zoology*, Supplement No.7, pp. 1–92.
- Allwood, AJ, Vueti, ET, Leblanc, L & Bull, R 2002, 'Eradication of introduced *Bactrocera* species (Diptera: Tephritidae) in Nauru using male annihilation and protein bait application techniques', in CR Veitch & MN Clout (eds), *Turning the tide: the eradication of invasive species*, pp. 19–25, Occasional papers of the IUCN Species Survival Commission, No. 27.
- Anderson, H & MacLeod, A 2008, CSL Pest Risk Analysis for *Milviscutulus mangiferae*, Central Science Laboratory, Sand Hutton, UK.
- ALA 2016, Atlas of Living Australia, viewed April 2016, [ala.org.au/](http://ala.org.au/)
- APPD 2016, Australian plant pest database, Plant Health Australia.
- Arai, T 2002, 'Attractiveness of sex pheromone of *Pseudococcus cryptus* Hempel (Homoptera: Pseudococcidae) to adult males in a citrus orchard', *Applied Entomology and Zoology*, 37, pp. 69–72.
- BA 2005, *Final report – Extension of existing policy for sweet oranges from Italy*, Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.
- -- 2006a, *Final report – import risk analysis for Tahitian limes from New Caledonia*, Biosecurity Australia, Canberra.
- -- 2006b, *Policy for the importation of fresh mangoes (Mangifera indica L.) from Taiwan*, Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.
- -- 2008, *Final import risk analysis report for fresh mango fruit from India*, Biosecurity Australia, Department of Agriculture, Fisheries and Forestry, Canberra.
- Barnidge-McIntyre, M 2010, Orchard trees of Rancho Los Cerritos: lemon, lime & mandarin, Pacific Horticulture, January 2010, viewed June 2016, [pacifichorticulture.org/articles/orchard-trees-of-rancho-los-cerritos-lemon-lime-mandarin/](http://pacifichorticulture.org/articles/orchard-trees-of-rancho-los-cerritos-lemon-lime-mandarin/)

- Beard, JJ, Ochoa, R, Braswell, WE & Bauchan, GR 2015, '*Brevipalpus phoenicis* (Geijskes) species complex (Acari: Tenuipalpidae)—a closer look', *Zootaxa* 3944, pp. 1–67.
- Beardsley, JW & Gonzalez, RH 1975, 'The biology and ecology of armored scales', *Annual Review of Entomology* 20, pp. 47–73.
- Beardsley, JW 2001, '*Fiorinia proboscidaria* Green, an armored scale insect new to the Hawaiian fauna (Homoptera: Diaspididae)', *Proceedings of the Hawaiian Entomological Society* 35, p.149.
- Bennett, FD, Rosen, D, Cochereau, P & Wood, BJ 1976, 'Biological control of pests of tropical fruits and nuts'. In CB Huffaker & PS Messenger (eds) *Theory and practice of biological control*, pp. 359–396, Academic Press, New York, United States of America.
- Blua, M, Phillips, PP & Redak RA 1999, 'A new sharpshooter threatens both crops and ornamentals', *California Agriculture* 53, pp. 22–25.
- Botha, J, Bennington, J & Poole, M 2016, 'Spider mite pests of Western Australia', Department of Agriculture and Food, viewed July 2016, [agric.wa.gov.au/plant-biosecurity/spider-mite-pests-western-australian-plants](http://agric.wa.gov.au/plant-biosecurity/spider-mite-pests-western-australian-plants)
- Brooks, JG 1964, 'New records of Coleoptera in Australia', *Australian Journal of Entomology* 64, p. 85.
- Broughton, S 2007, 'Scale in citrus', Farmnote 243, Western Australia Department of Agriculture and Food.
- Bullock, RC 1976, 'Aerial sprays vs. black scale on Florida citrus', *Proceedings of the Florida State Horticulture Society* 89, pp. 62–63.
- CABI 2016, Crop Protection Compendium, CAB International, Wallingford, UK, viewed March 2016, [cabi.org/cpc/](http://cabi.org/cpc/)
- Cannon, PF & Kirk, PM 2007, *Fungal families of the world*, CAB International, Wallingford, UK.
- Cantrell, B, Chadwick, B & Cahill, A 2002, *Fruit fly fighters: eradication of the papaya fruit fly*. CSIRO Publishing, Collingwood, Victoria, Australia.
- Carver, M, Gross, GF & Woodward, TE 1991, 'Hemiptera', in ID Naumann (ed) *Insects of Australia*, pp. 429–509, Melbourne University Press, Carlton, Australia.
- Carver, M, Hart, PJ & Wellings, PW 1993, 'Aphids (Hemiptera: Aphididae) and associated biota from the Kingdom of Tonga, with respect to biological control', *Pan-Pacific Entomologist* 69, pp. 250–260.
- Cassis, G, Namyatova, A, Tatarinic, N & Symonds, C 2012, 'Superfamily Coreoidea', Australian Faunal Directory. Australian Biological Resources Study, Canberra.
- Christenson, LD & Foote RH 1960, 'Biology of fruit flies', *Annual Review of Entomology* 5, pp. 171–192.
- Cook, RP & Dube, AJ 1989, *Host-pathogen index of plant diseases in South Australia*, South Australian Department of Agriculture.

- Cox, JM 1989, 'The mealybug genus *Planococcus* (Homoptera: Pseudococcidae)', *Bulletin of the British Museum (Natural History)* 58, pp. 1–78.
- CSIRO 2016, Australian Insect Common Names. Australian National Insect Collection, CSIRO, Canberra, viewed March 2016, [ces.csiro.au/aicn/name\\_s/b\\_1.htm](http://ces.csiro.au/aicn/name_s/b_1.htm)
- DAFF 2004, *Mangosteen fruit from Thailand – Final import risk analysis report*, Department of Agriculture, Fisheries and Forestry, Canberra.
- -- 2012, *Final import risk analysis report for fresh decrowned pineapple fruit from Malaysia*, Department of Agriculture, Fisheries and Forestry, Canberra.
- Davis, RI, McMichael, LA, Maireroa, N & Wigmore, WJ 2005, *Surveys for plant diseases caused by viruses and virus-like pathogens in the Cook Islands*, Technical paper 222, Secretariat of the Pacific Community, Suva, Fiji Islands.
- Davis, RI, Matalavea, P, Seth, M, Mauga, T & Jones, P 2006a, *Surveys for plant diseases caused by viruses and virus-like pathogens in Samoa and Vanuatu*, Technical paper 225, Secretariat of the Pacific Community, Suva, Fiji Islands.
- Davis, RI, Tupouniua, SK, Amice, R, Taufa, L & Jones, P 2006b, *Surveys for plant diseases caused by viruses and virus-like pathogens in Tonga and New Caledonia*, Technical Paper No. 224, Secretariat of the Pacific Community, Land Resources Division: Suva, Fiji Islands.
- Davis, RI, Ruabete, TK 2010, 'Records of plant pathogenic viruses and virus-like agents from 22 Pacific island countries and territories: a review and an update' *Australasian Plant Pathology*, 39, pp. 265–291.
- De Barro, PJ 1998, *Survey of Bemisia tabaci Biotype B whitefly (also known as B. argentifolii) and its natural enemies in the South Pacific. Final Report of ACIAR Project No. 96/148 Sept. 1997.*
- De Barro, PJ, Liebregts, W & Carver, M 1998, 'Distribution and identity of biotypes of *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) in member countries of the Secretariat of the Pacific Community', *Australian Journal of Entomology*, 37, pp. 214–218.
- De Barro, PJ, Liu, SS, Boykin, LM & Dinsdale, AB 2011, '*Bemisia tabaci*: a statement of species status', *Annual Review of Entomology* 56, pp. 1–19.
- Dingley, JM, Fullerton, RA & McKenzie, EHC 1981, *Survey of agricultural pests and diseases. Technical report volume 2. Records of fungi, bacteria, algae and angiosperms pathogenic on plants in Cook Islands, Fiji, Kiribati, Niue, Tonga, Tuvalu and Western Samoa*, South Pacific Bureau for Economic Co-operation, United Nations Development Programme, Food and Agriculture Organization of the United Nations.
- Donaldson, J & Tsang, K 2002, 'Family Diaspididae: Armoured scales, diaspidids'. Australian Faunal Directory. Australian Biological Resources Study, Canberra.
- Drew, RAI & Hancock, DL 1994, 'The *Bactrocera dorsalis* complex of fruit flies (Diptera: Tephritidae: Dacinae) in Asia', *Bulletin of Entomological Research Supplement*, 2, pp. 1–68.

Drew, RAI & Romig, MC 2001, 'The fruit fly fauna (Diptera: Tephritidae: Dacinae) of Bougainville, the Solomon Islands and Vanuatu', *Australian Journal of Entomology*, 40, pp. 113–150.

EPPO 1988, '*Parabemisia myricae*', *EPPO Bulletin* 18, pp. 539–542.

-- -- 1997, *Bemisia tabaci*, *Data sheets on quarantine pests*, European and Mediterranean Plant Protection Organisation, viewed March 2016, [eppo.int/QUARANTINE/data\\_sheets/insects/BEMITA\\_ds.pdf](http://eppo.int/QUARANTINE/data_sheets/insects/BEMITA_ds.pdf)

Evans, GA & Dooley JW 2013, 'Potential invasive species of scale insects for the USA and Caribbean Basin', in JE Peña (ed) *Potential Invasive Pests of Agricultural Crops*, pp. 320–341, CAB International, Wallingford, UK.

FAO 2007, *International Standards for Phytosanitary Measures (ISPM) no. 2: Framework for pest risk analysis*, Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome, Italy.

-- -- 2011, *International Standards for Phytosanitary Measures (ISPM) no. 2: Framework for pest risk analysis*, Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome, Italy.

-- -- 2013, *International Standards for Phytosanitary Measures (ISPM) no. 11: Pest risk analysis for quarantine pests*, Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome, Italy.

-- -- 2016, *International Standards for Phytosanitary Measures (ISPM) no. 5: Glossary of phytosanitary terms*, Secretariat of the International Plant Protection Convention, Food and Agriculture Organisation of the United Nations, Rome, Italy.

Farr, DF & Rossman, AY 2016 *Fungal databases*. Systematic Botany and Mycology Laboratory, ARS, USDA, viewed March 2016, [nt.ars-grin.gov/fungaldatabases/index.cfm](http://nt.ars-grin.gov/fungaldatabases/index.cfm)

Fasulo, TR & Brooks, RF 2013, *Scale pests of Florida citrus*, ENY-814, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, viewed March 2016, [edis.ifas.ufl.edu/pdf/CH/CH05900.pdf](http://edis.ifas.ufl.edu/pdf/CH/CH05900.pdf)

Francis, AW, Kairo, MTK, Roda, AL, Liburd, OE & Polar, P 2012, The passionvine mealybug, *Planococcus minor* (Maskell) (Hemiptera: Pseudococcidae), and its natural enemies in the cocoa agroecosystem in Trinidad, *Biological Control*, 60, pp. 290–296.

García Morales, M, Denno, BD, Miller, DR, Miller, GL, Ben-Dov, Y, & Hardy, NB 2016, *ScaleNet: A literature-based model of scale insect biology and systematics*. Database. doi: 10.1093/database/bav118, viewed March 2016, [scalenet.info](http://scalenet.info)

Gill, RJ 1988, *The scale insects of California, Part I: the soft scales (Homoptera: Coccoidea: Coccidae)*, California Department of Food and Agriculture, Sacramento, United States of America.

-- -- 1997, *The scale insects of California, Part 3: the armoured scales (Homoptera: Coccoidea: Diaspididae)*, California Department of Food and Agriculture, Sacramento, United States of America.



- Gill, RJ & Kosztarab, M 1997, 'Economic importance', in Y Ben-Dov & CJ Hodgson (eds), *Soft scale insects – their biology, natural enemies and control*, pp. 161–163, Elsevier Science, Amsterdam, Netherlands.
- Government of Western Australia 2017, 'Western Australia Organism List (WAOL)', viewed March 2017, [agric.wa.gov.au/bam/western-australian-organism-list-waol](http://agric.wa.gov.au/bam/western-australian-organism-list-waol)
- Grayum, MH, Hammel, BE & Madrigal, QJ 2012, 'Validation of a scientific name for the Tahitian lime', *Phytoneuron*, 101, pp. 1–5.
- Greathead, DJ 1997, 'Crawler behaviour and dispersal', in Y Ben-Dov & CJ Hodgson (eds), *Soft scale insects – their biology, natural enemies and control*, pp. 339–342, Elsevier Science, Amsterdam, Netherlands.
- Grimshaw, JF & Donaldson, JF 2007, New records of mango shield scale *Milviscutulus mangiferae* (Green) (Hemiptera: Coccidae) and *Brevennia rehi* (Lindinger) (Hemiptera: Pseudococcidae) in north Queensland. *Australian Journal of Entomology*, 46, pp. 96–98.
- Gullan, PJ 1997, 'Relationships with ants', in Y Ben-Dov & CJ Hodgson (eds), *Soft scale insects – their biology, natural enemies and control*, pp. 351–373, Elsevier Science, Amsterdam, Netherlands.
- Gutierrez, J & Schicha, E 1983, 'The spider mite family Tetranychidae (Acari) in New South Wales', *International Journal of Acarology*, 9, pp. 99–116.
- Hamon, AB, Nguyen, R & Browning, H 1990, 'The bayberry whitefly, *Parabemisia myricae*, in Florida (Homoptera: Aleyrodidae: Aleyrodinae)', *Entomology Circular* no. 328, Florida Department of Agriculture and Consumer Services.
- Heimoana, V, Leweniqila, L, Tau, D, Tunupopo, F, Nemeye, P, Kassims, A, Quashie-Williams, C, Allwood, A & Leblanc L 1997a, 'Non-host status as a quarantine treatment option for fruit flies', in AJ Allwood & RAI Drew (eds), *Management of fruit flies in the Pacific. A regional symposium, Nadi, Fiji 28-31 October 1996*, pp. 225–231, Australian Centre for International Agricultural Research, Canberra.
- Heimoana, V, Tunupopo, F, Toleafoa, E & Fakanai, C 1997b, 'The Fruit Fly Fauna of Tonga, Western Samoa, American Samoa and Niue', in AJ Allwood & RAI Drew (eds) *Management of fruit flies in the Pacific. A regional symposium, Nadi, Fiji 28-31 October 1996*, pp. 57–59, Australian Centre for International Agricultural Research, Canberra.
- Hill, DS 2008, *Pests of crops in warmer climates and their control*, Springer-Verlag, New York, USA.
- Hodgson, CJ 1994, *The scale insect family Coccidae. An identification manual to genera*, CAB International, Wallingford, United Kingdom.
- Holat, D, Kaydan, MB, Mustu, M 2014, 'Investigations on some biological characters of *Pseudococcus cryptus* (Hempel) (Hemiptera: Pseudococcidae) on four *Citrus* species', *Acta Zoologica Bulgarica*, Supplement 6, pp. 35–40.



- Hollis, D & Eastop, VH 2005, 'Superfamily Aphidoidea', Australian Faunal Directory. Australian Biological Resources Study, Canberra.
- Hou, X, Huang, F, Zhang, T, Xu, J, Hyde, DK & Li, H 2014, 'Pathotypes and genetic diversity of Chinese collections of *Elsinoe fawcettii* causing citrus scab', *Journal of Integrative Agriculture*, 13, pp. 1293–1302.
- Houston, WWK 2002, 'Superfamily Coccoidea (mealy bugs, scale insects)'. Australian Faunal Directory. Australian Biological Resources Study, Canberra.
- Hyun, JW, Yi, SH, MacKenzie, SJ, Timmer, LW, Kim, KS, Kang, SK, Kwon, HM & Lim HC 2009, 'Pathotypes and genetic relationship of worldwide collections of *Elsinoë* spp. causing scab diseases of citrus', *Phytopathology*, 99, pp. 721–728.
- Johnston, PR & Fullerton, RA 1988, '*Cryptosporiopsis citri* sp. nov.; cause of a Citrus leaf spot in the Pacific Islands', *New Zealand Journal of Experimental Agriculture*, 16, pp. 159–163.
- Kaszab, Z 1955, 'Die Tenebrioniden der Samoa-Inseln (Coleoptera)', *Proceedings, Hawaiian Entomological Society*, 15, pp. 631–671.
- Kim, SC, Song, JH & Kim, DS 2008, 'Effect of temperature on the development and fecundity of the cryptic mealybug, *Pseudococcus cryptus*, in the laboratory', *Journal of Asia-Pacific Entomology*, 11, pp. 149–153.
- Kondo, T and Munoz, JA 2016, 'Scale insects (Hemiptera: Coccoidea) associated with avocado crop, *Persea americana* Mill. (Lauraceae) in Valle del Cauca and neighboring departments of Colombia', *Insecta Mundi*, 0465, pp. 1–24.
- Ladaniya, M 2008, *Citrus fruit: biology, technology and evaluation*, Academic Press, San Diego, USA.
- Leblanc, L, Tora Vueti, E, Drew, RAI & Allwood, AJ 2012, 'Host Plant Records for Fruit Flies (Diptera: Tephritidae: Dacini) in the Pacific Islands', *Proceedings of the Hawaiian Entomological Society*, 44, pp. 11–53.
- Letham, DB 1995, *Host-pathogen index of plant diseases in New South Wales*. New South Wales Agriculture, Rydalmere, Australia.
- Malumphy, C 2014, 'An annotated checklist of scale insects (Hemiptera: Coccoidea) of Saint Lucia, Lesser Antilles', *Zootaxa*, 3846, pp. 69–86.
- Martin, PH, & Gillespie, PS 2001, 'Superfamily Aleyrodoidea: white flies', Australian Faunal Directory. Australian Biological Resources Study, Canberra.
- Martin Kessing, JL, Mau, RFL & Diez, JM 2007a, *Abgrallaspis cyanophylli* (Signoret), Crop Knowledge Master, Extension Entomology and UH-CTAHR Integrated Pest Management Program, viewed March 2016, [extento.hawaii.edu/kbase/Crop/Type/a\\_cyanop.htm](http://extento.hawaii.edu/kbase/Crop/Type/a_cyanop.htm).
- -- 2007b, *Aspidiotus destructor* (Signoret), Crop Knowledge Master, Extension Entomology and UH-CTAHR Integrated Pest Management Program, viewed March 2016, [extento.hawaii.edu/kbase/crop/type/a\\_destru.htm](http://extento.hawaii.edu/kbase/crop/type/a_destru.htm)

- -- 2007c, *Dysmicoccus neobrevipes* (Beardsley), Crop Knowledge Master, Extension Entomology and UH-CTAHR Integrated Pest Management Program, viewed March 2016, [extento.hawaii.edu/kbase/crop/type/d\\_neobre.htm](http://extento.hawaii.edu/kbase/crop/type/d_neobre.htm)
- Masten Milek, T, Simala, M & Koric, B 2009, 'The scale insects (Hemiptera: Coccoidea) of imported fruits in Croatia', *Lectures and papers presented at 9th Slovenian Conference on Plant Protection, Nova Gorica, 4–5 March, 2009*, pp. 385–388.
- McKenzie, EHC 1989, 'The fungi, bacteria and pathogenic algae of Vanuatu', Plant Diseases Division, Department of Scientific and Industrial Research, Auckland, New Zealand.
- Meister, CW 1973, 'Differential reaction of citrus species to diseases and pests at Koronivia', *Fiji Agricultural Journal*, 35, pp. 75–78.
- Miles, AK, Tan, YP, Shivas RG & Drenth, A 2015, 'Novel pathotypes of *Elsinoe australis* associated with *Citrus australasica* and *Simmondsia chinensis* in Australia', *Tropical Plant Pathology*, 40, pp. 26–34.
- Miller, DR & Davidson, JA 2005, *Armored scale insect pests of trees and shrubs (Hemiptera: Diaspididae)*, Cornell University Press, Ithaca, New York.
- Miller, D, Rung, A, Parikh, G, Venable G, Redford, AJ, Evans GA & Gill RJ 2014, Scale Insects, Edition 2. USDA APHIS Identification Technology Program (ITP), Fort Collins, Colorado, viewed July 2016, [idtools.org/id/scales/](http://idtools.org/id/scales/)
- Minter, DW 2006, *Meliola citricola*. IMI Descriptions of Fungi and Bacteria 168, Sheet 1672, viewed March 2016, [cabi.org/dfb/FullTextPDF/2006/20063129257.pdf](http://cabi.org/dfb/FullTextPDF/2006/20063129257.pdf)
- Morton, J 1987, 'Tahiti lime', in JF Morton (ed) *Fruits of warm climates*, pp. 172–175, Julia F Morton, Miami, USA.
- Muniappan, R, Pura, M, Tarilonga, B, Berukilukilu, L, Bule, S & Reddy, GVOP 2002, 'Fruit piercing moths and their management in Vanuatu', *Journal of South Pacific Agriculture*, 9, pp. 16–27.
- Naumann, ID 2002, *Exotic arthropod pests of concern to the Australian citrus industry*, Office of the Chief Plant Protection Officer, Canberra, Australia.
- PHA 2016, 'Fact sheet: Citrus tristeza virus', viewed July 2016, [planthealthaustralia.com.au/wp-content/uploads/2015/01/Citrus-tristeza-virus-Mandarin-stem-pitting-strain-FS.pdf](http://planthealthaustralia.com.au/wp-content/uploads/2015/01/Citrus-tristeza-virus-Mandarin-stem-pitting-strain-FS.pdf)
- Phillips, PA 2000, 'The Glassy-winged sharpshooter - a new threat for California citrus as a potential vector of CVC', *CAPCA Adviser Magazine*, July/August 2000, pp. 16–17, 28.
- Poole, M 2005, *Green coffee scale Coccus viridis (Green) [Hemiptera: Coccidae]*, Farmnote 16/2005. Western Australia Department of Agriculture, viewed February 2016, [citrusaustralia.com.au/literature\\_47827/Green\\_coffee\\_scale](http://citrusaustralia.com.au/literature_47827/Green_coffee_scale).
- -- 2010, *An annotated catalogue of insect and allied species associated with Western Australian agriculture and related industries*, perennial draft, July 2010, Department of Agriculture and Food, Government of Western Australia.

- Pranamornkith, T 2009, 'Effects of postharvest treatments on storage quality of lime (*Citrus latifolia* Tanaka) fruit', PhD thesis, Massey University, New Zealand.
- QDAF 2016, 'Cryptic mealybug', Queensland Department of Agriculture and Fisheries, viewed July 2016, [daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests/cryptic-mealybug](http://daf.qld.gov.au/plants/fruit-and-vegetables/a-z-list-of-horticultural-insect-pests/cryptic-mealybug)
- Qin, TK & Gullan, PJ 1994, 'Taxonomy of the wax scales (Hemiptera: Coccidae: Ceroplastinae) in Australia'. *Invertebrate Taxonomy* 8, pp. 923–959.
- Ray, JD, McTaggart, AR & Shivas RG 2008, 'First record of *Cryptosporiopsis citri* on lime in Australia', *Australasian Plant Disease Notes*, 3, pp. 158–159.
- Sampson, PJ & Walker, J 1982, *An annotated list of plant diseases in Tasmania*, Department of Agriculture Tasmania, Hobart, Australia.
- Shivas, RG 1989, Fungal and bacterial diseases of plants in Western Australia, *Journal of the Royal Society of Western Australia*, 72, pp. 1–62.
- Silva, EB & Mexia A 1999, The pest complex *Cryptoblabes gnidiella* (Millière) (Lepidoptera: Pyralidae) and *Planococcus citri* (Risso) (Homoptera: Pseudococcidae) on sweet orange groves (*Citrus sinensis* (L.) Osbeck) in Portugal: interspecific association, *Boletín de sanidad vegetal. Plagas*, 25, pp. 89–98.
- Simmonds, JH 1966, *Host index of plant diseases in Queensland*, Department of Primary Industries, Brisbane, Australia.
- Smith, D, Beattie, GAC & Broadley R 1997, *Citrus pests and their natural enemies: integrated pest management in Australia*, Department of Primary Industries, Brisbane / Horticultural Research and Development Corporation, Sydney.
- Smith, IM, McNamara, DG, Scott, PR & Holderness, M 1997, '*Elsinoë fawcettii* and *E. australis*', in *Quarantine pest for Europe. Second edition*. CAB International in association with the European and Mediterranean Plant Protection Organization (EPPO), Wallingford, UK.
- Sofy, AR, Mousa, AA, Fahmy, H, Ghazal, SA & El-DougDoug, KA 2007, 'Anatomical and ultrastructural changes in citrus leaves infected with Citrus psorosis virus Egyptian isolate (CPsV-EG)', *Journal of Applied Sciences Research*, 3, pp. 485–494.
- SPC 2013, *Incursion of Oriental fruit fly in to Cook Islands*, Pest Alert No. 47, July 2013, Plant Health, Land Resources Division, Secretariat of the Pacific Community.
- SPC 2016, Pacific Islands Pest List Database, Plant Protection Service, Secretariat of the Pacific Community, Suva, Fiji Islands, viewed May 2016, [pld.spc.int/pld/](http://pld.spc.int/pld/)
- Stocks, IC 2015, '*Fiorinia proboscidea* Green (Hemiptera: Diaspididae), a new armored scale pest of citrus in Florida', Pest alert February 2015, Florida Department of Agriculture and Consumer Services, viewed June 2016, [freshfromflorida.com/content/download/51395/1116140/PEST\\_ALERT\\_fiorinia\\_proboscidea.pdf](http://freshfromflorida.com/content/download/51395/1116140/PEST_ALERT_fiorinia_proboscidea.pdf).

- Stocks, IC & Roda A 2011, 'The Passionvine Mealybug, *Planococcus minor* (Maskell), a new exotic mealybug in South Florida (Hemiptera: Pseudococcidae)', Pest alert DACS-P-01769, Florida Department of Agriculture and Consumer Services, Division of Plant Industry.
- Stout, OO 1982, *Plant quarantine guidelines for movement of selected commodities the Pacific*, UNDP/FAO –SPEC survey of agricultural pests and diseases in the South Pacific, South Pacific Bureau for Economic Cooperation.
- Tau, D & Berukilukilu, L 2000, *Determination of fruit fly host status for citrus lime (variety 'Tahitian')*, Report 5, Vanuatu Quarantine and Inspection Services and FAO/AusAID/UNDP/ SPC Project on Regional management of Fruit Flies in the Pacific: RAS/ 97 331, Secretariat of the Pacific Community, Suva, Fiji.
- Timmer, LW, Priest, M, Broadbent, P & Tan, MK 1996, 'Morphological and pathological characterization of species of *Elsinoë* causing scab diseases of citrus', *Phytopathology*, 86, pp. 1032–1038.
- Timmer, LW 2000, 'Scab diseases', in LW Timmer, SM Garnsey & JH Graham (eds) *Compendium of citrus diseases*, Second edition, pp. 31–32, American Phytopathological Society.
- Tsatsia, H & Jackson, G 2017, 'Citrus scab', *Pacific Pests and Pathogens* fact sheet (048), viewed November 2017, [http://www.pestnet.org/fact\\_sheets/citrus\\_scab\\_048.pdf](http://www.pestnet.org/fact_sheets/citrus_scab_048.pdf)
- Vargas, RI, Leblanc, L, Putoa, R & Eitam, A 2007, 'Impact of introduction of *Bactrocera dorsalis* (Diptera: Tephritidae) and classical biological control releases of *Fopius arisanus* (Hymenoptera: Braconidae) on economically important fruit flies in French Polynesia', *Journal of Economic Entomology*, 100, pp. 670–679.
- Vargas, RI, Piñero, JC and Leblanc, L 2015, 'An overview of pest species of *Bactrocera* fruit flies (Diptera: Tephritidae) and the integration of biopesticides with other biological approaches for their management with a focus on the Pacific region', *Insects*, 6, pp. 297–318.
- Venette, RC & Davis, EE 2004, *Mini risk assessment, passionvine mealybug: Planococcus minor (Maskell) (Pseudococcidae: Hemiptera)*, Animal & Plant Health Inspection Service, United States Department of Agriculture.
- Vranjic, JA 1997, 'Effects on host plant', in Y Ben-Dov & CJ Hodgson (eds), *Soft scale insects – their biology, natural enemies and control*, pp. 323–336, Elsevier Science, Amsterdam, Netherlands.
- Walker, AK & Deitz, LL 1979, A review of entomophagous insects in the Cook Islands, *New Zealand Entomologist*, 7, pp. 70–82.
- Washington, WS & Nancarrow, RJ 1980, Lists of diseases recorded on fruit and vegetable crops in Victoria before 30 June, 1980. Department of Agriculture, Victoria, technical report no. 66, Plant Research Institute, Burnley, Victoria, Australia.
- Waterhouse, DF 1993, *Biological control: Pacific prospects – Supplement 2*, ACIAR monograph No. 20, Australian Centre for International Agricultural Research, Canberra.
- Waterhouse, DF & Norris, KR 1987, *Biological control: Pacific prospects*, Australian Centre for International Agricultural Research, Canberra.

- Watson, GW 2016, 'Diaspididae of the World', in SA Ulenberg (ed), *Arthropods of economic significance*, viewed March 2016, [wbd.etibioinformatics.nl/bis/diaspididae.php?menuentry=inleiding](http://wbd.etibioinformatics.nl/bis/diaspididae.php?menuentry=inleiding)
- White, IM & Elson-Harris, MM 1994, *Fruit flies of economic significance: their identification and bionomics*, CAB International, Wallingford, UK.
- Whiteside, JO 1975, 'Biological characteristics of *Elsinoë fawcettii* pertaining to the epidemiology of sour orange scab', *Phytopathology*, 65, pp. 1170–1175.
- -- 1980, 'Detection of benomyl-tolerant strains of *Elsinoe fawcettii* in Florida citrus groves and nurseries', *Plant Disease*, 64, pp. 871–872.
- Williams, DJ & Butcher, CF 1987, 'Scale insects (Hemiptera: Coccoidea) of Vanuatu', *New Zealand Entomologist*, 9, pp. 88–99.
- Williams, DJ & Watson, GW 1988a, *The scale insects of the tropical South Pacific region: Part 1: The armoured scales (Diaspididae)*, CAB International, Wallingford, UK.
- -- 1988b, *The scale insects of the tropical South Pacific region: Part 2: The mealybugs (Pseudococcidae)*, CAB International, Wallingford, UK.
- -- 1990, *The scale insects of the tropical South Pacific region: Part 3: The soft scales (Coccidae) and other families*, CAB International, Wallingford, UK.
- Williams, ML 1997, 'Morphology, systematics and phylogeny: the immature stages', in Y Ben-Dov & CJ Hodgson (eds) *Soft scale insects – their biology, natural enemies and control*, pp. 31–48, Elsevier Science, Amsterdam, Netherlands.
- WTO 1995, *Agreement on the application of sanitary and phytosanitary measures*, World Trade Organization, Geneva.
- Zhang, L 2008, 'Biology and pest management of spider mites', Fact sheet ENT 4, Northern Territory Department of Regional Development, Primary Industry, Fisheries and Resources, Darwin.