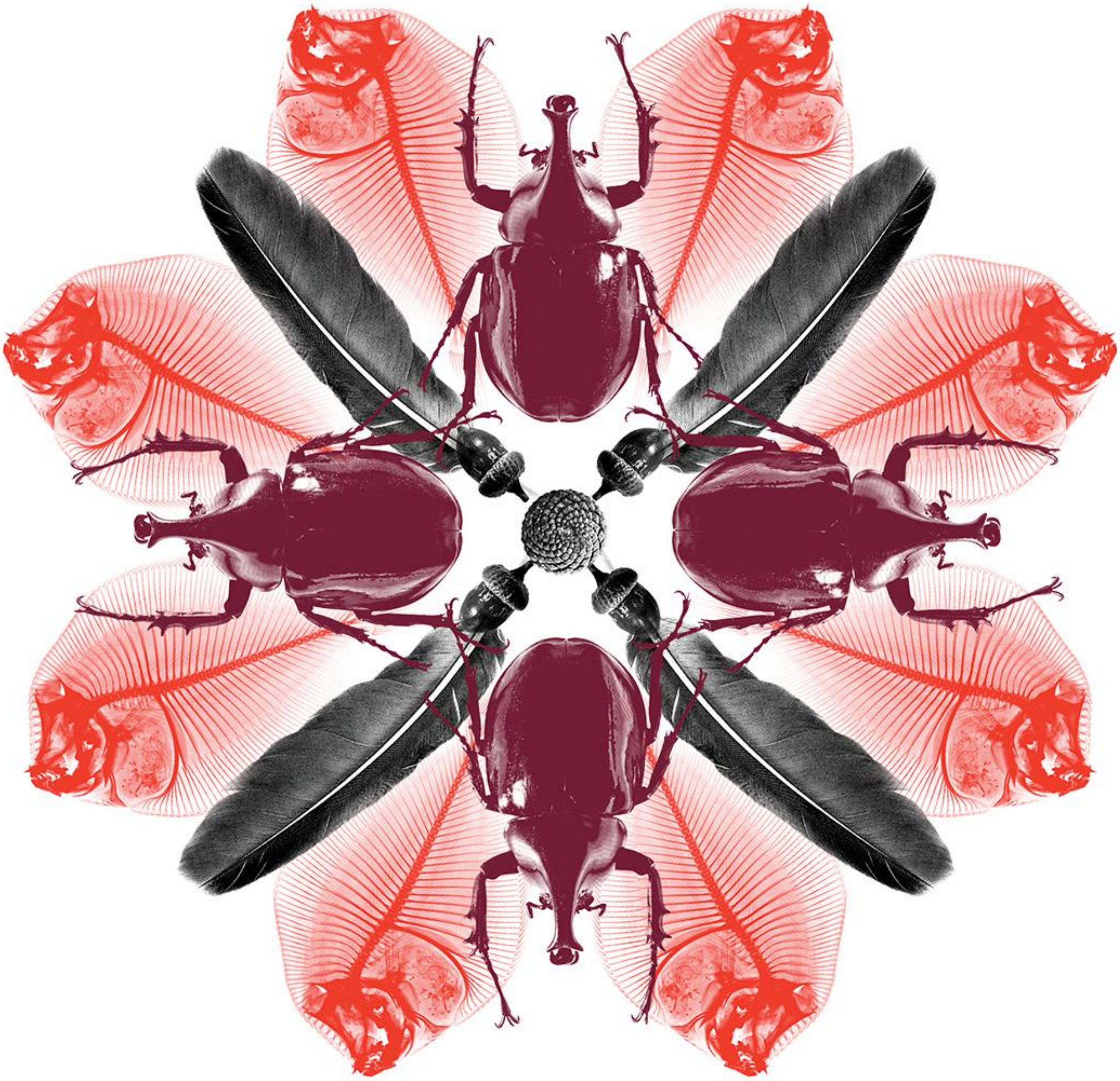
Australian Government
Department of Agriculture

Draft report for the non-regulated analysis of existing policy for fresh mango fruit from Indonesia, Thailand and Vietnam

July 2015



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Stakeholder submissions on draft reports

This draft report has been issued to give all interested parties an opportunity to comment on relevant technical biosecurity issues, with supporting rationale. The final report will then be produced taking into consideration any comments received.

Submissions should be sent to the Australian Department of Agriculture following the conditions specified within the related Biosecurity Advice, which is available at agriculture.gov.au/memos

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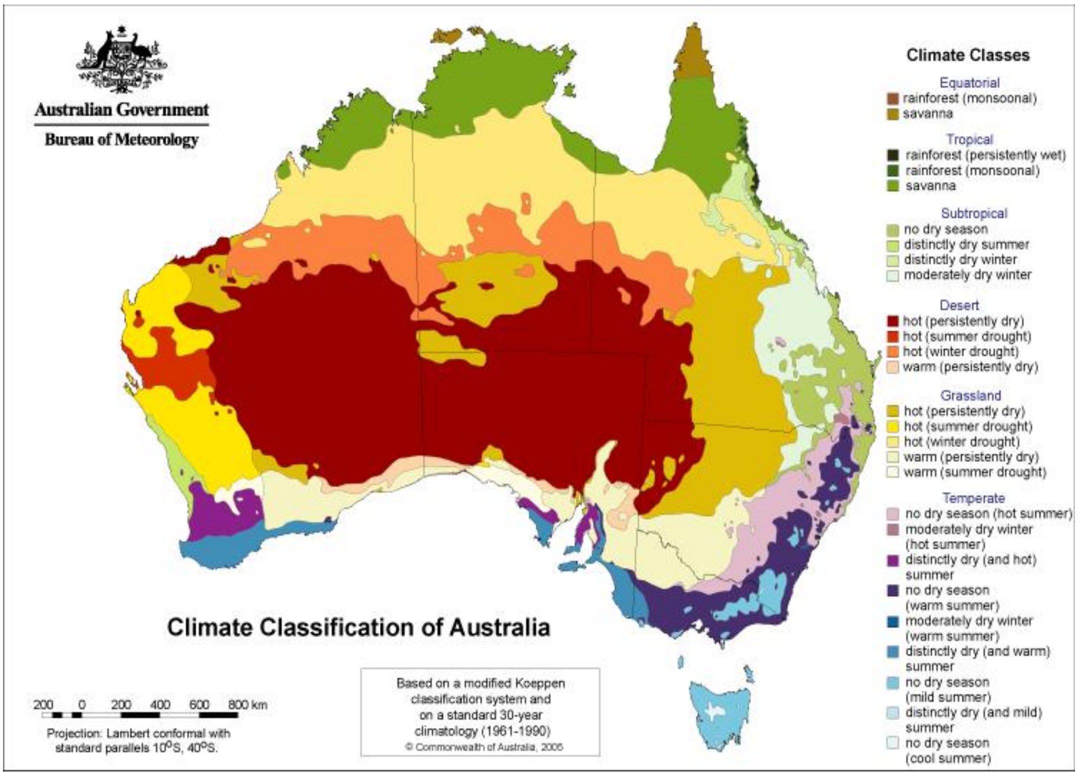

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Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
AMIA	Australian Mango Industry Association
BAM Act	Biosecurity and Agriculture Management Act 2007, Western Australia
BA	Biosecurity Advice
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DOA	Plant Protection Research & Development Office, Department of Agriculture, Thailand
EP	Existing policy
FAO	Food and Agriculture Organization of the United Nations
IAQA	Indonesian Agricultural Quarantine Agency
ICON	The Australian Department of Agriculture Import Conditions database
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
PPD	Plant Protection Department, Ministry of Agriculture & Rural Development, Vietnam
PRA	Pest risk assessment
Qld	Queensland
SA	South Australia
SPS	Sanitary and Phytosanitary
Tas.	Tasmania
VHT	Vapour heat treatment
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

Summary

The Australian Government Department of Agriculture has prepared this draft report to assess the proposals by Indonesia, Thailand and Vietnam for market access to Australia for fresh mango fruit.

Australia permits the importation of fresh mango fruit from Haiti, India, Mexico, Pakistan, the Philippines and Taiwan for human consumption provided they meet Australian quarantine requirements.

This draft report proposes that the importation of fresh mango fruit to Australia from all commercial production areas of Indonesia, Thailand and Vietnam be permitted, subject to a range of quarantine conditions.

This draft report identifies pests that require phytosanitary measures to manage risks to a very low level in order to achieve Australia's appropriate level of protection (ALOP). The pests requiring specific measures are mango weevils, fruit flies, mealybugs and red-banded mango caterpillar.

The proposed phytosanitary measures take account of regional differences within Australia. Two pests requiring risk mitigation, mango seed weevil and Pacific mealybug, have been identified as a regional quarantine pest for Western Australia.

This draft report proposes a range of risk management measure options in combination with operational systems that will reduce the risk associated with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam into Australia to achieve Australia's ALOP. The proposed risk management options include:

- irradiation for mango weevils, fruit flies, mealybugs and red-banded mango caterpillar
- vapour heat treatment for fruit flies
- visual inspection and remedial action for mealybugs
- systems approach and visual inspection and remedial action for red-banded mango caterpillar
- area freedom (including pest free areas, pest free places of production and pest free production sites) for mango weevils and red-banded mango caterpillar.

This draft report contains details of the risk assessments for the quarantine pests and the proposed phytosanitary measures in order to allow interested parties to provide comments and submissions to the Australian Government Department of Agriculture within the consultation period.

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 proposals to import new products into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP), risk management measures are proposed to reduce the risks to an acceptable level. But, if it is not possible to reduce the risks to an acceptable level, then no trade will be allowed.

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

Australia's risk analyses are undertaken by the Department of Agriculture using technical and scientific experts in relevant fields, and involve consultation with stakeholders at various stages during the process.

The Department of Agriculture's assessment may take the form of an import risk analysis (IRA), a non-regulated analysis of existing policy, or technical advice.

Further information about Australia's biosecurity framework is provided in Appendix C of this report and in the *Import Risk Analysis Handbook 2011* located on the Department of Agriculture website.

1.2 This import risk analysis

1.2.1 Background

The Indonesian Agricultural Quarantine Agency (IAQA) formally requested market access for fresh mango fruit to Australia in a submission received in 2011 (IAQA 2011a). This submission included information on the main pests of mango fruit in Indonesia and the commercial production practices, post harvest management and pest management for mango in the provinces of East and West Java, Indonesia.

The Thailand Department of Agriculture (DOA) formally requested market access for fresh mango fruit to Australia in a submission received in 2011 (DOA Thailand 2011). This submission included information on the pests associated with mango crops in Thailand, including the plant part affected, and the standard commercial production practices for fresh mango fruit in Thailand.

In 2012, Thailand made a new request for market access of fresh mango fruit proposing irradiation as a phytosanitary treatment to mitigate the risks of pests associated with mango. In July 2014, Thailand submitted survey data on the absence of mango seed weevil (*Sternochetus* *mangiferae*) in Thai production areas (DOA Thailand 2014). Thailand also requested that Australia consider all available phytosanitary measures including irradiation when developing the protocol for the importation of Thai mangoes.

The Plant Protection Department (PPD), Ministry of Agriculture and Rural Development (MARD), Vietnam formally requested market access for fresh mango fruit to Australia in a submission received in 2009 (PPD 2009). This submission included information on the pests associated with mango crops in Vietnam, including the plant part affected, and the standard commercial production practices for fresh mango fruit in Vietnam.

At a bilateral technical meeting in February 2015, Vietnam requested Australia include vapour heat treatment (VHT), as well as the option of irradiation, as a risk mitigation measure.

On 1 August 2014, the Department of Agriculture formally announced the commencement of this risk analysis, advising that it would be progressed as a non-regulated review of existing policy for Indonesia, Thailand and Vietnam, using the process described in the *Import Risk Analysis Handbook 2011*.

1.2.2 Scope

The scope of this risk analysis is to consider the biosecurity risk that may be associated with the importation of commercially produced fresh mango fruit (*Mangifera indica* L.), free from trash, from Indonesia, Thailand and Vietnam, for human consumption in Australia.

In this risk analysis, mangoes are defined as fruit with skin, pulp and seed with a small portion of stem attached but not other plant parts, including leaves (Figure 1). This risk analysis covers all commercially produced fresh mango fruit of all cultivars and provinces or regions of Thailand and Vietnam in which they are grown for export. In the case of Indonesia, the market access request was for the provinces of East and West Java.

1.2.3 Existing policy

International policy

Import policy exists for fresh mango fruit from India (Biosecurity Australia 2008a), the Philippines (Guimaras Island and Davao del Sur) (AQIS 1999; Biosecurity Australia 2010), Taiwan (Biosecurity Australia 2006b) and Pakistan (Biosecurity Australia 2011b) as well as Haiti and Mexico.

The import requirements for this commodity can be found at the Australian Government Department of Agriculture website.

The Australian Government Department of Agriculture has considered all the pests previously identified in the existing policies and where relevant, the information in these assessments has been taken into account in this risk analysis.

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 jurisdiction. 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.

1.2.4 Contaminating pests

In addition to the pests of fresh mango fruit from Indonesia, Thailand and Vietnam that are assessed in this risk analysis, there are other organisms that may arrive with the imported commodity. These organisms could include pests of other crops or predators and parasitoids of other arthropods. The Department of Agriculture considers these organisms to be contaminating pests that could pose sanitary and phytosanitary risks. These risks are addressed by existing operational procedures that require a 600 unit inspection of all consignments, or equivalent, and investigation of any pest that may be of quarantine concern to Australia.

1.2.5 Consultation

On 1 August 2014, the Australian Government Department of Agriculture notified stakeholders in Biosecurity Advice 2014/10 of the formal commencement of a non regulated analysis of existing policy to consider proposals from Indonesia, Thailand and Vietnam for market access to Australia for fresh mango fruit.

The Australian Government Department of Agriculture has regularly consulted with Indonesia's IAQA, Thailand's DOA and Vietnam's PPD and Australian state and territory government departments during the preparation of this draft report.

The Australian Mango Industry Association was consulted prior to commencement of the non-regulated analysis. The department provided an update on the progress of the risk analysis to horticultural industries, including AMIA, at a number of industry teleconferences held throughout 2015.

1.2.6 Next Steps

This draft report gives stakeholders the opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors.

The Department of Agriculture will consider submissions received on the draft report and may consult informally with stakeholders. The department will revise the draft report as appropriate. The department will then prepare a final report, taking into account stakeholder comments.

The final report will be published on the department website along with a notice advising stakeholders of the release. The department will also notify the proposer, the registered stakeholders and the WTO Secretariat about the release of the final report. Publication of the final report represents the end of the process. The conditions recommended in the final report will be the basis of any import permits issued.

2 Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The Department of Agriculture has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2007b) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013) that have been developed under 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 2012). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2012).

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

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, the Department of Agriculture 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 2012).

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

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

2.1 Stage 1 Initiation

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

Appendix A of this risk analysis report lists the pests with the potential to be associated with the exported commodity produced using commercial production and packing procedures. Appendix A does not present a comprehensive list of all the pests associated with the entire plant, but concentrates on the pests that could be on the assessed commodity. Contaminating pests that have no specific relation to the commodity or the export pathway have not been listed and would be addressed by Australia's current approach to contaminating pests.

The identity of the pests is given in Appendix A. The species name is used in most instances but a lower taxonomic level is used where appropriate. Synonyms are provided where the current scientific name differs from that provided by the exporting country's National Plant Protection Organisation (NPPO) or where the cited literature used a different scientific name.

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

For pests that had been considered by the Department of Agriculture in other risk assessments and for which import policies already exist, a judgement was made on the likelihood of entry of pests on the commodity and whether existing policy is adequate to manage the risks associated with its import. Where appropriate, the previous risk assessment was taken into consideration when developing the new policy.

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 2012).

The following three, consecutive steps were used in pest risk assessment:

2.2.1 Pest categorisation

Pest categorisation identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and 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 (FAO 2012).

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

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

The results of pest categorisation are set out in Appendix A. The quarantine pests identified during categorisation were carried forward for pest risk assessment and are listed in Table 7.

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the ‘probability of entry’, ‘probability of establishment’ and ‘probability of spread’ of a pest are given in ISPM 11 (FAO 2013). A summary of this process is given below, followed by a description of the qualitative methodology used in this risk analysis.

Probability of entry

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

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

For the purpose of considering the probability of entry, the Department of Agriculture divides this step into two components:

- **Probability of importation—**the probability that a pest will arrive in Australia when a given commodity is imported.
- **Probability of distribution—** the probability that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Factors considered in the probability of importation include:

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

Factors considered in the probability of distribution include:

- commercial procedures (for example, refrigeration) applied to consignments during distribution in Australia
- dispersal mechanisms of the pest, including vectors, to allow movement from the pathway to a host
- whether the imported commodity is to be sent to a few or many destination points in the PRA area

- proximity of entry, transit and destination points to hosts
- time of year at which import takes place
- intended use of the commodity (for example, for planting, processing or consumption)
- risks from by-products and waste.

Probability of establishment

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2012). In order to estimate the probability of establishment of a pest, reliable biological information (for example, lifecycle, host range, epidemiology, survival) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment.

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

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

Probability of spread

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2012). The probability of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the probability of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread.

Factors considered in the probability of spread include:

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

Assigning qualitative likelihoods for entry, establishment and spread

In its qualitative PRAs, the Department of Agriculture uses the term 'likelihood' for the descriptors it uses for its estimates of probability of entry, establishment and spread. Qualitative likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 1). Descriptive definitions for these descriptors and their indicative probability ranges are given in Table 1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors and are not used beyond this purpose in qualitative PRAs. These indicative probability ranges provide guidance to the risk analyst and promote consistency between different pest risk assessments.

Table 1 Nomenclature of qualitative likelihoods

Likelihood	Descriptive definition	Indicative probability (P) range
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	$0 < P \leq 0.000001$

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the likelihood of importation is assigned a descriptor of ‘low’ and the likelihood of distribution is assigned a descriptor of ‘moderate’, then they are combined to give a likelihood of ‘low’ for entry. The likelihood for entry is then combined with the likelihood assigned for establishment of ‘high’ to give a likelihood for entry and establishment of ‘low’. The likelihood for entry and establishment is then combined with the likelihood assigned for spread of ‘very low’ to give the overall likelihood for entry, establishment and spread of ‘very low’. This can be summarised as:

importation x distribution = entry [E]	**low x moderate = low**
entry x [establishment = [EE]	**low x high = low**
[EE] x spread = [EES]	**low x very low = very low**

Table 2 Matrix of rules for combining qualitative likelihoods

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

Time and volume of trade

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

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

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

In assessing the volume of trade in this risk analysis, the Department of Agriculture assumed that a substantial volume of trade will occur.

2.2.3 Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the likely consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), ISPM 5 (FAO 2012) and ISPM 11 (FAO 2013).

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

- plant life or health

- other aspects of the environment.

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

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

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

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

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

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

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

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

Indiscernible—pest impact unlikely to be noticeable.

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

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

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

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a qualitative impact score (A-G) using Table 3. For example, a consequence with a magnitude of 'significant' at the 'district' level will have a consequence impact score of D.

Table 3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales

	Geographic scale			
Magnitude	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 4 were adjusted accordingly.

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules Table 4. These rules are mutually exclusive, and are assessed in numerical order until one applies.

Table 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 probability of entry, establishment and spread and for potential consequences are completed, the unrestricted risk can be determined for each pest or groups of pests. This is determined by using a risk estimation matrix (Table 5) to combine the estimates of the probability of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the product of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (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 5 Risk estimation matrix

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

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 5 marked 'very low risk' represents Australia's ALOP.

2.3 Stage 3 Pest risk management

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

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

ISPM 11 (FAO 2013) provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the probability of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments—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, 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
- options for other types of pathways—for example, consider natural spread, measures for human travellers and their baggage, cleaning or disinfestations of contaminated machinery
- options within the importing country—for example, surveillance and eradication programs
- prohibition of commodities—if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the risk exceeds Australia's ALOP. These are presented in Chapter 5: Pest risk management, of this report.

3 Commercial production practices for mangoes

This chapter provides information on the pre-harvest, harvest and post-harvest practices, considered to be standard practices in Indonesia, Thailand and Vietnam for the production of fresh mango fruit for export. The export capability of each country is also outlined.

3.1 Assumptions used in estimating unrestricted risk

Indonesia, Thailand and Vietnam provided Australia with information on the standard commercial practices used in the production of export quality mangoes in the different production areas of Indonesia, Thailand and Vietnam. This information was complemented with data from other sources and was taken into consideration when estimating the unrestricted risks of pests that may be associated with the import of mangoes from Indonesia, Thailand or Vietnam.

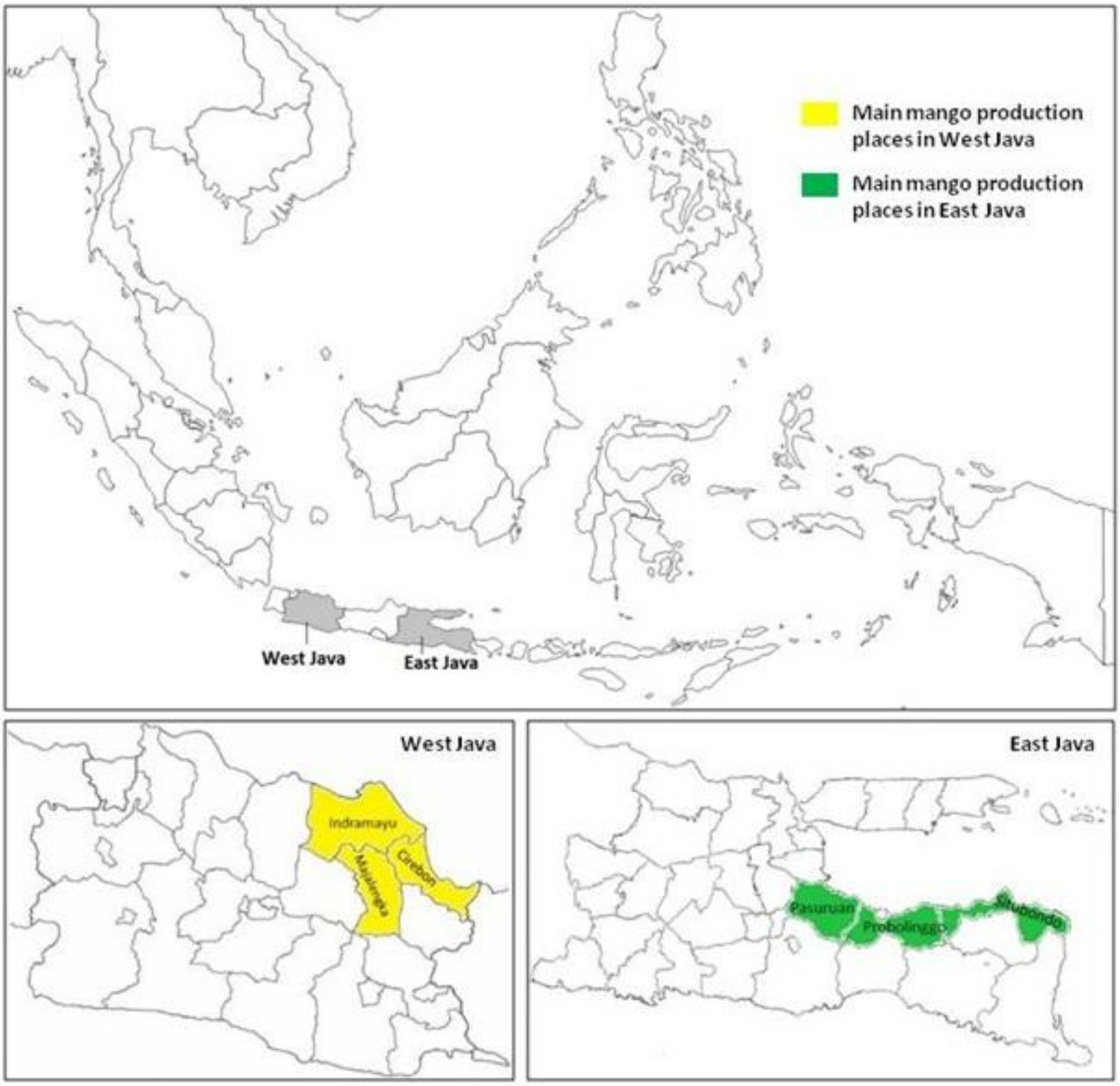
In estimating the likelihood of pest introduction it was assumed that the pre-harvest, harvest and post-harvest production practices for mangoes as described in this chapter are implemented for all production areas and for all mango varieties within the scope of this analysis. Where a specific practice described in this chapter is not taken into account to estimate the unrestricted risk, it is clearly identified and explained in Chapter 1.

3.2 Production areas

Indonesia

The main mango growing provinces of Indonesia are East Java and West Java (IAQA 2007). Mangoes are commercially produced in the districts of Probolingo, Situbondo and Pasuruan, East Java and the districts of Cirebon, Majalengka and Indramayu, West Java (IAQA 2007). A map showing the main mango production areas is presented in Map 4.

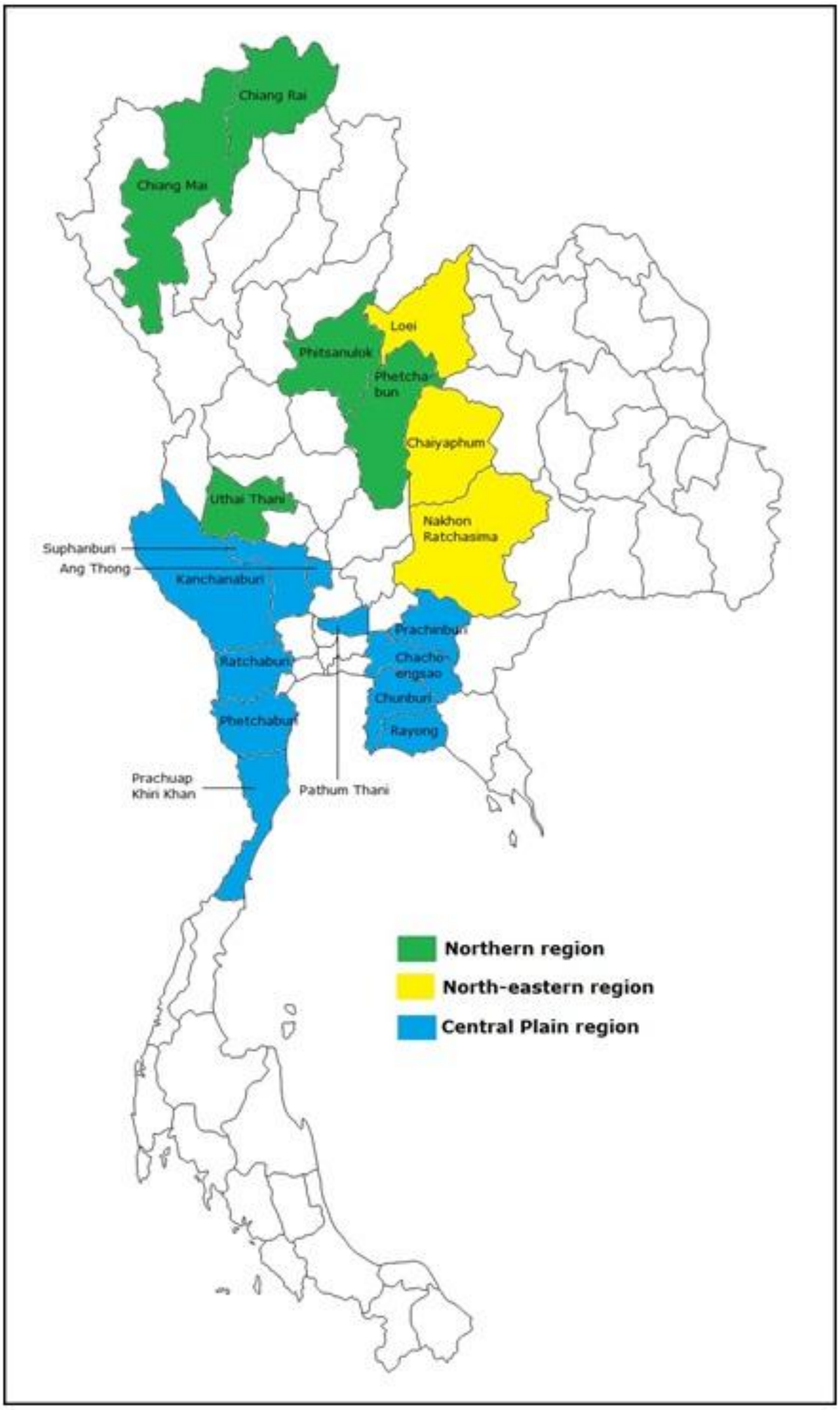
Map 4 Main mango production areas in Indonesia



Thailand

Thailand is one of the largest mango producing countries (Valavi *et al.* 2012). The total mango growing area in Thailand is estimated to be around 384 000 hectares (Valavi *et al.* 2012). Mango production areas are expanding throughout the country with the main mango commercial growing regions and provinces located in the Northern region (Chiang Mai, Chiang Rai, Phetchabun, Phitsanulok, Uthai Thani), North Eastern region (Loei, Chaiyaphum, Nakhon Ratchasima) and Central Plain region (Ang Thong, Pathumthani, Chachoengsao, Chun Buri, Phetchaburi, Ratchaburi, Suphan Buri, Prachinburi, Kanchanaburi, Rayong, Prachuap Khiri Khan) (DOA Thailand 2011). A map showing the main mango production regions and provinces is presented in Map 5.

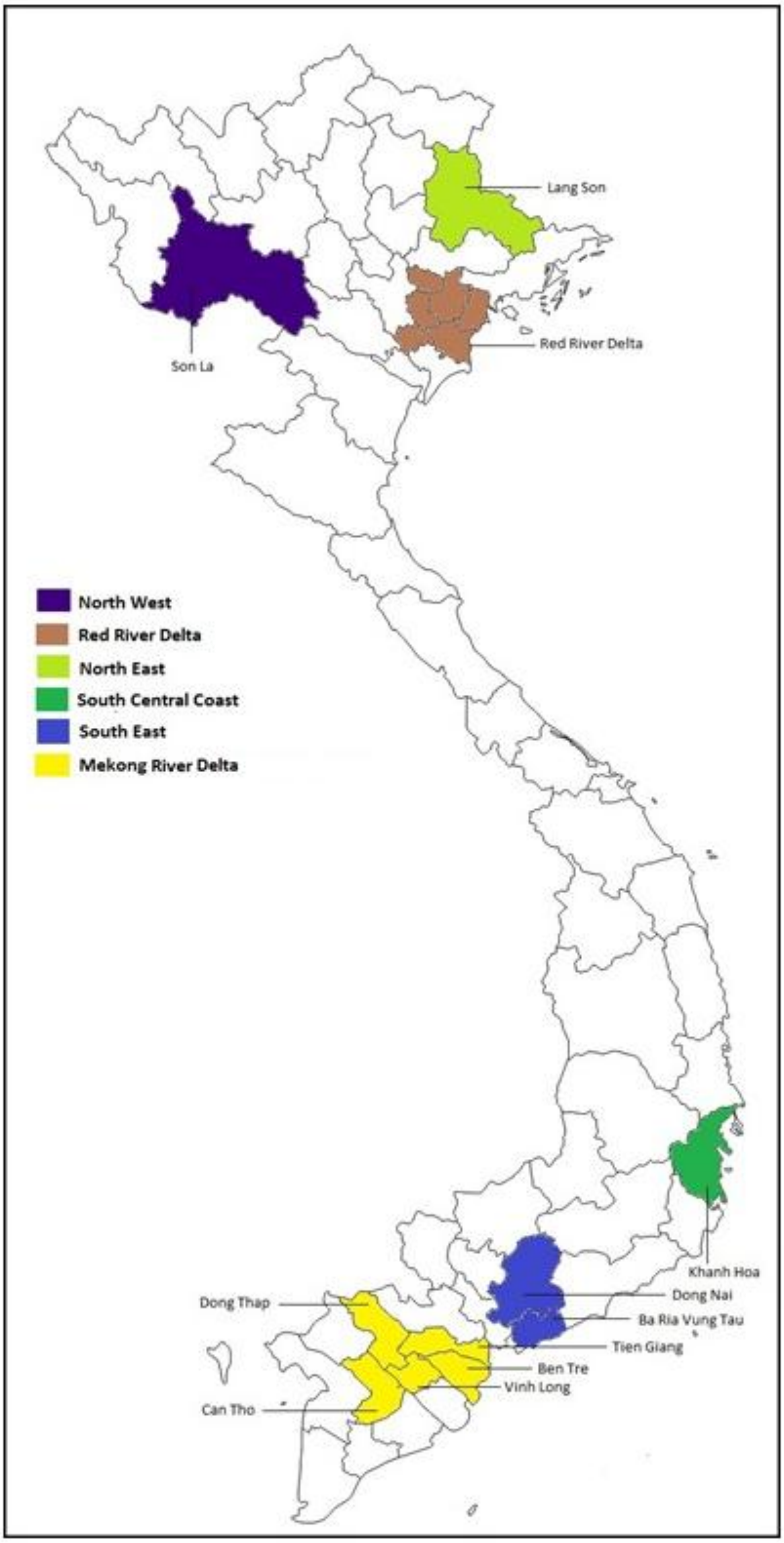
Map 5 Main commercial mango production regions and provinces in Thailand



Vietnam

Mangoes have traditionally been cultivated in the central and southern parts of Vietnam (PPD 2009). The main mango growing provinces are found in the Mekong Delta region of southern Vietnam (Tien Giang, Dong Thap, Can Tho, Vinh Long and Ben Tre), South Central Coast (Khanh Hoa) and South East (Dong Nai and Ba Ria Vung Tau) (PPD 2009). Mangoes are not commercially grown in the north of Vietnam, except in the provinces of Son La and Lang Son and the Red River Delta area (PPD 2009). A map showing the main mango production areas is presented in Map 6.

Map 6 Main mango production areas in Vietnam



3.3 Climate in production areas

Indonesia

Indonesia lies on the equator, which means that the climate is almost entirely tropical (Goode's world atlas 2005); hot and humid throughout the country most of the year. The average temperature in Indonesia ranges from 23 °C to 28 °C with an average relative humidity between 70 and 90 per cent (Indonesian Embassy 2009).

Indonesia is divided into five major island groups; Sumatra, Kalimantan, Java, Sulawesi, and Papua (Frederick and Worden eds. 2011). Mangoes are produced commercially in East and West Java, located on Java Island (IAQA 2007). Seasonal variation is dominated by precipitation with Indonesia's climate being divided into two seasons: the rainy season and the dry season. The extreme variations in rainfall are linked with the monsoons. The north-western monsoons bring the rainy season from December to March, while the southern and eastern monsoons bring the dry weather that occurs from June to September (Frederick and Worden eds. 2011). The dry season does not mean there is no rain, but less rain with tropical showers occurring in the afternoons.

Rainfall in Indonesia also varies with topography. In the lowland areas of Indonesia, the annual rainfall averages 1800 to 3200 millimetres and increases with elevation to more than 6000 millimetres (NationsEncyclopedia 2015). In West Java, the average rainfall is 2000 millimetres per year. However, in the mountainous areas the annual rainfall ranges from 3000 to 5000 millimetres (JavaIndonesia.org 2011). East Java receives less rainfall, with the annual rainfall for East Java being around 1900 millimetres per year (JavaIndonesia.org 2011).

Although the rainfall in Indonesia varies throughout the year, temperatures remain relatively constant throughout the seasons. Average temperatures range from 22 °C to 29 °C in East Java, and 21 °C to 34 °C in West Java (JavaIndonesia.org 2011).

Thailand

The climate in Thailand can be described as tropical (Goode's world atlas 2005). The weather is generally hot and humid across most of the country throughout most of the year (TMD 2014; Tourism Authority of Thailand 2015).

Thailand can be divided into four topographic regions; Northern, North-eastern, Central, and Southern (GlobalSecurity.org 2012). Mangoes are produced commercially in three of these regions – Northern, North-eastern, and Central (DOA Thailand 2011). The climate in each of these topographic regions is influenced by the tropical monsoons and can be divided into three seasons; the rainy or south-west monsoon season (mid-May to mid-October), winter or cool season caused by the north-east monsoon (mid-October to mid-February) and the summer or hot season also referred to as the pre-monsoon season (mid-February to mid-May) (Worldmark Encyclopedia of Nations 2007; TMD 2014).

Temperatures in the commercial production regions usually experience a long period of warm weather because of its inland nature and tropical latitude zone (TMD 2014; Tourism Authority of Thailand 2015). During the hot season temperatures can reach extremes of over 43 °C, with an average temperature range from 21 °C to 35 °C (TMD 2014).

The onset of the rainy season from mid-May results in a slow decline in temperature. However, the weather is still quite hot and humid, with average temperatures of 23 °C to 32 °C (TMD 2014). The rainy season is dominated by the south-west monsoon which consists of flash-flood downpours once or twice a day rather than continual daily rain (Worldmark Encyclopedia of Nations 2007; Thaifocus.com 2015). During the rainy season, the average rainfall reaches over 900 millimetres, with the heaviest rainfall occurring in the months of August and September (TMD 2014).

During the winter season the temperatures are still relatively warm but significantly less than the hot and rainy seasons. Average temperatures range from 18 °C to 30 °C (TMD 2014). In the mountainous northern regions, outbreaks of cold air from China can significantly reduce the temperature which can drop to near or below 0 °C (TMD 2014).

Vietnam

As a whole, Vietnam includes both tropical and subtropical climatic zones. The climate is typically warm and humid, has a considerable amount of sunshine, and is characterised by strong monsoonal influences (Weatheronline 2015). However, because of the differences in latitude and the diverse topography, the climate tends to vary between the north and the south of Vietnam. Generally, Vietnam's climate can be divided into three different zones—North, Central and South.

The climate in the northern production areas of Vietnam is subtropical (Goode's world atlas 2005). The summer months, May to October, are hot and experience heavy rainfall and occasional typhoons (Hickery *et al.* 2015). The temperature can rise to around 33 °C in the peak summer months of June and July, with the average temperatures ranging from 22 °C to 30 °C (Climate-data.org 2015). The average total rainfall for the summer months is around 1300 millimetres (Climate-data.org 2015).

The winter months in the North are from November to April, and are often cloudy with persistent drizzle (Vietnam Travel Guide 2010; Hickery *et al.* 2015). The temperature is generally cool, with an average temperature of approximately 19 °C (Climate-data.org 2015). The mountainous Northwest production areas are much colder with temperatures dropping to 10 °C or below for long periods (Vietnam Travel Guide 2010; Climate-data.org 2015). Total winter rainfall is much lower than in the summer season, averaging less than 300 millimetres.

The climate in the southern and central production areas of Vietnam is tropical (Goode's world atlas 2005) with two main seasons—the wet or rainy season and the dry season. The wet season lasts from around May to November and experiences heavy afternoon rains and typhoons (Vietnam Travel Guide 2010; Hickery *et al.* 2015). Rainfall during the wet season is higher in the southern region, with an average of 1600 millimetres, compared with 900 millimetres in central Vietnam.

The dry season is between December and April and is characterised by winds from the northeast monsoon, little rain, and warm temperatures (Vietnam Travel Guide 2010; Hickery *et al.* 2015). There is little variation in temperature between the two seasons; however minimum and maximum temperatures in the dry season tend to be around 2 °C cooler than in the wet season. The monthly average temperature is around 24 °C to 29 °C in the central production areas, and around 25 °C to 29 °C in southern production areas (Climate-data.org 2015).

3.4 Pre-harvest

3.4.1 Cultivars

Indonesia

Mangoes were introduced into Indonesia 1500 years ago (Valavi *et al.* 2012). Hundreds of varieties are grown locally and although they taste good and have high domestic demand they are not as robust as the mango cultivars developed specifically for growing on a commercial scale.

The main mango varieties that are produced commercially in East Java are Arumanis, Manalagi, Golek and Lalijiwo (Valavi *et al.* 2012). There are only two main mango varieties that are produced commercially in West Java, these being Gedong and Indramayu (Valavi *et al.* 2012). The mango varieties Indonesia intends to export to Australia are Arumanis and Gedong (IAQA 2007).

Thailand

Thailand is one of the largest mango producing countries with approximately 210 local mango cultivars grown throughout Thailand (Valavi *et al.* 2012).

The main commercial mango varieties developed for the export market are Nam Dork Mai, Maha Chanok, Pimsen, Tong Dam and Nang Klangwan (DOA Thailand 2011).

Vietnam

'Xoai' is a Vietnamese term for mango. It is customary to use it in front of the many mango cultivars grown throughout Vietnam (PPD 2009).

There are 46 mango varieties grown across Vietnam (Valavi *et al.* 2012). The main commercial mango cultivars grown in the south of Vietnam are Xoai Cat Hoa Loc, Xoai Cat Chu, Xoai Hon, Xoai Xiem Num, Xoai Buoi (PPD 2009), Xoai Cat Bo, Xoai Thanh Ca and Xoai Canh Non (Valavi *et al.* 2012).

Xoai Yen Chau is a cultivar specifically grown in the Son La province of northwest Vietnam (PPD 2009).

The two main commercial mango cultivars Vietnam intends to export to Australia are Xoai Cat Hoa Loc and Xoai Cat Chu (PPD 2009).

3.4.2 Cultivation practices

Mangoes are grown commercially in Indonesia, Thailand and Vietnam by following good agricultural management practices. This ensures good quality mangoes are produced and improves mango productivity. All three countries implement orchard management practices (or standard operating procedures) to produce commercial quality fruit.

The orchard management practices carried out by Indonesia, Thailand and Vietnam to produce commercial quality mangoes are similar, these being:

- Plant propagation—mangoes are propagated by vegetative techniques such as grafting or budding. Rootstock seedlings germinated from seeds from suitable cultivars are grafted with commercial cultivars.
- Irrigation—increased irrigation occurs in the initial growing stage of the mango plant and according to the plant's development and growth phase, for example after flower stimulation and fruiting period (Valavi *et al.* 2012). This ensures the mango plant receives sufficient amount of water for optimum growth and development (Valavi *et al.* 2012; IAQA 2012).
- Fertilisation—organic and inorganic fertilisers are applied depending on the plant's development phase (Valavi *et al.* 2012; IAQA 2012). The application of fertilisers increases productivity and overall plant health.
- Orchard hygiene—orchard sanitation including removal of weeds through mulching, slashing or chemical application; removal of damaged or fallen fruit; and removal of infested fruit or damaged limbs from the tree, are common practices for the control of pests and diseases in the mango orchards (Valavi *et al.* 2012; IAQA 2012).
- Pruning—trees are pruned and shaped to form the basic tree structure, maintain canopy size, enhance air circulation and improve light penetration. Maintenance pruning, which includes removal of dead, broken or diseased branches is undertaken to optimise plant growth and production and control pests and diseases (Valavi *et al.* 2012; IAQA 2012).
- Fruit thinning—fruit bunches are thinned to obtain optimum fruit size and quality. Thinning usually occurs when the fruit is 3 to 5 centimetres in size. Small, unhealthy and abnormal fruit are removed from the bunch. The bunch is further thinned to reduce overcrowding thus improving the size and quality of the fruit (Chomchalow and Songkhla 2008; PPD 2009; IAQA 2012).
- Fruit bagging—mangoes are typically bagged after fruit is thinned to improve fruit quality and appearance, and to protect the fruit from mechanical damage, pest infestation and disease infection (PPD 2009; Valavi *et al.* 2012; IAQA 2012).
- Pest and disease management—mango growers implement a pest and disease management plan to reduce the incidence of pests in the orchard (further details of each countries pest and disease management practices are outlined in section 3.4.3.

3.4.3 Pest management

The following information on pest and disease management was provided by Indonesia, Thailand and Vietnam. The information was complimented by data from additional sources. In general, all three countries follow an integrated pest/disease management (IPM/IDM) program, which includes a range of cultivation practices (as described in section 3.4.2), crop monitoring and the use of a range of registered fungicides and insecticides to reduce the number of arthropod and pathogen pests in mango orchards.

Indonesia

Pesticides and fungicides are not commonly used to control pests and diseases, but rather IPM/IDM programs such as improved cultivation practices, the use of biological control agents, fruit bagging, monitoring of crops and removal of infected plant parts. The application of pesticides is the last option and applied periodically when the pest and disease population exceeds an economical threshold (IAQA 2012).

Thailand

Common practices to control pests and diseases in commercial mango orchards include the implementation of cultivation practices, such as orchard hygiene and pruning, fruit bagging, crop monitoring and pesticide application (Valavi *et al.* 2012).

Vietnam

Pests and diseases are controlled through the implementation of cultivation and cultural practices such as fruit bagging, crop monitoring, and the removal and destruction of malformed or diseased fruit or branches. Pesticides and fungicides are applied when the pest and disease population exceeds an economical threshold. Biological control options and annual flooding may also be used to control pests. Fruit fly control programs are implemented annually which includes methyl eugenol trapping and protein bait spraying (PPD 2009; Hoa *et al.* 2010; Valavi *et al.* 2012).

3.5 Harvesting and handling procedures

Mangoes are produced almost all year round in Thailand and Vietnam. The main harvesting period for mangoes in Vietnam is from February to April, with peak production in March and April. In Thailand, the main harvesting period is from January and June, with peak production in March, April and May. Indonesia's main harvesting period is from August to January, with peak production in November. The main mango harvest period for Indonesia, Thailand and Vietnam is outlined in Table 6.

Table 6 Harvest period for Indonesia, Thailand and Vietnam

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Indonesia	HP	–	–	–	–	–	–	HP	HP	HP	HP	HP
Thailand	HP	HP	HP	HP	HP	HP	–	–	–	–	–	–
Vietnam	–	HP	HP	HP	–	–	–	–	–	–	–	–

HP harvest period

Fruit is generally harvested around 80 days after flowering. Mango fruit are generally harvested when the fruit is fully mature, aromatic and green to pale yellow in colour; have even pores, a thickened wax layer, dried stalk, and flattened fruit curvature. Harvesting time and fruit criteria can vary depending on the variety of mango produced.

Mango fruits are harvested by hand, with scissors, or by using a picking pole device with an attached net or basket. Mangoes that have been bagged are harvested with the bag and a short stalk still attached (approximately 5 to 10 centimetres in length), and placed in boxes, crates, or lined/unlined field baskets for transport to a local collection house or packing house.

3.6 Post-harvest

The post-harvest procedures for mangoes carried out by Indonesia, Thailand and Vietnam are similar.

3.6.1 Collection house

Generally, harvested fruit are taken to a collection house which is located close to the orchards. Harvested mangoes are removed from the bags and undergo an initial sort. All damaged and defective fruit are removed and fruit that does not meet the export market criteria are separated for sale to the domestic market. The mangoes are placed into containers and transported in covered trucks to a packing house.

Where there is no collection house, fruit are transported straight from the orchard to the packing house or treatment facility where they undergo an initial sort and bag removal, followed by packing house procedures as described in section 3.6.2.

3.6.2 Packing house

Packing houses (which may be part of a treatment facility), receive commercially grown mango fruit, either direct from the orchard or from the collection house. The stalk of the mango is trimmed to 1 to 3 centimetres in length, and the mango sap is drained by placing fruit stalk-side downwards. In Indonesia and Thailand, mangoes are washed with clean water and detergent or chlorine to remove excess sap and dirt, and then dried. Indonesian mangoes are then immersed in warm water and dried. Thailand mangoes also undergo immersion in warm water and/or thiabendazole solution to reduce anthracnose infection. Vietnam has advised that although normal post-harvest procedures include washing mango fruit in warm water, this step will not be applied for mangoes destined for Australia (PPD 2009).

Fruit is then graded according to size, weight, variety, maturity level and uniformity. In Thailand mangoes are usually graded and packed according to the destination market requirements after they have under gone phytosanitary treatment (for example, either vapour heat treatment or irradiation).

3.6.3 Packing, storage and distribution

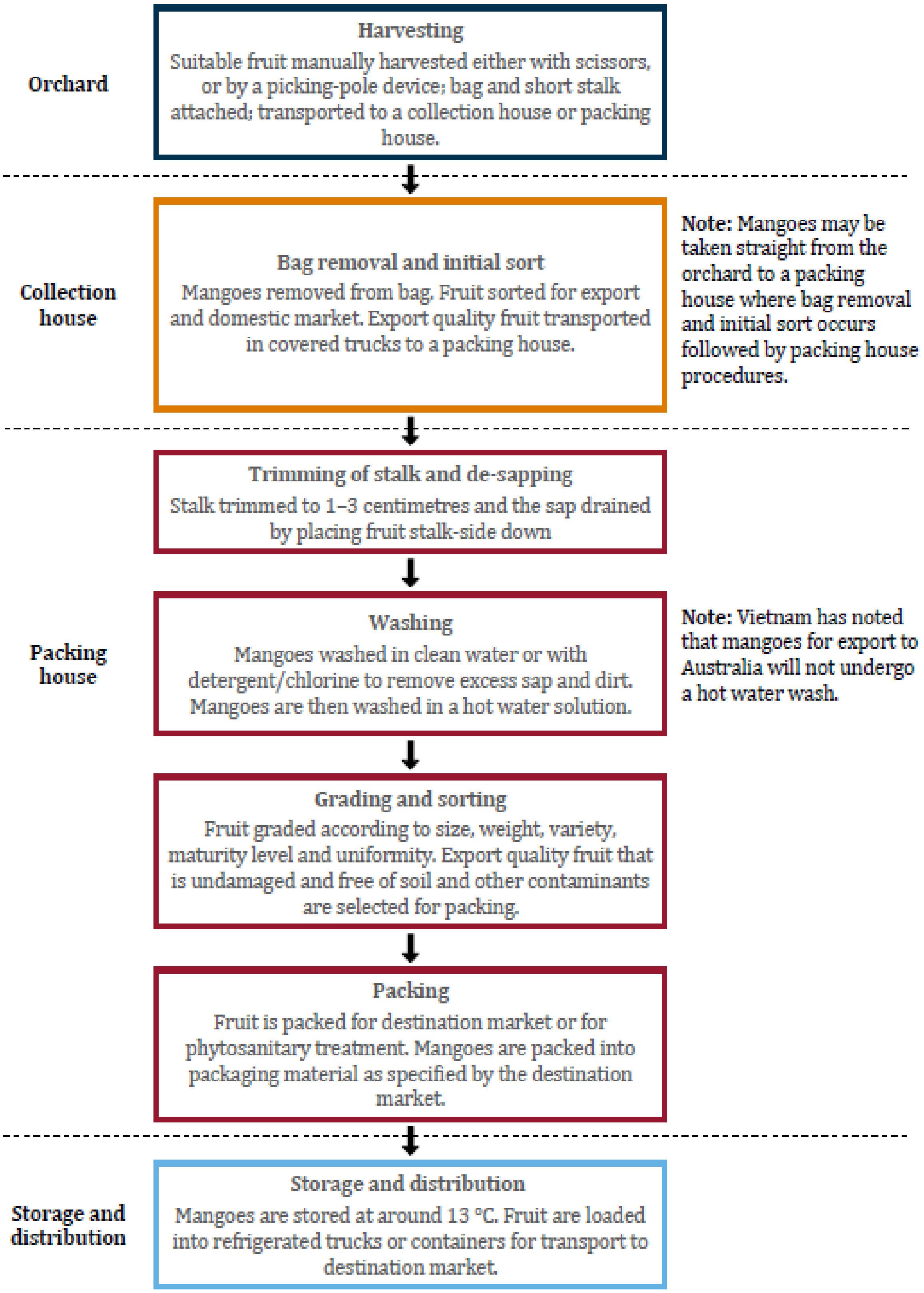
Mango fruit is generally packed into plastic or cardboard export cartons. Packaged fruit are labelled for quality assurance and trace-back purposes.

In Thailand, mangoes are packed into corrugated or plastic boxes, depending on the destination market. For export markets, the ventilation holes of the corrugated boxes are screened. In Indonesia, the packaging material also depends on the destination market requirements. Currently, exported mangoes are packed in carton or plastic boxes and the fruit is separated by Styrofoam or a fruit net.

Mangoes are kept in refrigerated storage (around 13 °C) before loading into sealed refrigerated trucks or containers and transported to the port or airport for export to destination market.

Figure 2 summarises the harvest and post-harvest steps (orchard, collection house, packing house, storage and distribution) for mangoes grown in Indonesia, Thailand and Vietnam (adapted from (PPD 2009; DOA Thailand 2011; IAQA 2012).

Figure 2 Summary of orchard and post-harvest steps for commercial mangoes grown in Indonesia, Thailand and Vietnam



3.7 Export capability

3.7.1 Production and export statistics

Indonesia is the third largest mango producing country of the world. East Java is the largest production province followed by West Java. In 2010, the total production for mangos in East Java and West Java was 416 803 and 137 104 tonnes respectively (IAQA 2012). Most of Indonesia's mangoes are sold to the domestic market with a small volume exported to international markets. Each year export volumes have gradually increased. Exports increased from 941 tonnes in 2005 to 1616 tonnes in 2009 (Valavi *et al.* 2012).

Thailand is one of the main mango producing countries of the world. In 2009, the total production area for mangoes was approximately 384 000 hectares and total production was 2.4 million tonnes. The majority of mangoes produced are consumed domestically and around two percent are exported (Valavi *et al.* 2012).

Vietnam's main mango production areas are located in the south of Vietnam. In 2009 a total of 380 000 tonnes of mangoes were grown in Vietnam, with the greatest volume of mangoes produced in the Mekong River Delta (237 000 tonnes), South East (86 500 tonnes) and South central coast (23 700 tonnes) regions (PPD 2009). Commercial production is developing in the north as a result of improved cultivars and production practices. Mangoes are mainly sold to Vietnam's domestic market.

3.7.2 Export markets

Indonesia exports mangoes to a number of markets including Singapore, Hong Kong, Japan, the Kingdom of Saudi Arabia, Malaysia, Europe and Taiwan (Valavi *et al.* 2012; IAQA 2012).

The main export markets for Thailand are Singapore, Malaysia, China, Japan, Korea and Europe (DOA Thailand 2011; Suthikul 2015).

Vietnam currently exports mangoes to China, Taiwan and more recently gained access to New Zealand (PPD 2009).

3.7.3 Export season

Mangoes are likely to be exported from Indonesia, Thailand and Vietnam during the peak production period.

Mangoes are harvested in Indonesia from August to January (IAQA 2012) with peak production in November (Valavi *et al.* 2012).

Mangoes are harvested in Thailand from January to June (DOA Thailand 2011), with peak production in March, April and May (Valavi *et al.* 2012).

The harvesting period for export quality mangoes in Vietnam is from February to April (PPD 2009), with peak production in March and April (Valavi *et al.* 2012).

4 Pest risk assessments for quarantine pests

Quarantine pests associated with fresh mango fruit from Indonesia, Thailand and Vietnam are identified in the pest categorisation process (Appendix A). This chapter assesses the probability of the entry, establishment and spread of these pests and the likelihood of associated potential economic, including environmental, consequences.

Pest categorisation identified a total of 26 quarantine pests associated with fresh mango fruit from Indonesia, Thailand and Vietnam. Of these, 20 pests are of national concern and six are of regional concern. Table 7 identifies these quarantine pests, and full details of the pest categorisation are given in Appendix A.

Pest risk assessments already exist for some of the pests considered here as they have been assessed previously by the Australian Government Department of Agriculture. For these pests, the likelihood of entry (importation and/or distribution) could be different from the previous assessment due to differences in the commodity, country and commercial production practices in the export areas, and hence will be re-assessed. Unless there is new information to suggest otherwise, the likelihood of establishment and of spread in the PRA area, and the consequences the pests may cause will be the same for any commodity/country with which the pests are imported. Accordingly, there is no need to re-assess these components and the risk ratings given in the previous assessment will be adopted. For a pest that has previously been assessed and a policy already exists, this will be stated in the introduction of the pest risk assessment, and the acronym 'EP' (existing policy) is used to highlight this.

Some pests identified in this assessment have been recorded in some regions of Australia, and due to interstate quarantine regulations are considered pests of regional concern. The acronym for the state for which the regional pest status is considered, such as 'WA' (Western Australia), is used to identify these organisms.

The department is aware of the recent changes in fungal nomenclature which ended the separate naming of different states of fungi with a pleiomorphic 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 still uses dual names for most fungi. As official lists of accepted and rejected fungal names become available, these accepted names will be adopted.

Table 7 Quarantine pests for fresh mango fruit from Indonesia, Thailand and Vietnam

Pest	Common name	Indonesia	Thailand	Vietnam
Weevils [Coleoptera: Curculionidae]				
Sternochetus gravis (EP)	mango pulp weevil	Yes	Yes	Yes
Sternochetus mangiferae (EP, WA)	mango seed weevil	Yes	No	No
Sternochetus olivieri	mango seed boring weevil	No	Yes	Yes
Fruit flies [Diptera: Tephritidae]				
Bactrocera carambolae (EP)	carombola fruit fly	Yes	Yes	Yes
Bactrocera correcta (EP)	guava fruit fly	No	Yes	Yes
Bactrocera dorsalis (EP)	Oriental fruit fly	No	Yes	Yes
Bactrocera zonata (EP)	peach fruit fly	No	Yes	Yes
Mealybugs [Hemiptera: Pseudococcidae]				
Dysmicoccus neobrevipes (EP)	annona mealybug	No	Yes	Yes
Paracoccus marginatus (EP)	papaya mealybug	Yes	Yes	No
Planococcus lilacinus (EP)	coffee mealybug	Yes	Yes	Yes
Planococcus minor (EP, WA)	Pacific mealybug	Yes	Yes	Yes
Pseudococcus cryptus (EP)	citriculus mealybug	Yes	Yes	Yes
Pseudococcus jackbeardsleyi (EP)	Jack Beardsley mealybug	Yes	Yes	Yes
Rastrococcus iceryoides (EP)	downy snowline mealybug	Yes	Yes	No
Rastrococcus invadens (EP)	mango mealybug	Yes	Yes	Yes
Rastrococcus rubellus	Oriental mealybug	Yes	No	No
Rastrococcus spinosus (EP)	Philippine mango mealybug	Yes	Yes	Yes
Soft scales [Hemiptera: Coccidae]				
Ceroplastes rusci	fig wax scale	Yes	No	Yes
Armoured scales [Hemiptera: Diaspididae]				
Abgrallaspis cyanophylii (EP, WA)	cyanophyllum scale	Yes	Yes	No
Pinnaspis aspidistrae (EP, WA)	aspidistra scale	Yes	Yes	No
Pseudaonidia trilobitiformis (EP, WA)	trilobite scale	Yes	Yes	Yes
Radionaspis indica	mango scale	Yes	No	No
Unaspis acuminata (EP)	unaspis scale	No	Yes	No
Moths [Lepidoptera: Pyralidae]				
Deanolis sublimbalis (EP)	red banded mango caterpillar	Yes	Yes	Yes
Thrips [Thysanoptera: Thripidae]				
Rhipiphorothrips cruentatus (EP)	mango thrips	No	Yes	No
Fungi [Myriangiales: Elsinoaceae]				
Elsinoë mangiferae (EP, WA)	mango scab	Yes	Yes	Yes

4.1 Mango weevils

Sternochetus gravis **(EP),** ***Sternochetus mangiferae*** **(WA, EP) and** ***Sternochetus olivieri***

Sternochetus gravis, *S. mangiferae* and *S. olivieri* belong to the Curculionidae or weevil family characterised by their long snouts with mouthparts situated at the apex. They have been grouped together because of their related biology and taxonomy, and are predicted to pose a similar risk and to require similar mitigation measures. In this assessment, the term 'mango weevils' is used to refer to these three species. The scientific name is used when the information is about a specific species.

Sternochetus mangiferae (mango seed weevil) is not present in Western Australia and is a pest of regional quarantine concern for that state. *Sternochetus gravis* (= *S. frigidus*) (mango pulp weevil) and *Sternochetus olivieri* (mango seed weevil) are not present in Australia and are pests of quarantine concern for all of Australia.

Mango weevils have four life stages: egg, larva, pupa and adult (CABI 2015a). Adult weevils overwinter under loose bark around the base of trees, in the forks of tree branches, in the leaf litter (Chen *et al.* 2011) while a proportion of the population of *S. mangiferae* remain inside the seed (QDAF 2012c).

The risk scenario of concern for *Sternochetus gravis*, *S. mangiferae* and *S. olivieri* is the presence of immature larvae, pupae or mature adult weevils in fresh mango fruits from Indonesia, Thailand and Vietnam.

This assessment focuses on three mango weevils, two species having previously been assessed for which relevant policy already exists. *Sternochetus gravis* (as *S. frigidus*) and *Sternochetus mangiferae* were assessed in the existing import policy for mango fruit from India (Biosecurity Australia 2008a) and the Philippines (AQIS 1999). It is considered that these previous assessments for *S. gravis* and *S. mangiferae* can equally apply to *S. olivieri*. Therefore, the risk assessment of the *Sternochetus* weevils presented here builds on these previous assessments.

Differences in horticultural practices, climatic conditions and the prevalence of these three mango weevils between previous export areas in India and the Philippines make it necessary to reassess the likelihood that *S. gravis*, *S. mangiferae* and *S. olivieri* will be imported into Australia with mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur over a similar time period that mango fruit is already able to be imported from India and the Philippines and for which policy exists. After importation, mangoes will be distributed throughout Australia or Western Australia for retail sale in a similar way to those mangoes from India and the Philippines. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and of spread of *S. gravis*, and *S. olivieri* in Australia or *S. mangiferae* in Western Australia will be comparable for any mango imported into Australia, as these likelihoods relate specifically to events that occur in Australia or Western Australia and are largely independent of the importation pathway. The consequences they may cause are also independent of the importation pathway. Accordingly, there is no need to reassess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for *S. gravis* (as *S. frigidus*) and *S. mangiferae* in the existing policy for mangoes from India (Biosecurity Australia 2008a). Therefore, those risk ratings will be adopted for this assessment.

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 *S. gravis* and *S. olivieri* will arrive in Australia or that *S. mangiferae* will arrive in Western Australia with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam has been assessed as: **High**.

The following information provides supporting evidence for this assessment.

- The mango weevils *Sternochetus gravis*, *S. mangiferae* and *S. olivieri* are present throughout South-East Asia and the Indomalayan archipelago. *Sternochetus gravis* is present in Indonesia (IAQA 2011a), Thailand (DOA Thailand 2011; DOA Thailand 2014) and Vietnam (PPD 2009). *Sternochetus mangiferae* is present in Indonesia (Waterhouse 1993; CABI 2015a) but is absent from Vietnam (PPD 2009) and Thailand. *Sternochetus olivieri* is absent from Indonesia but is present in Thailand (DOA Thailand 2014) and Vietnam (EPPO 2011).
- Adult weevils are nocturnal and hide during the day, for example in bark crevices or under epiphytic plants and are well camouflaged because of their cryptic colouration. At night adults feed on flowers, panicles, fruit and on the gum that exudes from puncture wounds on young fruits. *S. gravis* adults are strong fliers but do not move far from their emergence sites (CABI 2015a). The limited natural dispersal of the weevil means that high infestations appear year after year in some locations while infestations are low in nearby trees (CABI 2015a). Therefore, infestations are easy to detect and then manage.
- All three species have one generation per year (Kalshoven 1981; Shukla and Tandon 1985; De and Pande 1988; Krairiksh *et al.* 2002; Verghese *et al.* 2005; Devi *et al.* 2011; Chen *et al.* 2011).
- The larva of all three species feed only on mango fruit (de Jesus *et al.* 2002; DOA Thailand 2005; OEPP-EPPO 2011; Chen *et al.* 2011). *Sternochetus gravis* develops in the pulp of mango (de Jesus 2008) while *S. mangiferae* (CABI-EPPO 1997a) and *S. olivieri* (Krairiksh *et al.* 2002; Chen *et al.* 2011) develop in the seed. Newly hatched *S. gravis* larvae tunnel directly through the fruit pulp to the kernel, avoiding the gum-laden tissues because contact with them may cause their death (CABI 2015a).
- Mango weevils make incisions in very small mango fruit in which to lay their eggs. These egg-laying marks disappear quickly as the fruit grows (OEPP-EPPO 2011). Eggs of *S. gravis* are laid singly on developing fruit (Srivastava 1997; de Jesus and Gabo 2000) and are immediately covered by a black fruit exudate produced by a wound cut by the female (de Jesus and Gabo 2000; Follett 2002). Eggs of *S. mangiferae* and *S. olivieri* are also laid in a

similar fashion (Srivastava 1997; CABI-EPPO 1997a; Krairiksh *et al.* 2002; Smith and Brown 2008; Infonet-Biovision 2012; CABI 2015a).

- Early infestation of mango fruits leads to premature fruit fall. If the attacks occur at a later stage, fruit infestation is very difficult to detect, since there are no external signs of infestation (Materu *et al.* 2014).
- On hatching the first stage larvae of *S. mangiferae* and *S. olivieri* burrow through the pulp to penetrate the seed to complete their development (Hansen *et al.* 1989; CABI-EPPO 1997a; Krairiksh *et al.* 2002; Chen *et al.* 2011; Infonet-Biovision 2012). Complete larval development usually occurs within the maturing seed, but both *S. mangiferae* and *S. olivieri* occasionally successfully develop within the pulp (Balock and Kozuma 1964; De and Pande 1988; Hansen *et al.* 1989).
- The larva of *S. gravis* feeds and develops inside the fruit leaving no external symptoms of its presence (de Jesus and Gabo 2000; Obra *et al.* 2014) making it difficult to differentiate between infested and uninfested fruit (de Jesus and Cortez 1998; Velasco and Medina 2004). Up to 20% of the larvae of *S. gravis* die when the fruits are harvested, because they are unable to complete their development. Adults found in the fruits usually survive (CABI 2015a).
- *Sternochetus gravis* weevils leave the ripe fruit through a hole in the peel. Since the fruit shows no outward sign of infestation before they emerge infested fruit are difficult to detect (Kalshoven 1981). In many cases *S. mangiferae* attacks remain undetected in the field (Materu *et al.* 2014).
- If pupation occurs inside the fruit newly developed adults of *S. gravis* remain in a pupal cell inside the fruit until it rots (De and Pande 1988; de Jesus *et al.* 2002; Obra *et al.* 2014).
- *Sternochetus gravis* (as *S. frigidus*) has been intercepted on mango in passenger baggage entering the USA (USDA-APHIS 2006), demonstrating that it can survive transport and storage and could be imported into Australia via the movement of fruit.
- *Sternochetus olivieri* is specific to mango and is a pest of quarantine concern for fresh Thai mangoes exported to Malaysia, China and other countries (Krairiksh *et al.* 2002; Gu *et al.* 2013). It has been intercepted on fresh mangoes in passenger baggage on several occasions in Chinese ports during 2005–2011 (Gu *et al.* 2013).
- *Sternochetus mangiferae* has also been intercepted on fresh commercial quality mango fruit as well as in passenger baggage on several occasions entering England, Wales and Beijing, China (Malumphy 2011; Bian *et al.* 2012).

The mango weevils *Sternochetus gravis*, *S. mangiferae* and *S. olivieri* are widespread in South-East Asia. All three species are host specific and will only complete their development in fresh mango fruit. *Sternochetus gravis* develops in the pulp of mango while *S. mangiferae* and *S. olivieri* develop in the seed. Adults are strong fliers but do not move far from their emergence sites. This limited natural dispersal of the weevil means that high infestations appear year after year in some locations while infestations are low in nearby trees, indicating that infestations are easily detectable and managed. Although female *Sternochetus* weevils make a small incision in very small mango fruit in which to lay their eggs, these egg laying marks disappear quickly as the fruit grows. Where the incision creates a sap flow it solidifies to form a protective opaque coating for the egg that fades as the fruit ripens and would be equally difficult to see. Therefore it is difficult to distinguish infested from un-infested commercial quality fruit in the case of the seed-boring species in particular. In the case of late developing mango pulp weevils (*S. gravis*), infested fruit can remain undetected due to no outward sign of infestation before the adults emerge leaving a hole in the peel. *Sternochetus* species have been detected or intercepted in fruit in several countries demonstrating that they can survive existing pest management procedures in orchards and packing house procedures. The pest's cryptic life-cycle, lack of any visible external signs of infestation and history of interception in commercial consignments all support a likelihood estimate for importation of 'high'.

Likelihood of distribution

As indicated, the likelihood of distribution for the mango weevils assessed here would be the same as that for *Sternochetus gravis* (as *S. frigidus*) and *S. mangiferae* for fresh mango fruit from India (Biosecurity Australia 2008a). It is considered that *S. olivieri* would have the same likelihood of distribution, that is **Low**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *S. gravis* and *S. olivieri* will enter Australia or that *S. mangiferae* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Low**.

4.1.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for *Sternochetus gravis* and *S. mangiferae* is being based on the assessment for fresh mango fruit from India (Biosecurity Australia 2008a). That assessment used the same methodology as described in Chapter 2 of this report. It is considered that *S. olivieri* would have the same likelihood of establishment and spread. The ratings from the previous assessment are:

Likelihood of establishment	**Moderate**
Likelihood of spread	**Moderate**

4.1.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The likelihood that *S. gravis* and *S. olivieri* will enter Australia or that *S. mangiferae* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia or Western Australia and subsequently spread within Australia or Western Australia has been assessed as: **Low**.

4.1.4 Consequences

The potential consequences of the establishment of *Sternochetus gravis* in Australia or *S. mangiferae* in Western Australia have been estimated previously for fresh mango fruit from India (Biosecurity Australia 2008a). *Sternochetus olivieri* is considered to have a similar impact. The overall consequences have been estimated to be **Moderate**.

4.1.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Sternochetus gravis, S. mangiferae* and *S. olivieri*	
Overall likelihood of entry, establishment and spread	Low
Consequences	Moderate
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *Sternochetus gravis, S. mangiferae* and *S. olivieri* has been assessed as 'low', which is above Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.2 Fruit flies

Bactrocera carambolae **(EP),** ***Bactrocera correcta*** **(EP),** ***Bactrocera dorsalis*** **(EP) and** ***Bactrocera zonata*** **(EP)**

This assessment focuses on four fruit flies of the genus *Bactrocera*; *B. carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* belong to the family Tephritidae, or true fruit flies, and are considered to be among the most damaging pests to horticulture (White and Elson-Harris 1992; Peña *et al.* 1998). Fruit flies are responsible for causing significant economic losses to the mango industry (Srivastava 1997). They have been grouped together in this assessment because of their related biology and taxonomy, and are predicted to pose a similar risk and require similar mitigation measures. In this assessment, the term 'fruit flies' is used to refer to these four species of *Bactrocera* fruit flies. The respective scientific name is used when the information is about a specific species.

These fruit flies are not present in Australia and are therefore pests of quarantine concern for all of Australia. *Bactrocera correcta*, *B. dorsalis* and *B. zonata* are the dominant fruit fly pests of mangoes in India, Indonesia, Thailand, Vietnam, Laos, Malaysia, Philippines and Singapore (Clarke *et al.* 2005; Kapoor 2005). Although *Bactrocera carambolae* is a serious pest of carambola in Malaysia, it is a lesser problem for many economically important hosts cultivated in South-East Asia such as mango (CABI 2015b).

Fruit flies have four life stages; egg, larva, pupa and adult (Christenson and Foote 1960; CABI 2015a). Eggs are laid beneath the skin of host fruits (Cantrell *et al.* 2002) and larvae feed within the fruit before exiting the fruit to pupate in the soil under the host plant (Christenson and Foote 1960; Charernsom 2003; PPD 2009; DOA Thailand 2011; IAQA 2011b; Badri 2013). Fruit flies can produce several generations each year depending on the temperature (CABI 2015a) and can be active year round when conditions are favourable.

The risk scenario of concern for *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* is the potential presence of eggs and larvae in fresh mango fruits from Indonesia, Thailand and Vietnam.

These species have previously been assessed for other commodities for which relevant policy already exists. *Bactrocera carambolae* was assessed for mangosteen fruit from Thailand (DAFF 2004b). *Bactrocera correcta* was assessed for mango fruit from India (Biosecurity Australia 2008a) and included in the policy review for mango fruit from Pakistan (Biosecurity Australia 2011b). *Bactrocera dorsalis* was previously assessed for mango fruit from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a) and included in the policy review for mango fruit from Pakistan (Biosecurity Australia 2011b), longan and lychee fruit from China and Thailand (DAFF 2004a), lychee from Taiwan and Vietnam (DAFF 2013) and for mangosteens from Thailand (DAFF 2004b) and Indonesia (DAFF 2012) (as *Bactrocera papayae*). *Bactrocera zonata* was previously assessed for mango fruit from India (Biosecurity Australia 2008a) and included in the policy review for mango fruit from Pakistan (Biosecurity Australia 2011b). The risk assessment presented here builds on those previous assessments.

Differences in commodity, horticultural practices, climatic conditions and the prevalence of these four species of *Bactrocera* between export areas considered in existing policy make it necessary to reassess the likelihood that *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* will be imported into Australia with mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur during a similar period that host fruit can currently be imported from China, India, Pakistan, Taiwan, Mexico and the Philippines. After importation, mangoes from Indonesia, Thailand and Vietnam will be distributed throughout Australia for retail sale in a similar way to that for mangoes from India, Pakistan, Taiwan, Mexico and the Philippines. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and spread of *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* in Australia will be comparable for any host commodity of these species imported into Australia, as these likelihoods relate specifically to post import events that occur in Australia and are largely independent of the importation pathway. The consequences that these four *Bactrocera* fruit flies may cause are also independent of the importation pathway. Accordingly, there is no need to reassess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and found no new information that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for fruit flies in the existing policies for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). Therefore, those risk ratings will be adopted where relevant for this PRA.

4.2.1 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 *Bactrocera carambolae, B. correcta, B. dorsalis and B. zonata* will arrive in Australia with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam has been assessed as: **High**.

The following information provides supporting evidence for this assessment.

- *Bactrocera carambolae*, *B. dorsalis* and *B. zonata* are present in Indonesia, Thailand and Vietnam and have been found to infest mango fruit (Drew 1982; Waterhouse 1993; Drew and Hancock 1994; Peña and Mohyuddin 1997; Mahmood 1999; Charernsom 2003; Clarke *et al.* 2005; DOA Thailand 2005; Hasyim *et al.* 2008; Hoa *et al.* 2010; DOA Thailand 2011; Sumrandee *et al.* 2011; IAQA 2011a; PPD 2012; CABI 2015a).
- *Bactrocera correcta* is present in Thailand and Vietnam and has been recorded attacking mango fruit (Waterhouse 1993; Peña and Mohyuddin 1997; Charernsom 2003; DOA Thailand 2005; PPD 2009; DOA Thailand 2011; CABI 2015a).
- *Bactrocera carambolae*, *B. correcta*, B. dorsalis and *B. zonata* are a major pest of mangoes in tropical Asia (Allwood and Drew eds. 1997). In particular, *Bactrocera correcta*, *B. dorsalis* and *B. zonata* are major pests of mangoes in Indonesia, Thailand and Vietnam (Clarke *et al.* 2005).

- *Bactrocera* species are typically managed in Indonesia, Thailand and Vietnam by trapping, bait sprays, natural enemies, bagging, sterile insect technique and collection and deep burial of fallen fruit (Allwood *et al.* 2001; Ramadan and Messing 2003; Sutantawong *et al.* 2004; Indonesian Ministry of Agriculture 2010; ACIAR 2014). These methods may suppress but not necessarily eliminate populations.
- In Thailand, fruit flies can cause 12–65 per cent crop losses to mango. *Bactrocera carambolae* and *B. dorsalis* are the most abundant and predominant in southern Thailand (Drew and Romig 2001; Danjuma *et al.* 2013). Fruit flies have been recorded causing crop losses of up to 80 per cent in mango in Indonesia (ACIAR 2014).
- Typically eggs of fruit flies are laid beneath the skin of host fruits. Larvae feed on the pulp inside the fruit (Christenson and Foote 1960; Waterhouse 1993; Charernsom 2003; DOA Thailand 2005; PPD 2009; NPQS 2010; DOA Thailand 2011; IAQA 2011a; IAQA 2011b; Badri 2013; CABI 2015a). Infested fruit cannot always be distinguished from uninfested fruit (White and Elson-Harris 1992).
- Fruit fly larvae can survive in harvested fruit and may be present in mango fruit packed for export. As fruit fly eggs are laid internally, infested fruit may not be detected during routine sorting, packing and inspection procedures. Inspection procedures carried out in the packing houses are concerned primarily with quality standards of fruit with regard to blemishes, bruising or damage to the skin.
- For the export of mangoes from Thailand, Indonesia and Vietnam, fruit flies are the highest quarantine concern (Srivastava 1997; Allwood *et al.* 2002; Clarke *et al.* 2005; Kurniasih *et al.* 2013).
- *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* are quarantine pests for mangoes from Thailand and Vietnam for New Zealand and the United States (MAF New Zealand 1999; USDA-APHIS 2005).
- *Bactrocera correcta* and *B. zonata* have been intercepted in mangoes carried in passenger baggage arriving in Taiwan from Thailand and Vietnam (CNA 2007).
- Chinese quarantine authorities have intercepted *Bactrocera correcta* and *B. dorsalis* on commercial consignments of mangoes imported from Thailand (Bian *et al.* 2012; Gu *et al.* 2013).
- *Bactrocera zonata* has also been intercepted in commercial consignments of mango from Pakistan in the United Kingdom (DEFRA 2006).
- The optimum temperature for storage of mangoes is 13 °C to 14 °C, as storage below this may result in chilling injury to the fruit (Lederman *et al.* 1997; Nair and Singh 2003). At low temperatures, development times for fruit flies are extended significantly and mortality increases for all life stages (Duyck *et al.* 2004). Lower development thresholds have been estimated from a linear regression model for the eggs and larvae of the four species assessed here;
  - the lower development threshold for the eggs and larvae respectively of *B. carambolae* are 12.4 °C and 11.2 °C (Danjuma *et al.* 2014)
  - for *B. correcta* the lower development threshholds are 8.5 °C and 7.6 °C (Liu and Ye 2009)

- for *B. dorsalis* (as *B. papayae*) the lower development threshholds are 12.1 °C and 10.5 °C (Danjuma *et al.* 2014)
- for *B. zonata* the lower development threshholds are 12.7 °C and 12.6 °C (Duyck *et al.* 2004).

- Therefore, immature stages could continue to develop normally at higher storage temperatures or at a marginally slower rate at lower storage temperatures.

Bactrocera carambolae, *B. correcta*, *B. dorsalis* and *B. zonata* are recognised as major pests of mangoes in tropical Asia. In particular, *Bactrocera correcta*, *B. dorsalis* and *B. zonata* are major pests of mangoes in Indonesia, Thailand and Vietnam, causing significant losses to mango crops. Although *Bactrocera* fruit flies are being managed in Indonesian, Thai and Vietnamese mango orchards by trapping, use of bait sprays, sterile insect technique, natural enemies and bagging, populations will only be reduced to a low level but not necessarily eradicated.

In newly infested fruit, damage may not be immediately apparent until secondary infections have developed showing obvious signs of attack or tissue decay. Newly infested fruit may not be easily distinguished from fruit that is un-infested during sorting, packing and quality inspection procedures. Since mangoes are stored and transported at temperatures that allow the eggs and larvae of these four fruit flies to develop, the immature stages may survive transportation to Australia.

The ability of fruit flies to survive management procedures, the difficulty of detecting them within fruit, their ability to survive transportation and storage temperatures and a history of previous interception on commercial mango consignments on arrival in importing countries supports a likelihood estimate for importation of 'high'.

Likelihood of distribution

As indicated in previous assessments, the likelihood of distribution for the fruit flies assessed here would be the same as that for *Bactrocera dorsalis* for mangoes from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a) and *B. correcta* and *B. zonata* for mangoes from India (Biosecurity Australia 2008a). It is considered *B. carambolae* would have the same likelihood of distribution, that is **High**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **High**.

4.2.2 Likelihood of establishment and spread

As indicated in previous assessments, the likelihood of establishment and of spread for *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* is being based on the assessment for fresh mango fruit from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). Those assessments used the same methodology as described in Chapter 2 of this report. The ratings from the previous assessments are:

Likelihood of establishment	**High**
Likelihood of spread	**High**

4.2.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The overall likelihood that *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia has been assessed as: **High**.

4.2.4 Consequences

The potential consequences of the establishment of *Bactrocera carambolae* in Australia has been estimated previously for mangosteens from Thailand (DAFF 2004b), while the potential consequences of the establishment of *Bactrocera correcta*, *B. dorsalis* and *B. zonata* in Australia have also been estimated previously for mango fruit from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a). The overall consequencesfor these species have been estimated to be **High**.

4.2.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Bactrocera carambolae, B. correcta, B. dorsalis and B. zonata*	
Overall likelihood of entry, establishment and spread	High
Consequences	High
Unrestricted risk	High

As indicated, the unrestricted risk estimate for *Bactrocera carambolae, B. correcta, B. dorsalis and B. zonata* has been assessed as 'high', which is above Australia's ALOP. Therefore, specific risk management measures are required for these pests.

4.3 Mealybugs

Dysmicoccus neobrevipes* (EP), *Paracoccus marginatus* (EP), *Planococcus lilacinus* (EP), *Planococcus minor* (EP, WA), *Pseudococcus cryptus* (EP), *Pseudococcus jackbeardsleyi* (EP), *Rastrococcus iceryoides* (EP), *Rastrococcus invadens* (EP), *Rastrococcus spinosus* (EP) and *Rastrococcus rubellus

The 10 species of mealybugs assessed in this risk assessment belong to the family Pseudococcidae. They have been grouped together because of their related biology and taxonomy, and are predicted to pose a similar risk and to require similar mitigation measures if their risks are assessed above Australia's ALOP. In this assessment, the term 'mealybug' or 'mealybugs' is used to refer to these 10 species. The scientific name is used when the information is about a specific species.

Planococcus minor is not present in Western Australia and is a pest of regional quarantine concern for that state. *Dysmicoccus neobrevipes*, *Paracoccus marginatus*, *Planococcus lilacinus*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* are not present in Australia and are pests of quarantine concern for the whole of Australia.

Mealybugs are highly polyphagous and have been recorded on a wide range of host plants including mangoes. Many mealybug species pose serious problems to agriculture when introduced into new areas of the world where natural enemies are not present (Miller *et al.* 2002). Mealybugs are small, oval, soft-bodied insects that are covered with a white, cottony or mealy wax secretion that is moisture repellent and protects them against desiccation (Cox 1987). Mealybugs develop through a number of nymphal (immature instar) stages before undergoing a final moult into the adult form. Female mealybugs have four instar stages (Williams 2004), with the adult female being similar in appearance to the nymphal stage and approximately 4 mm in length. This contrasts with male mealybugs, which have five instar stages (Williams 2004), with the adult male emerging from a cocoon as a tiny winged form. The adult males do not feed, having no mouthparts, and their sole purpose is to locate a female and mate. Mealybugs reproduce sexually or parthenogenically, that is, without a mate, and there may be multiple generations per year.

The risk scenario of concern for these mealybugs is the presence of immobile juveniles and adult females on fresh mango fruit from Indonesia, Thailand and Vietnam.

This assessment focuses on 10 mealybug species, nine species having previously been assessed for which relevant policy already exists. It is considered that these previous assessments can equally apply to *Rastrococcus rubellus*. The risk assessment presented here builds on these previous assessments.

Table 8 Existing policies for mealybugs

Mealybug species	Existing Policy
Dysmicoccus neobrevipes	Bananas from the Philippines (Biosecurity Australia 2008b); mangosteens from Thailand (DAFF 2004b)
Paracoccus marginatus	Pineapples (Biosecurity Australia 2002)
Planococcus lilacinus	Mangoes from India (Biosecurity Australia 2008a) and Taiwan (Biosecurity Australia 2006b); lychee fruit from Taiwan and Vietnam (DAFF 2013)
Planococcus minor (WA)	Mangoes from India (Biosecurity Australia 2008a) and Taiwan (Biosecurity Australia 2006b); lychee fruit from Taiwan and Vietnam (DAFF 2013); bananas from the Philippines (Biosecurity Australia 2008b); mangosteens from Indonesia (DAFF 2012)
Pseudococcus cryptus	Persimmon from Japan, Korea and Israel (DAFF 2004c); mangoes from Taiwan (Biosecurity Australia 2006b); mangosteens from Thailand (DAFF 2004b) and Indonesia (DAFF 2012)
Pseudococcus jackbeardsleyi	Pineapples (Biosecurity Australia 2002); mangoes from Taiwan (Biosecurity Australia 2006b); bananas from the Philippines (Biosecurity Australia 2008b)
Rastrococcus iceryoides	Mangoes from India (Biosecurity Australia 2008a)
Rastrococcus invadens	Mangoes from India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b)
Rastrococcus spinosus	Mangoes from India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b); mangosteens from Indonesia (DAFF 2012)

Differences in commodities, horticultural practices, climatic conditions and the prevalence of these pests between Indonesia, Thailand and Vietnam and other countries make it necessary to reassess the likelihood that the assessed mealybug species will be imported into Australia or Western Australia with mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur over a similar time period that host fruit is already able to be imported from India, Pakistan, Taiwan, Mexico and the Philippines and for which policy exists. After importation, mangoes will be distributed throughout Australia or Western Australia for retail sale in a similar way to those mangoes from India, Pakistan, Taiwan, Mexico and the Philippines. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and of spread of mealybugs in Australia or Western Australia will be comparable regardless of the commodity on which these assessed mealybugs are imported into Australia or Western Australia, as these likelihoods relate specifically to events that occur in Australia and are independent of the importation pathway. The consequences they may cause are also largely independent of the importation pathway. Accordingly there is no need to re-assess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for mealybugs in the existing policies for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). Therefore, those risk ratings will be adopted for this assessment.

4.3.1 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 *Dysmicoccus neobrevipes*, *Paracoccus marginatus*, *Planococcus lilacinus*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* will arrive in Australia or that *Planococcus minor* will arrive in Western Australia with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam has been assessed as: **High**.

The following information provides supporting evidence for this assessment.

- The assessed mealybugs are widespread in tropical and subtropical regions affecting the twigs, leaves, blossoms and fruit of mango (Williams 2004; Germain *et al.* 2010; PPD 2012; CABI 2015a).
- *Phenacoccus solenopsis*, *Planococcus lilacinus*, *Pl. minor*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus invadens* and *R. spinosus* have been reported from Indonesia, Thailand and Vietnam (Williams 2004; Muniappan *et al.* 2009; Suputa *et al.* 2010; Ben-Dov 2015; CABI 2015a).
- *Paracoccus marginatus* and *Rastrococcus iceryoides* are recorded from Indonesia and Thailand (Muniappan *et al.* 2008; Suputa *et al.* 2010; PPD 2012) but absent from Vietnam. *Dysmicoccus neobrevipes* is recorded from Thailand and Vietnam (Williams 2004) but absent from Indonesia, while *Rastrococcus rubellus* is recorded from Indonesia (Williams 2004) and is absent from Thailand and Vietnam.
- The assessed mealybugs are reported affecting the leaves, inflorescences and fruit of mango (Peña and Mohyuddin 1997; Peña *et al.* 1998). In particular the *Rastrococcus* species – *R. iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* are known to infest mango fruit, leaves, inflorescences and branches (Rawat and Jakhmola 1970; Peña and Mohyuddin 1997; Germain *et al.* 2010; Galanihe and Watson 2012).
- Later instar nymphs and adult females of *R. iceryoides* usually feed on the tender terminal shoots, inflorescences and fruits, whereas first instar nymphs feed on the undersides of leaves. In severe infestations, all the tender shoots, inflorescences and fruits of mango are infested by different stages of *Rastrococcus* species (Rawat and Jakhmola 1970).
- Fruit bagging is not effective in preventing fruit from being infested as a closely related mealybug, *Pseudococcus comstocki*, can still access fruit through openings in the bag (Yang *et al.* 2011).
- Once mealybugs find a suitable feeding site, they insert their stylets into plant tissue and begin to suck plant sap. This procedure anchors the mealybugs to the plant, where they generally remain and are dislodged with difficulty (Williams 2004). Once feeding begins, mealybugs secrete a cottony or 'mealy' waxy, moisture repellent coating that helps to protect their bodies against loss of water (desiccation) as well as predators and parasitoids (Carver *et al.* 1991).

- Mealybug infestations may promote the growth of sooty mould on the surface of the fruit. Fruit with sooty mould may be rejected at the point of harvest.
- The normal post-harvest practice of washing fruit to remove sap (Morton 1987) may remove some mealybug species on the fruit at the time of harvest, but the effective removal of all mealybugs may be difficult (Taverner and Bailey 1995).
- Adult females of these mealybugs range in length from 1.2 mm to 4.0 mm in length, eggs are approximately 0.2 mm in length and newly hatched nymphs are approximately 0.3 mm to 0.5 mm in length (Williams and Granara de Willink 1992; CABI 2015a). As the early stages of mealybugs are very small in size, they are unlikely to be detected at low population levels during routine visual inspection procedures in the packing house, where procedures are directed to ensuring fruit quality.
- Mangoes packed for export typically consist of the fruit and a very short (approximately 0.3 cm to 0.5 cm) pedicel attached to the top of the fruit. The morphology of the fruit does not provide many hiding places for mealybugs. Despite this, mealybugs have survived storage and transportation on mango consignments entering the USA (USDA-APHIS 2006), indicating that they are associated with the fruit pathway.
- *Dysmicoccus neobrevipes* has been intercepted on several occasions on mango from Thailand and the Philippines to the USA (Walker *et al.* 2014) although it is unclear whether the records were from commercial consignments of mango fruit.
- USDA APHIS-PPQ interception records for the period 1997 to 2002 reveal that *Paracoccus marginatus* and *Planococcus minor*, were amongst the ten most frequently intercepted mealybugs at US ports of entry (Miller and Miller 2002; Venette and Davis 2004).
- Interceptions of *Planococcus minor* or "*Planococcus* sp." have been reported 5299 times on fruit from 1984 to 2004 at US ports of entry; 16 per cent of these interceptions have been associated with permit cargo (Venette and Davis 2004).
- The Department of Primary Industry and Fisheries, Northern Territory recommends transport temperatures of 12 °C to 14 °C, as temperatures below 10 °C can cause chilling injury to the mango fruit (DPIF Northern Territory 2015).
- The optimum temperature for storage of mangoes is approximately 13 °C to 14 °C, as storage below this temperature may result in chilling injury to the fruit (Lederman *et al.* 1997; Nair and Singh 2003). Mealybugs are likely to survive transportation and storage at these temperatures as demonstrated by their detection at ports of entry.

Dysmicoccus neobrevipes, *Paracoccus marginatus*, *Planococcus lilacinus*, *Pl. minor*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* are widely distributed throughout the tropical and subtropical regions of Asia. All of these species have been recorded as being associated with mango fruit. The practice of fruit bagging has been shown not to be effective in preventing fruit from being infested by a closely related mealybug, *Pseudococcus comstocki*, as it still has access to the fruit through openings in the bag. Since most life stages of these assessed mealybugs are quite small it is likely that they will remain undetected during routine packing house procedures, especially at low population densities. Mangoes are transported at relatively moderate temperatures that make it likely that the assessed mealybugs will survive transportation and storage. A history of their interception on arrival on commercial consignments also supports a likelihood estimate for importation of ‘high’.

Likelihood of distribution

As indicated, the likelihood of distribution for the mealybugs assessed here would be the same as that for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). It is considered that *Rastrococcus rubellus* would have the same likelihood of distribution, that is **Moderate**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *Dysmicoccus neobrevipes*, *Paracoccus marginatus*, *Planococcus lilacinus, Pseudococcus cryptus*, *Ps. jackbeardsleyi, Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* will enter Australia or that *Planococcus minor* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Moderate**.

4.3.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for the assessed mealybugs is being based on the assessment for fresh mango fruit from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). Those assessments used the same methodology as described in Chapter 2 of this report. It is considered that *Rastrococcus rubellus* would have the same likelihood of establishment and spread. The ratings from the previous assessments are:

Likelihood of establishment	**High**
Likelihood of spread	**High**

4.3.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The likelihood that *Dysmicoccus neobrevipes*, *Paracoccus marginatus*, *Planococcus lilacinus*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* will enter Australia or that *Planococcus minor* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia or Western Australia and subsequently spread within Australia or Western Australia has been assessed as: **Moderate**.

4.3.4 Consequences

The potential consequences of the establishment of the assessed mealybugs in Australia or Western Australia have been estimated previously for mango fruit from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia

2011b). *Rastrococcus rubellus* is considered to have a similar impact. The overall consequences have been estimated to be **Low**.

4.3.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for mealybugs	
Overall likelihood of entry, establishment and spread	Moderate
Consequences	Low
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *Dysmicoccus neobrevipes*, *Paracoccus marginatus*, *Planococcus lilacinus*, *Pl. minor*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* has been assessed as ‘low’, which is above Australia’s ALOP. Therefore, specific risk management measures are required for these pests.

4.4 Fig wax scale

Ceroplastes rusci

Ceroplastes rusci belongs to the family Coccidae or soft scale insects. These insects are small, sessile and covered with a thick layer of greyish to pinkish-white, oily wax which serves as a protective covering against inclement environmental conditions and predators (Miller and Williams 1997).

Ceroplastes rusci is a pest of mango in Israel (Ben-Dov 2012) and previously a serious pest of mango in Egypt (Bakr *et al.* 2009). It is a pest of cultivated fig (Önder and Soydanbay 1984) and citrus around the Mediterranean Basin and is occasionally a serious pest of citrus in Israel (Ben-Dov 1988). It is also a pest of kiwi fruit crops in Italy (Pellizzari Scaltriti and Antonucci 1982).

The risk scenario of concern for the fig wax scale is the presence of eggs, crawlers, immobile (sessile) juveniles or adult scales on imported fresh mango fruit from Indonesia and Vietnam.

Ceroplastes rusci was assessed during pest categorisation in the import policy for sweet oranges from Italy (Biosecurity Australia 2005). It was considered not to be associated with the fresh fruit pathway and was not assessed further. However, the fact that *C. rusci* has been found on mango fruit entering the UK from the Dominican Republic (Malumphy 2010) indicates that this species can sometimes be associated with the fresh fruit pathway when mangoes are concerned.

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 *Ceroplastes rusci* will arrive in Australia with the importation of fresh mango fruit from Indonesia and Vietnam has been assessed as: **Low**.

The following information provides supporting evidence for this assessment.

- *Ceroplastes rusci* is a cosmopolitan wax scale recorded from Indonesia (Ben-Dov 2014a; CABI 2015a) and Vietnam (Vu *et al.* 2006). Although mango is a recognised host for this species (Bakr *et al.* 2009; Ben-Dov 2012; Kumar 2013) it is mostly a pest of fig and citrus and there is limited information of this species as a pest of mango in Indonesia and Vietnam.
- *Ceroplastes rusci* was previously a serious pest of mango in Egypt. *Ceroplastes rusci* is now considered a secondary pest of mango most likely because of the absence of fig trees, a preferred host, in the vicinity of the mango trees sampled (Bakr *et al.* 2009).
- Infestations of *C. rusci* usually occur on foliage, stems and branches (CABI 2015a) but occasionally on fruits (Malumphy 2010; Guerrero *et al.* 2012).
- Adult females range from 4–5 mm in length, nymphs from 1.0–1.3 mm in length while eggs are approximately 0.3 mm in length (Guerrero *et al.* 2012). As the early stages of this pest are very small in size, they may not to be detected during routine visual inspection procedures in the packing house, especially at low population levels.

- Routine washing procedures undertaken in the packing house are likely to remove some pests from the surface of the mango fruit, particularly the mobile crawler stage that is not attached to the surface of the fruit. However, eggs (under the scale of the female), sessile nymphs and adults of *C. rusci* around the stem end of the fruit may not be removed as it is has been reported that soft scales are difficult to remove from fruits (Bakr *et al.* 2009).
- *Ceroplastes rusci* has been intercepted on 17 or 18 occasions on fruit, cut flowers and growing plants imported into the UK from Europe (mostly Italy), South America and the Caribbean (Malumphy and Anderson 2011). *Ceroplastes rusci* scales have been intercepted once on mango fruit imported into the UK from the Dominican Republic (Malumphy and Anderson 2011). However, whether the scales were alive, and on commercial fruit, were not stated.
- The fact that *C. rusci* has been intercepted on a range of fruits and plant material imported into the UK (Malumphy 2010) indicates that it is possible it can survive commercial storage and transportation conditions. Mangoes are typically transported at moderate temperatures of 12 °C to 14 °C (DPIF Northern Territory 2015) that are unlikely to cause significant mortality.

Infestations of *C. rusci* usually occur on the foliage, stems and branches of its host plants but occasionally on fruit. *Ceroplastes rusci* is mainly a pest of fig, citrus and kiwi fruit although it is occasionally found on mango fruit. *Ceroplastes rusci* has been recorded once on mango fruit intercepted at an international border although it is not clear whether this was on commercial quality fruit. The relatively large size of the adult females ranging from 4 mm to 5 mm in length would make it likely many adult scales, including eggs beneath the scale, would be detected during packing house processes. The mobile crawler stages are likely to be removed during routine pack house processes. However, the small size of sessile nymphs may result in these early stages remaining attached to the fruit and undetected during routine packing house processes. If *C. rusci* is associated with commercial fruit, it is likely to survive the storage and transportation temperatures of 12 °C to 14 °C. Although *C. rusci* is recorded from Indonesia and Vietnam, there are no reports of this scale associated with or causing damage to mango plants in Indonesia or Vietnam.

Taking account of the limited records of *Ceroplates rusci* in the export countries and only a single record of the scale associated with commercial fruit, all support a likelihood estimate for importation of 'low'.

Likelihood of distribution

The likelihood that *Ceroplastes rusci* will be distributed within Australia in a viable state as a result of the processing, sale or disposal of fresh mango fruit from Indonesia, Thailand and Vietnam and subsequently transfer to a susceptible part of a host has been assessed as: **Low**.

The following information provides supporting evidence for this assessment.

- Mango fruit may be distributed throughout Australia for retail sale, as the intended use of the commodity is for human consumption.
- As packed mangoes are usually not processed or handled again until they arrive at the retailers, sessile nymphs of *C. rusci* could be present on the mango fruit and remain undetected on fruit during transportation and distribution to retailers.

- Waste material would be generated (for example, fruit skins, over-ripe or damaged fruits) and discarded over a wider area. Most fruit waste will be discarded into managed waste systems and will be disposed of in municipal tips and would therefore pose a very low risk for transmission of the scale to a susceptible host.
- Consumers will discard small quantities of fruit waste in urban, rural and the natural environment. Small amounts of fruit waste will be discarded in domestic compost. There is some potential for consumer waste to be discarded near a host plant, including commercially grown, household or feral plants.
- If present in fruit waste, *C. rusci* would then need to transfer from the mango waste to a suitable host plant. Nymphs would need to complete development to adult and then females could lay eggs that could then hatch into the mobile crawler stage. Parthenogenesis (reproduction without a mate) is common in soft scales with some species having both bisexual and parthenogenetic strains (Hamon and Williams 1984; Miller *et al.* 2007). *Ceroplastes rusci* can be parthenogenetic and therefore females would not need to find a mate to produce viable eggs (CABI 2015a).
- However, mango waste would be subject to desiccation and waste material is unlikely to be a suitable substrate for nymphal development. Sap sucking insects are known to respond negatively to plant tissues under moisture stress (Huberty and Denno 2004).
- If crawlers were present, they are known to be dispersed by wind as well as phoretically on other flying insects and birds enabling them to potentially disperse over considerable distances (Greathead 1990; Greathead 1997; Malumphy and Anderson 2011; Neumann *et al.* 2011). In established scale populations, where populations can be large, crawlers would have the opportunity to alight from host vegetation (such as shrubs and trees) that could be many metres above the ground where wind speed is likely to be much greater and therefore increasing the likelihood of successful dispersal. Under this situation, the majority of crawlers fail to be carried above the vegetation canopy and crawlers are not carried far (Hanks and Denno 1998). However, mango waste is most likely to be discarded on the ground and the dispersal of crawlers by air from mango waste would be limited even further due to the lower alighting point and lower wind speed near the ground.
- *Ceroplastes rusci* is highly polyphagous being recorded on host plants belonging to 77 genera in 49 plant families, including many economic crops, ornamentals and amenity plants (Ben-Dov 2014a). These host plants are widely available in Australia.
- Eggs and the crawler stage are environmentally vulnerable and mortality is generally highest during these stages (Beardsley Jr and Gonzalez 1975; Marotta 1997). Failure to settle is considered to be one of the major mortality factors for many species of soft scales (Beardsley Jr and Gonzalez 1975; Marotta 1997).

The wide range of host plants available in Australia increase the likelihood of mango waste being discarded near a suitable host. However, it is unlikely the mobile crawler stage is associated with mango waste to allow successful dispersal. Sessile nymphs that could be associated with mango waste are unlikely to develop to adult and therefore it is unlikely that eggs, and then crawlers, would be produced. If crawlers were associated with mango waste it is likely the ability to disperse by air currents would be limited by the location of waste near the ground. This information supports a likelihood estimate for distribution of 'low'.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *Ceroplastes rusci* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Very low**.

4.4.2 Likelihood of establishment

The likelihood that *Ceroplastes rusci* will establish within Australia based on a comparison of factors in the source and destination areas that affect pest survival and reproduction has been assessed as: **High**.

The following information provides supporting evidence for this assessment.

- *Ceroplastes rusci* is broadly polyphagous, occurring on host plants belonging to 77 genera in 49 plant families. Host plants include avocado, banana, cotton, fig, grape, guava, lemon, lychee, mango, orange, pear, quince and rambutan as well as ornamentals such as *Crataegus* (hawthorn), *Nerium* (oleander), *Platanus orientalis* (Oriental plane), *Pittosporum*, *Populus* (poplar), *Prunus* and *Salix* (willow) (Ben-Dov 2014a). It is most common on *Citrus*, *Ficus*, *Myrtus*, *Nerium* and *Pistacia* (Pellizzari and Camporese 1994). All of these host plants are widely grown commercially and domestically in Australia.
- *Ceroplastes rusci* occurs widely in tropical, subtropical and warm temperate areas. It is distributed throughout the Mediterranean basin, parts of Africa, Europe, Canary Islands, Madeira, the Azores, the Caribbean, as well as Indonesia, Vietnam, China and Florida, USA (Malumphy and Anderson 2011; Wang *et al.* 2014; Ben-Dov 2014a). Environments with climates similar to these regions exist in various parts of Australia indicating that *C. rusci* has the potential to establish particularly in the northern regions of Australia.
- *Ceroplastes rusci* can reproduce sexually as well as parthenogenetically, that is reproduction without a mate (Hamon and Williams 1984; Miller *et al.* 2007). Therefore, *C. rusci* does not need to find a mate to successfully found a population in a newly introduced area.
- The size of the female influences fecundity and females can usually produce from 800 to 1500 eggs (CABI 2015a). This high reproductive rate will increase the likelihood of rapid population increase in newly introduced areas.
- *Ceroplastes rusci* produces one or two generations per year in temperate regions (Pellizzari and Camporese 1994; CABI 2015a) but four generations are known to occur throughout the year in tropical to subtropical countries (Vu *et al.* 2006).
- Natural enemies such as parasitic wasps of the families Aphelinidae, Encyrtidae, Eulophidae and Pteromalidae, predators such as ants (such as *Oecophylla smaragdina*), ladybirds, a noctuid moth larva (*Eublemma amabilis*) and entomopathogenic fungi (Vu *et al.* 2006; Awamleh *et al.* 2009; Kumar 2013; CABI 2015a) are known to exert limited control over *C. rusci*. Suitable natural enemies may be present in Australia, but their potential impact is unknown.

Ceroplastes rusci is capable of surviving and reproducing on a wide variety of host plants that include commercially grown crops as well as several commonly grown ornamental and amenity plants in Australia. *Ceroplastes rusci* reproduces both sexually and parthenogenetically (reproduction without a mate). It has a high reproductive rate and is capable of producing up to four generations per year in warmer regions thus allowing this species to rapidly increase its population in newly introduced areas. All of these biological characteristics support a likelihood estimate for establishment of 'high'.

4.4.3 Likelihood of spread

The likelihood that *Ceroplastes rusci* will spread within Australia, based on a comparison of factors in the source and destination areas that affect the expansion of the geographic distribution of the pest has been assessed as: **Moderate**.

The following information provides supporting evidence for this assessment.

- *Ceroplastes rusci* is highly polyphagous, being recorded on many host plants including economically important plants, ornamentals and amenity plants (Ben-Dov 2014a). These host plants are widely grown commercially and domestically in Australia.
- Adults are sessile remaining securely attached to plant surfaces (leaves, stems, twigs and fruits). Dispersal of *C. rusci* to previously uninfested areas may occur by transport of fruit or nursery stock infested with nymphs and adults. *Ceroplastes rusci* has been intercepted on 17 or 18 occasions on fruit, cut flowers and growing plants imported into the UK from Europe (mostly Italy), South America and the Caribbean (Malumphy 2010; Malumphy and Anderson 2011).
- Commercial nursery stock is usually well managed and may limit to movement of *C. rusci* by this pathway. However, nursery stock moved by passengers and the general public is typically not regulated, particularly within a State.
- Once established, crawlers of scale insects are known to be dispersed by wind as well as phoretically on other flying insects and birds enabling them to potentially disperse over considerable distances (Ross *et al.* 2010; Neumann *et al.* 2011).
- Eggs and the crawler stage are environmentally vulnerable and mortality is highest during these stages (Beardsley Jr and Gonzalez 1975; Marotta 1997). Natural barriers in Australia, including arid environments and climatic gradients, are likely to limit the natural spread of *C. rusci*.
- There are many species of soft scale already present in Australia that are considered pests and existing management measures are likely to minimise the impact of *C. rusci* in commercial situations (Smith *et al.* 1997).
- *Ceroplastes rusci* is distributed throughout the Mediterranean basin, parts of Africa, Europe, the Canary Islands, Madeira, the Azores, the Caribbean, as well as Indonesia, Vietnam, China and Florida, USA (Malumphy and Anderson 2011; Wang *et al.* 2014; Ben-Dov 2014a). This suggests that there are suitable environments with climates similar to these regions existing in various parts of Australia suggesting that *C. rusci* has the potential to spread in Australia.

The main dispersal stage is the first instar or crawler which can actively crawl over short distances or be carried in air currents or on other animals (birds, other insects). Long distance dispersal is likely to be in trade particularly of ornamental nursery plants such as palms, *Strelitzia*, flowers and foliage. The suitable climatic conditions and availability of host plants in various parts of Australia, moderated by the limited natural dispersal of crawlers of *C. rusci*, the systems in place for the movement and certification of nursery stock in Australia and existing management measures for other soft scales in Australia, support a likelihood estimate for spread of 'moderate'.

4.4.4 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The overall likelihood that *Ceroplastes rusci* will enter Australia as a result of trade in fresh mango fruit fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia has been assessed as: **Very low**.

4.4.5 Consequences

The potential consequences of the establishment of *Ceroplastes rusci* in Australia have been estimated according to the methods described in Table 3.

Based on the decision rules described in Table 4, that is, where the potential consequences of a pest with respect to one or more criteria are '**D**', the overall consequences are estimated to be **Low**.

Criterion	Estimate and rationale
Direct	
Plant life or health	D—significant at the district level *Ceroplastes rusci* is an economic pest of cultivated fig and citrus in the Mediterranean Basin and is occasionally a serious pest of citrus in Israel (Ben-Dov 1988). It is the main pest of fig trees in western Turkey (Önder and Soydanbay 1984) and a pest of kiwi fruit in Italy (Pellizzari and Camporese 1994). It is a pest of mango in India (Kumar 2013), Israel (Ben-Dov 2012) and Egypt (Bakr *et al.* 2009) and a major pest of soursop (*Annona muricata*) and the culturally important Hoa Mai flower in Vietnam (Vu *et al.* 2006). Soft scales extract large amounts of plant sap, reducing plant vigour and growth, causing die back of twigs and branches, early leaf drop and sometimes death of the entire plant (Gill and Kosztarab 1997; Sharma and Buss 2011). Soft scales inject saliva that appears to be toxic to plants resulting in chlorotic, yellow or red discolouration of the leaves and fruits and/or deformation of the shoots, twigs and branches (Gill and Kosztarab 1997). They also cause indirect damage to the plants by excreting honeydew that provides a substrate for black sooty mould to grow on. This sooty mould coating interferes with photosynthesis and may cause poor growth, a reduction in fruit size and also downgrading of fruit quality and an unsightly appearance to the crop (Gill and Kosztarab 1997). *Ceroplastes rusci* may also have a limited impact on the aesthetic quality and market value of ornamental plants in the nursery trade.
Other aspects of the environment	B—minor significance at the local level There are no known direct consequences of this species on the natural or built environment but its introduction into a new environment may lead to competition for resources with native scale species. It may also have

Criterion	Estimate and rationale
	significant impacts on native flora and ecosystems.
Indirect	
Eradication, control	D—significant at the district level Indirect consequences of control or an eradication program as a result of the introduction of *C. rusci* may be: • an increase in the use of insecticides for control of the pest due to difficulties involved in estimating optimum times for application • disruption to IPM programs due to the increased need to use insecticides • adverse affects on potential predators and natural enemies of *C. rusci* • additional applications of costly pesticides that may alter the economic viability of mango crops • increases in control measures and impacts on existing production practices • subsequent increases in costs of production to producers and increased costs for crop monitoring and consultant's advice to producers.
Domestic trade	C—minor significance at the district level The presence of *C. rusci* in commercial production areas may result in interstate trade restrictions on the movement of some fruit and nursery stock, resulting in additional costs to producers. These restrictions may lead to the loss of markets.
International trade	C—minor significance at the district level The presence of *C. rusci* in commercial production areas of Australia may limit access to overseas markets where this pest is absent. Trading partners may impose phytosanitary restrictions or measures to reduce the risk of entry of *C. rusci*. These restrictions may lead to a loss of international markets.
Environmental and non-commercial	B—minor significance at the local level Additional pre-harvest pesticide applications would be required to contain and/or eradicate this pest and control it on susceptible crops. However, this is unlikely to impact on the environment, endangered or threatened species to any greater extent than already occurs from run-off into waterways from commercial mango crops due to control measures for other pests.

4.4.6 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Ceroplastes rusci*	
Overall likelihood of entry, establishment and spread	Very low
Consequences	Low
Unrestricted risk	Negligible

As indicated, the unrestricted risk estimate for *Ceroplastes rusci* has been assessed as 'negligible', which achieves Australia's ALOP. Therefore, no specific risk management measures are required for this pest.

4.5 Armoured scales

Hemiberlesia cyanophylli **(EP, WA),** ***Pinnaspis aspidistrae*** **(EP, WA),** ***Pseudaonidia trilobitiformis*** **(EP, WA),** ***Unaspis acuminata*** **(EP) and** ***Radionaspis indica***

The five species of armoured scales assessed in this risk assessment belong to the family Diaspididae. They have been grouped together because of their related biology and taxonomy, and are predicted to pose a similar risk and require similar mitigation measures if their risk is assessed as above Australia's ALOP. In this assessment, the term 'armoured scales' is used to refer to these five species. The scientific name is used when the information is about a specific species.

Hemiberlesia cyanophylli (previously *Abgrallaspis cyanophylli*), *Pinnaspis aspidistrae*, and *Pseudaonidia trilobitiformis* are not present in Western Australia and are pests of regional quarantine concern for that state. *Radionaspis indica* and *Unaspis acuminata* are not present in Australia and are pests of quarantine concern for the whole of Australia.

Female armoured scales have three life stages that include an adult, egg and nymph stage. Male armoured scales have five life stages: adult, egg, nymph, pre-pupa and pupa stages (Beardsley Jr and Gonzalez 1975; Koteja 1990). In general, scale nymphs (crawlers) settle and feed on branches, leaves and fruit of the host plant, becoming immobile as they develop into late instar nymphs (Beardsley Jr and Gonzalez 1975; Koteja 1990). The female reaches sexual maturity undergoing slight metamorphosis of the internal and external organs (Koteja 1990). The male scale, which has a pupal stage, emerges as a winged adult form (Koteja 1990) and only lives for 1–3 days (Koteja 1990). They do not feed and their primary purpose is to locate a female and mate (Koteja 1990). The adult female can reproduce with or without a male scale (Beardsley Jr and Gonzalez 1975) and will continuously produce offspring for several weeks until its death (Koteja 1990). Hatched or live-born young remain motionless under the body or scale cover of the adult female for a short period of time before emerging as crawlers. The crawler stage is the dispersal stage for armoured scales and at the end of the wandering period, crawlers secure themselves to the plant host with their mouthparts. Once settled, the crawlers draw their legs beneath the body and flatten themselves against the host to commence feeding and develop a protective covering (Beardsley Jr and Gonzalez 1975; Koteja 1990).

The risk scenario of concern for the above-listed armoured scales is the presence of crawlers, immobile juveniles or adult scales on imported fresh mango fruit from Indonesia, Thailand and Vietnam.

This assessment focuses on five armoured scale species, four species having previously been assessed for which relevant policy already exists. *Hemiberlesia cyanophylli* (previously *Abgrallaspis cyanophylli*) was assessed for mangoes from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a). *Pinnaspis aspidistrae* was assessed for mangoes from Taiwan (Biosecurity Australia 2006b) as well as limes from New Caledonia (Biosecurity Australia 2006a) and the policy adopted for mangoes from India (Biosecurity Australia 2008a). *Pseudaonidia trilobitiformis* was assessed for limes from New Caledonia (Biosecurity Australia 2006a) but not assessed for mangoes from Taiwan (Biosecurity Australia 2006b) or India (Biosecurity Australia 2008a). *Unaspis acuminata* was assessed for mangoes from Taiwan (Biosecurity Australia 2006b). It is considered that that these previous assessments can equally apply to *Radionaspis indica*. The risk assessment presented here builds on these previous assessments.

Differences in commodities, horticultural practices, climatic conditions and the prevalence of these pests between Indonesia, Thailand and Vietnam and other countries make it necessary to reassess the likelihood that the assessed armoured scale species will be imported into Australia with mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur over a similar time period that host fruit is already able to be imported from India, New Caledonia and Taiwan and for which policy exists. After importation, mangoes will be distributed throughout Australia or Western Australia for retail sale in a similar way to host fruit from India and Taiwan. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and of spread of the assessed armoured scales in Australia or Western Australia will be comparable regardless of the commodity on which these armoured scales are imported into Australia or Western Australia, as these likelihoods relate specifically to events that occur in Australia or Western Australia and are independent of the importation pathway. The consequences they may cause are also largely independent of the importation pathway. Accordingly there is no need to re-assess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for armoured scales in the existing policies for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a), Pakistan (Biosecurity Australia 2011b) and limes from New Caledonia (Biosecurity Australia 2006a). Therefore, those risk ratings will be adopted for this assessment.

4.5.1 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 *Radionaspis indica* and *Unaspis acuminata* will arrive in Australia or that *Hemiberlesia cyanophylli*, *Pinnaspis aspidistrae* and *Pseudaonidia trilobitiformis* will arrive in Western Australia with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam has been assessed as: **High**.

The following information provides supporting evidence for this assessment.

- The assessed armoured scales are widely distributed throughout the tropical and subtropical regions of the world (Miller and Davidson 2005). *Pseudaonidia trilobitiformis* is present in all three countries (Watson 2005; Ben-Dov *et al.* 2015). *Hemiberlesia cyanophylli* and *Pinnaspis aspidistrae* are present in Indonesia and Thailand but are absent from Vietnam (Ben-Dov *et al.* 2015). *Radionaspis indica* is present only in Indonesia (Watson 2005) while *Unaspis acuminata* is present only in Thailand (Ben-Dov *et al.* 2015).

- Mango is a known host for all the assessed armoured scales (Watson 2005). In recent years, *Radionaspis indica* has assumed greater importance on mango in Florida, USA (Peña 1994).
- Most armoured scales feed on the aerial parts of their host plants (Beardsley Jr and Gonzalez 1975) especially on plant organs with a thick epidermal layer such as leaves, branches and fruit (Beardsley Jr and Gonzalez 1975; Koteja 1990).
- Armoured scales produce a hard, fibrous, impermeable, wax like covering (scale) that covers the insect (Carver *et al.* 1991) providing a protective barrier against physical and chemical damage (Foldi 1990) and strongly attaching the scale to its host plant (Burger and Ulenberg 1990). Thus chemical pest control or commercial fruit cleaning procedures undertaken in the orchard or within the packing house may not eliminate all viable scales due to the protective physical properties of the external scale covering (Foldi 1990). The normal post-harvest practice of washing fruit (Morton 1987) may remove some armoured scales on the fruit at harvest-time, but the effective removal of all scales may be difficult.
- First instar nymphs, also known as crawlers, are capable of movement onto fruit where they permanently attach and commence feeding (Beardsley Jr and Gonzalez 1975). Subsequent instars under the scale cover are sessile remaining attached to the host plant (Koteja 1990). Adult females remain securely attached to the plant surfaces (leaves, stems, twigs and fruits) throughout life (Blank *et al.* 1993).
- Armoured scales are very small in size, the adult female scale of the species assessed here range in length from 0.5 mm to 3.0 mm in length while the adult male is smaller ranging in length from 0.8 mm to 1.8 mm in length (Watson 2005). Their small size may make them difficult to detect, especially at low population densities and as they settle around the stem end of mango fruit blending in with the colour of the fruit skin (Morse *et al.* 2009).
- *Pseudaonidia trilobitiformis* has been intercepted on mangoes imported into the USA on numerous occasions (USDA-APHIS 2006) demonstrating that post-harvest cleaning and washing will not remove all armoured scales and quality control inspectors in the packing house may miss some infested fruit.
- Inspection procedures carried out within the packing house are concerned primarily with fruit quality (detection of blemishes, bruising or skin damage) rather than the detection of small insect pests present on the fruit surface especially at low population levels.
- Armoured scales overwinter as eggs, first instar nymphs or adult females (Beardsley Jr and Gonzalez 1975) in temperate regions and are likely to survive the temperatures that mangoes are transported and stored at.

Hemiberlesia cyanophylli, *Pinnaspis aspidistrae*, *Pseudaonidia trilobitiformis*, *Radionaspis indica* and *Unaspis acuminata* are widely distributed throughout tropical and subtropical Asia. Mango is a known host for all of these assessed armoured scales. These armoured scales are very small in size making them difficult to detect during harvesting and packing house processes at low population densities. The temperatures that mangoes are transported and stored are unlikely to affect the viability of these armoured scales. One of the assessed species has been intercepted on numerous occasions on commercial mango consignments into the USA demonstrating that post-harvest cleaning and washing will not remove all armoured scales. The association of armoured scales with mango fruit, their small size and sessile nature of most life stages as well as their previous interceptions on arrival on mangoes, all support a likelihood estimate for importation of ‘high’.

Likelihood of distribution

As indicated, the likelihood of distribution for the armoured scales assessed here would be the same as that for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). It is considered that *Radionaspis indica* would have the same likelihood of distribution, that is **Moderate**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *Radionaspis indica* and *Unaspis acuminata* will enter Australia or that *Hemiberlesia cyanophylli*, *Pinnaspis aspidistrae* and *Pseudaonidia trilobitiformis* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Moderate**.

4.5.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for the assessed armoured scales is being based on the assessment for mango fruit from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a). Those assessments used the same methodology as described in Chapter 2 of this report. It is considered that *Radionaspis indica* would have the same likelihood of establishment and spread. The ratings from the previous assessments are:

Likelihood of establishment:	**High**
Likelihood of spread:	**Moderate**

4.5.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The overall likelihood that *Radionaspis indica* and *Unaspis acuminata* will enter Australia or that *Hemiberlesia cyanophylli*, *Pinnaspis aspidistrae* and *Pseudaonidia trilobitiformis* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia or Western Australia and subsequently spread within Australia or Western Australia has been assessed as: **Low**.

4.5.4 Consequences

The potential consequences of the establishment of *Radionaspis indica* and *Unaspis acuminata* in Australia or *Hemiberlesia cyanophylli*, *Pinnaspis aspidistrae* and *Pseudaonidia trilobitiformis* in Western Australia are being based on the assessments for mango fruit from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). *Radionaspis indica* is considered to have a similar impact. The overall consequences have been estimated to be **Low**.

4.5.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Hemiberlesia cyanophylli, Pinnaspis aspidistrae, Pseudaonidia trilobitiformis, Radionaspis indica and Unaspis acuminata*	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very Low

As indicated, the unrestricted risk estimate for *Hemiberlesia cyanophylli, Pinnaspis aspidistrae, Pseudaonidia trilobitiformis, Radionaspis indica and Unaspis acuminata* has been assessed as 'very low', which is achieves Australia's ALOP. Therefore, no specific risk management measures are required for these pests.

4.6 Red-banded mango caterpillar

***Deanolis sublimbalis* (EP)**

Deanolis sublimbalis previously known as *Noorda albizonalis* and *Autocharis albizonalis* belongs to the family Pyralidae. It is commonly referred to as the red-banded mango caterpillar because the larva is distinctively marked with alternating red and white bands along its body and is a serious pest of mangoes wherever this fruit is grown in South-East Asia, including in Indonesia, Thailand and Vietnam (Duc and Hao 2001; Van Mele *et al.* 2001; Krull and Basedow 2006; Gibb *et al.* 2007; DOA Thailand 2011; IAQA 2011a).

Deanolis sublimbalis is a moth that has four life stages: egg, larva, pupa and adult (CABI 2015a). Larvae bore into both young and maturing mango fruits, feeding on the seed and fruit pulp (Krull and Basedow 2006).

Since 1990 it has been detected on several Torres Strait Islands and is now known to occur at several locations on the far northern tip of Cape York Peninsula, Queensland, Australia (CSIRO 2005; Royer 2009) and is under official control (Royer 2008; QDAF 2013). A quarantine area has been established to restrict the movement of mango fruit and plant materials (Royer 2008; QDAF 2013).

The risk scenario of concern for the red-banded mango caterpillar is the presence of eggs around the base of the peduncle and early instar larvae in fresh mango fruit from Indonesia, Thailand and Vietnam.

Deanolis sublimbalis was assessed in the existing import policy for mango fruit from India (Biosecurity Australia 2008a) and for the extension of existing policy for mango fruit from the Philippines (Biosecurity Australia 2010). The risk assessment presented here builds on these previous assessments.

Differences in horticultural practices, climatic conditions and the prevalence of *D. sublimbalis* between previous export areas in India and the Philippines make it necessary to reassess the likelihood that *D. sublimbalis* will be imported into Australia with mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur over a similar time period that mango fruit is already able to be imported from India and the Philippines and for which policy exists. After importation, mangoes will be distributed throughout Australia for retail sale in a similar way to those for mangoes from India and the Philippines. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and spread of *D. sublimbalis* in Australia, will be comparable for any mango imported into Australia, as these likelihoods relate specifically to events that occur in Australia and are independent of the importation pathway. The consequences that *D. sublimbalis* may cause are also independent of the importation pathway. Accordingly, there is no need to reassess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for *D. sublimbalis* in the existing policies for mangoes from India and the Philippines (Biosecurity Australia 2008a; Biosecurity Australia 2010). Therefore, those risk ratings will be adopted for this assessment.

4.6.1 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 *Deanolis sublimbalis* will arrive in Australia with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam has been assessed as: **Low**.

The following information provides supporting evidence for this assessment.

- *Deanolis sublimbalis* has been reported on mangoes in Indonesia, Thailand and Vietnam (Kuroko and Lewvanich 1993; Waterhouse 1993; Zhang 1994; Van Mele *et al.* 2001; PPD 2009; DOA Thailand 2011; IAQA 2011a; CABI 2015a).
- Studies of its biology have demonstrated that *D. sublimbalis* can only develop in the fruit of mango (Krull and Basedow 2006). Attempts to rear this species on mango leaves, shoots or stems have all failed (Golez 1991).
- *Deanolis sublimbalis* causes crop losses ranging from 10–52 per cent in India, 30–40 per cent in Indonesia and Papua New Guinea, and 40–50 per cent in the Philippines and South-East Asia (Golez 1991; Waterhouse 1998; Tenakanai *et al.* 2006; Sahoo and Jha 2009; Bhattacharyya 2014a; Bhattacharyya 2014b).
- In Vietnam, damage of *D. sublimbalis* has previously been wrongly attributed to the fruit fly *Bactrocera dorsalis*. Eighty-nine per cent of mango growers in the Mekong Delta consider *D. sublimbalis* to be a serious pest of mango (Duc and Hao 2001; Van Mele *et al.* 2001).
- Krull and Basedow (2006) found that 98 per cent of eggs were laid on the peduncle or non-fruiting vegetative branches of mango trees while only a small proportion of the eggs (1.92 per cent) were laid on fruit.
- Eggs are laid in small crevices on the peduncle, on non-fruiting vegetative branches close to the fruit, or on the fruit itself (Golez 1991; Krull and Basedow 2006; Royer 2008; Bhattacharyya 2014a). Eggs are typically laid on fruit of marble size (Krull and Basedow 2006) or rarely on mature fruit and always in crevices such as on dried anthracnose spots. No eggs were recorded on the leaves (Krull and Basedow 2006).
- After 3–4 days, larvae hatch and burrow into the distal (apical) end of the mango fruit (Golez 1991). Larvae pass through 5 instars within the fruit, with a larval development period of 14–20 days (Golez 1991). Mature larvae enter a quiescent pre-pupal stage that lasts 2–3 days followed by a pupal period ranging from 9–14 days (Golez 1991). The total life cycle takes 28–55 days depending upon cultivars and season (Golez 1991; Tenakanai *et al.* 2006). There are 3 to 4 overlapping generations that emerge continuously during the fruiting season.
- The first and second larval instars feed on the fruit pulp beneath the rind forming a network of tunnels which may eventually cause the fruit to collapse (Golez 1991). Later instar larvae tunnel toward the seed where they feed on the seed (Golez 1991; Kuroko and Lewvanich 1993; Krull and Basedow 2006; Royer 2008; Bhattacharyya 2014a). Up to 11 larvae have

been found in a single fruit, however larvae disperse in search of fresh fruit as the food source runs out (Tenakanai *et al.* 2006). Commonly, there is only a single larva in a fruit (Waterhouse 1998).

- Fully grown larvae leave the fruit in search of suitable sites for pupation, and pupate in dead wood on the tree, or in cracks and crevices in the bark of infested host trees, (Leefmans and Van der Vecht 1930; Golez 1991; Butani 1993; Srivastava 1997; Waterhouse 1998; Krull and Basedow 2006; Royer 2008; Sahoo and Jha 2009; Bhattacharyya 2014a) or in the soil (QDAF 2013) where they pass the off-season.
- Pupation in fruit was not observed in surveys by Sujatha and Zaheruddeen (2002) and Krull and Basedow (2006). Reports of pupation inside mango fruit in India (Sengupta and Behura 1957) are most likely to be misidentification of larvae not kept until adult emergence to confirm identification (Krull and Basedow 2006).
- Adult emergence appears to be triggered by the onset of flowering (Pinese 2015) or synchronised with early mango fruit development, although the mechanism is unknown (Golez 1991).
- Damaged fruit may be attacked secondarily by fruit flies or various fungal and bacterial organisms and may fall from the tree prematurely (QDAF 2013).
- Fruit infested at a young stage of development are misshapen and may abort. Although *D. sublimbalis* caterpillars feed internally, all fruit found to be infested with *D. sublimbalis* during a survey have shown some external signs of damage (Royer 2009).
- Damage is conspicuous as sap oozing from entry holes and the presence of a sap stain running from the larval bore hole to the fruit apex (Golez 1991; Tenakanai *et al.* 2006). Frass may also be deposited around the hole and infested fruits may split at the apex and develop longitudinal cracks (Krull and Basedow 2006). However, early signs of infestation may not be seen easily (Plant Health Australia 2013) with only a small entry hole and pale sap stain (Royer 2008).
- Early infested fruit that are most prone to egg-laying would not mature to harvestable fruit. This is due to the larvae completely consuming such small fruit and being then forced to infest new mango fruit to complete their development.
- Infested fruit with obvious symptoms is likely to be graded out during harvesting and grading operations. However, late infested fruit with early instars and non-symptomatic infested fruit may remain undetected.
- Infestation of fruit by *D. sublimbalis* caterpillars can be controlled by synthetic pyrethroid insecticidal sprays (Golez 1991). However, these will not have any impact on the larvae inside the mango seed.

Deanolis sublimbalis is widespread throughout South-East Asia and recorded damaging mango in Indonesia, Thailand and Vietnam. Mango is the only host that this moth can successfully complete its life cycle. This moth typically lays its eggs on fruit the size of a marble. Red-banded mango caterpillars normally completely consume these small fruit and are forced to find another fruit in which to complete their life cycle. Since early infested fruit would not mature to harvestable fruit but typically drops from the tree or shows obvious signs of infestation this would reduce the likelihood that *D. sublimbalis* would be associated with commercial quality fruit. After completing its development *D. sublimbalis* larvae exit the fruit to pupate. Any late fruit that is infested late in the season may still have further larvae present inside mango fruit close to harvest time. Such fruit is unlikely to show any signs of infestation and is unlikely to be detected by packing house procedures. However, *D. sublimbalis* rarely lays eggs on mature fruit. The ability of the pest to survive management procedures, its potential cryptic life cycle with some early instar larvae developing inside the fruit, moderated by the fact that mature larvae leave the fruit to pupate and the likelihood that the majority of infested fruit would not be of commercial quality and show obvious signs of infestation at harvest supports a likelihood estimate for importation of 'low'.

Likelihood of distribution

As indicated, the likelihood of distribution for *D. sublimbalis* assessed here would be the same as that for fresh mango fruit from India (Biosecurity Australia 2008a) and the Philippines (Biosecurity Australia 2010), that is **Moderate**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *D. sublimbalis* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Low**.

4.6.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for *D. sublimbalis* is based on the assessment for mango fruit from India (Biosecurity Australia 2008a) and the Philippines (Biosecurity Australia 2010). Those assessments used the same methodology as described in Chapter 2 of this report. The ratings from the previous assessments are:

Likelihood of establishment	**Moderate**
Likelihood of spread	**Moderate**

4.6.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The overall likelihood that *D. sublimbalis* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia has been assessed as: **Low**.

4.6.4 Consequences

The potential consequences of the establishment of *Deanolis sublimbalis* in Australia is being based on the assessments for mango fruit from India (Biosecurity Australia 2008a) and the Philippines (Biosecurity Australia 2010). The overall consequences have been estimated to be **Moderate**.

4.6.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Deanolis sublimbalis*	
Overall likelihood of entry, establishment and spread	Low
Consequences	Moderate
Unrestricted risk	Low

As indicated, the unrestricted risk estimate for *Deanolis sublimbalis* has been assessed as ‘low’, which is above Australia’s ALOP. Therefore, specific risk management measures are required for this pest.

4.7 Mango thrips

Rhipiphorothrips cruentatus (EP)

Rhipiphorothrips cruentatus (Mango thrips) belongs to the thrips family Thripidae.

Thrips are small, slender insects that are only a few millimetres long, with membranous wings delicately fringed with long hairs (Mound and Heming 1991; Lewis 1997). *Rhipiphorothrips cruentatus* has four main life stages: egg (that is inserted into the green tissue of plants), two active larval instars that feed, followed by two relatively inactive pupal instars that normally do not feed, and adult of one or both sexes which may be winged or wingless (Rahman and Bhardwaj 1937; Jensen *et al.* 1992; Roques 2006). The life cycle and development of *Rhipiphorothrips cruentatus* are dependent on optimum temperature and relative humidity conditions (Rahman and Bhardwaj 1937; Aslam *et al.* 2001; Kulkarni *et al.* 2007).

The risk scenario of concern for *R. cruentatus* is the presence of larvae and adult thrips on fresh mango fruit from Indonesia, Thailand and Vietnam.

Rhipiphorothrips cruentatus was assessed in the existing import policy for mango fruit from Taiwan (Biosecurity Australia 2006b) which was adopted for mango fruit from India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). It was also assessed for table grapes from China (Biosecurity Australia 2011a). However, the risk rating for the likelihood of importation for table grapes from China was assessed as 'high' due to table grape bunches having more places for thrips to hide and thus escape detection. The risk assessment presented here builds on these previous assessments.

Differences in commodities, horticultural practices, climatic conditions and the prevalence of this pest between Indonesia, Thailand and Vietnam and other countries make it necessary to reassess the likelihood that *R. cruentatus* will be imported into Australia with fresh mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur over a similar time period that mango fruit is already able to be imported from India, Pakistan and Taiwan and for which policy exists. After importation, mangoes will be distributed throughout Australia for retail sale in a similar way to those mangoes from India, Pakistan and Taiwan. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and of spread of *R. cruentatus* in Australia, will be comparable for any mango imported into Australia, as these likelihoods relate specifically to events that occur in Australia and are independent of the importation pathway. The consequences that *R. cruentatus* may cause are also independent of the importation pathway. Accordingly there is no need to reassess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for *Rhipiphorothrips cruentatus* in the existing policies for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). Therefore, those risk ratings will be adopted for this assessment.

4.7.1 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 *Rhipiphorothrips cruentatus* will arrive in Australia with the importation of fresh mango fruit from Indonesia, Thailand and Vietnam has been assessed as: **Moderate**.

The following information provides supporting evidence for this assessment.

- *Rhipiphorothrips cruentatus* is widespread in south Asia (CABI 2015a). It has been recorded from Thailand (Waterhouse 1993) but no records were found of its presence in Indonesia or Vietnam. It is known to attack mango in India (Srivastava 1997) and Pakistan (Buriro 2006).
- *Rhipiphorothrips cruentatus* is a blossom pest that causes damage by laying eggs in the panicle and feeding on floral parts of mango (Lee and Wen 1982; Srivastava 1997).
- Feeding and egg-laying typically results in visible morphological changes in affected tissues. *Rhipiphorothrips cruentatus* sucks sap from the epidermis of leaves and fruit of mango, with affected areas becoming darkly stained or scar formation being produced on the fruit surface (Lee and Wen 1982). *Rhipiphorothrips cruentatus* feeds almost exclusively on the lower surface of leaves, and the larvae often occur in groups (CABI 2015a). Damaged leaves turn silver in colour before gradually turning brown with leaves being coated in spots of thrips excreta (CABI 2015a).
- *Rhipiphorothrips cruentatus* adults are extremely small, often less than 1.5 mm long and yellow to blackish-brown in colour (CABI 2015a). Thrips tend to be inconspicuous, hiding in cryptic habitats such as the crevices found at the stem end of fruit.
- Mangoes packed for export typically consist of the fruit and a very short (approximately 0.3 to 0.5 cm) pedicel attached to the top of the fruit. The morphology of the fruit does not provide many hiding places for thrips, but it is possible thrips present around the pedicel may be difficult to detect at harvest.
- Post harvest grading, washing and quality inspection procedures undertaken in the packing house are likely to detect fruit with blemishes, bruising or damage to the skin, which will be discarded. Heavy damage to the fruit could be obvious. However, the damage caused by thrips at low population levels may be difficult to detect during routine packing house inspection procedures.
- Thrips have been recorded on produce entering the Netherlands from 30 different countries over a thirteen year period from 1980 to 1983 (Morse and Hoddle 2006). The United States has reported the interception of 102 species of Thripidae at its ports of entry over the period 1983 to 1999 from Europe, the Mediterranean and Africa (Nickle 2003). Japan has also reported the interception of at least 138 species of Thripidae, although their interception frequency was not reported (Hayase 1991; Oda and Hayase 1994; Masumoto *et al.* 1999; Masumoto *et al.* 2003; Masumoto *et al.* 2005). This indicates that thrips are capable of surviving transport conditions.

The small size, cryptic behaviour and inconspicuous colouring of adult and larval *R. cruentatus* may lead to it escaping detection at harvest. Packing house procedures are likely to reduce the numbers of adults and larvae of *R. cruentatus* present on mango fruit. Eggs are laid in the panicle or leaf of mango while the adults and larvae feed on the floral parts and leaves. Adults and larvae feed by puncturing and sucking cell contents from the epidermis of leaves and fruit of their host plants. Eggs are not associated with mango fruit and the presence of obvious symptoms caused by large thrips populations would result in fruit being rejected at the packing house. Inspite of the obvious symptoms caused by large thrips populations the difficulty of finding such small insects during standard packing house quality assurance procedures and inspection, and the ability to survive transport conditions; all support a likelihood estimate for importation of 'moderate'.

Likelihood of distribution

As indicated, the probability for *Rhipiphorothrips cruentatus* assessed here would be the same as that for *R. cruentatus* for mangoes from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b), that is **Moderate**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *Rhipiphorothrips cruentatus* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Low**.

4.7.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for *R. cruentatus* is being based on the assessment for *R. cruentatus* on mango fruit from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). The ratings from the previous assessments are:

Likelihood of establishment	**High**
Likelihood of spread	**High**

4.7.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The overall likelihood that *Rhipiphorothrips cruentatus* will enter Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Australia and subsequently spread within Australia has been assessed as: **Low**.

4.7.4 Consequences

The potential consequences of the establishment *Rhipiphorothrips cruentatus* in Australia have been estimated previously for mango fruit from Taiwan (Biosecurity Australia 2006b), India

(Biosecurity Australia 2008a) and Pakistan (Biosecurity Australia 2011b). The overall consequences have been estimated to be **Low**.

4.7.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Rhipiphorothrips cruentatus*	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very low

As indicated, the unrestricted risk estimate for *Rhipiphorothrips cruentatus* has been assessed as ‘very low’, which achieves Australia’s ALOP. Therefore, no specific risk management measures are required for this pest.

4.8 Mango scab

Elsinoë mangiferae (EP, WA)

The fungus *Elsinoë mangiferae* Bitanc. & Jenkins, belongs to the family Elsinoaceae and causes mango scab disease. There are no reports of it affecting plants other than mango (Ploetz *et al.* 1994; CABI 2015a). Mango scab was first reported from Cuba and Florida, USA, and later from Puerto Rico and Panama. Now it is found in most of the mango growing areas around the world, including South East Asia (Conde *et al.* 2007). Mango scab was first identified in Australia in 1997, near Darwin and it appears to have been in the Northern Territory and Queensland since at least the early 1990s but was thought to be a form of flower anthracnose (Conde *et al.* 2007). *Elsinoë mangiferae* is not present in Western Australia and is a pest of regional concern for that state. It is regulated as a prohibited disease in Western Australia (Government of Western Australia 2014).

Elsinoë mangiferae is a biotrophic fungus, which means it will only survive on living plant tissue. Young leaf, twig, flower and fruit tissues are preferentially infected (Ploetz *et al.* 1994). In general, host tissues become increasingly resistant as they mature and fruit is no longer susceptible to infection after it reaches about half size (Conde *et al.* 2007).

This fungus produces two types of spores: ascospores (the sexual stage); and conidia (the asexual stage). The asexual stage of the mango scab fungus is also referred to by another name, *Denticularia mangiferae* (synonym: *Sphaceloma mangiferae*). The sexual stage of mango scab has rarely been detected and plays a minor role in infection and spread of the disease (Ploetz *et al.* 1994). The asexual conidia of *Elsinoë* are responsible for the bulk of the infection of host tissues. High humidity and free moisture are required for the production of spores and for host infection (Ploetz *et al.* 1994).

The risk scenario of concern for *Elsinoë mangiferae* is that infected or contaminated mango fruit may not have been detected during harvesting or during sorting and packing house processes.

Elsinoë mangiferae was assessed in the existing import policy for mango fruit from Taiwan (Biosecurity Australia 2006b) and adopted for India (Biosecurity Australia 2008a). The risk assessment presented here builds on this previous assessment.

Differences in horticultural practices, climatic conditions and the prevalence of this pest between Indonesia, Thailand and Vietnam and other countries make it necessary to reassess the likelihood that *Elsinoë mangiferae* will be imported into Western Australia with mangoes from Indonesia, Thailand and Vietnam.

The importation of fresh mango fruit from Indonesia, Thailand and Vietnam is expected to occur over a similar time period that mango fruit is already able to be imported from India and Taiwan and for which policy exists. After importation, mangoes will be distributed throughout Australia including Western Australia for retail sale in a similar way to those mangoes from India and Taiwan. Therefore, it is considered unnecessary to reassess the likelihood of distribution.

The likelihood of establishment and of spread of *Elsinoë mangiferae* in Western Australia, will be comparable for any mango imported into Australia, as these likelihoods relate specifically to events that occur in Australia and are independent of the importation pathway. The consequences that *E. mangiferae* may cause are also independent of the importation pathway. Accordingly there is no need to re-assess these components of the risk.

In addition, the Australian Government Department of Agriculture has reviewed the latest literature and no new information is available that would significantly change the risk ratings for distribution, establishment, spread and consequences as set out for *E. mangiferae* in the existing policy for mangoes from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a). Therefore, those risk ratings will be adopted for this assessment.

4.8.1 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 *Elsinoë mangiferae* will arrive in Australia with the importation of fresh mango fruit from Indonesia, Thailand or Vietnam has been assessed as: **Low**.

The following information provides supporting evidence for this assessment.

- *Elsinoë mangiferae* is present in Indonesia (Suputa *et al.* 2010), Thailand (CABI 2015a) and Vietnam (PPD 2009).
- The conidia of *E. mangiferae* can only infect young succulent host tissues (Conde *et al.* 2007; CABI 2015a). In general host tissues become increasingly resistant as they mature (Ploetz *et al.* 1994). Mango fruit are no longer susceptible to infection after they reach about half size (Conde *et al.* 2007). Further, sorting and other commercial practices in place in the packing houses will eliminate any immature, undeveloped and infected fruit being packed.
- Signs of scab on young leaves are small, circular to angular spots which turn from dark-brown to black. Numerous small brown lesions or shot holes on young leaves may cause their defoliation. Spots on mature leaves are larger, slightly raised with brown margins and dirty white centres. Stem lesions are grey 1–2 mm in diameter, slightly raised and irregular in shape. Large, tan and corky areas resembling scar tissue may be present in the infected stems (Horst 2008). However, mango consignments are expected to be free of stems, branches and leaves.
- Most noticeable symptoms are on the fruit, which vary depending on the mango cultivars. Newly-set fruit develops small black lesions and heavy infestations may cause fruit drop. The scabs of multiple lesions may coalesce to form large irregular scars. The infestation could cause depression of the area surrounding the larger lesions resulting in fruit distortion (Conde *et al.* 2007).
- Due to visible symptoms of the disease on any mature fruit, most infected fruit would be removed during harvesting and packing house procedures. However, some fruit with minor symptoms may not be observed and be exported (CABI 2015a).
- The occurrence of all symptoms is dependent on the availability of free water when the tissue is at the susceptible stage. Some of the symptoms can be confused with physical or insect injury or infection with other diseases (Conde *et al.* 2007; CABI 2015a).

- It is only during wet weather that the characteristic, pale-brown growth of the conidiophores and conidia on active lesions has been found (CABI 2015a).
- *Elsinoë mangiferae* is likely to survive storage and transportation. Partially developed infection may progress to visible lesions ranging from small black spots to small or large scarred areas during storage and transport (CABI 2015a).

Young mango tissue is particularly susceptible to infection by *E. mangiferae.* The host tissues of mango become increasingly resistant to infection from *E. mangiferae* as they mature. Mango fruit are no longer susceptible after they reach about half size. Although the symptoms of mango scab are easily visible on infected mature fruits, some fruit with minor symptoms may not be detected and removed during harvest and packing house procedures. Fruit that is heavily infected drops prematurely and even if present at harvest would show obvious symptoms including distortion. This would significantly reduce the likelihood that *E. mangiferae* would be associated with commercial quality fruit. This supports a likelihood estimate for importation of 'low'.

Likelihood of distribution

As indicated, the likelihood of distribution for *E. mangiferae* assessed here would be the same as the existing policy for fresh mango fruit from Taiwan (Biosecurity Australia 2006b) and India (Biosecurity Australia 2008a) that is **Moderate**.

Overall likelihood of entry

The overall likelihood of entry is determined by combining the likelihood of importation with the likelihood of distribution using the matrix of rules shown in Table 2.

The likelihood that *Elsinoë mangiferae* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam and be distributed in a viable state to a susceptible host has been assessed as: **Low**.

4.8.2 Likelihood of establishment and spread

As indicated, the likelihood of establishment and of spread for *E. mangiferae* is being based on the assessment for mango fruit from Taiwan (Biosecurity Australia 2006b) that was adopted for India (Biosecurity Australia 2008a). That assessment used the same methodology as described in Chapter 2 of this report. The ratings from the previous assessment are:

Likelihood of establishment	**Moderate**
Likelihood of spread	**Moderate**

4.8.3 Overall likelihood of entry, establishment and spread

The overall likelihood of entry, establishment and spread is determined by combining the likelihoods of entry, of establishment and of spread using the matrix of rules shown in Table 2.

The overall likelihood that *E. mangiferae* will enter Western Australia as a result of trade in fresh mango fruit from Indonesia, Thailand and Vietnam, be distributed in a viable state to a susceptible host, establish in Western Australia and subsequently spread within Western Australia has been assessed as: **Low**.

4.8.4 Consequences

The potential consequences of the establishment *E. mangiferae* in Western Australia have been estimated previously for mango fruit from Taiwan (Biosecurity Australia 2006b). The overall consequences have been estimated to be **Low**.

4.8.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the outcome of overall consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 5.

Unrestricted risk estimate for *Elsinoë mangiferae*	
Overall likelihood of entry, establishment and spread	Low
Consequences	Low
Unrestricted risk	Very low

As indicated, the unrestricted risk estimate for *Elsinoë mangiferae* has been assessed as 'very low', which achieves Australia's ALOP. Therefore, no specific risk management measures are required for this pest.

4.9 Pest risk assessment conclusions

Key to Table 9 (starting next page)

Genus species (EP): pests for which policy already exists. The outcomes of previous assessments and/or reassessments in this IRA are presented in Table 9

Genus species (Acronym for state/territory): state/territory in which regional quarantine pests have been identified

P[EES] overall probability of entry, establishment and spread

URE unrestricted risk estimate. This is expressed on an ascending scale from negligible to extreme.

Table 9 Summary of unrestricted risk estimates for quarantine pests associated with fresh mango fruit from Indonesia, Thailand and Vietnam

Pest name	Likelihood of						Consequences	URE
	Entry			**Establishment**	**Spread**	**P[EES]**		
	Importation	Distribution	**Overall**					
Mango weevils [Coleoptera: Curculionidae]								
Sternochetus gravis (EP)	High	Low	**Low**	Moderate	Moderate	Low	Moderate	**Low**
Sternochetus mangiferae (EP, WA)								
Sternochetus olivieri								
Fruit flies [Diptera: Tephritidae]								
Bactrocera carambolae (EP)	High	High	**High**	High	High	High	High	**High**
Bactrocera correcta (EP)								
Bactrocera dorsalis (EP)								
Bactrocera zonata (EP)								
Mealybugs [Hemiptera: Pseudococcidae]								
Dysmicoccus neobrevipes (EP)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**
Paracoccus marginatus (EP)								
Planococcus lilacinus (EP)								
Planococcus minor (EP, WA)								
Pseudococcus cryptus (EP)								
Pseudococcus jackbeardsleyi (EP)								
Rastrococcus iceryoides (EP)								
Rastrococcus invadens (EP)								
Rastrococcus rubellus								
Rastrococcus spinosus (EP)								
Soft scales [Hemiptera: Coccidae]								
Ceroplastes rusci	Low	Low	**Very low**	High	Moderate	Very low	Low	**Negligible**

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	P[EES]		
	Importation	Distribution	**Overall**					
Armoured scales [Hemiptera: Diaspididae]								
Abgrallaspis cyanophylii (EP, WA)	High	Moderate	**Moderate**	High	Moderate	Low	Low	**Very low**
Pinnaspis aspidistrae (EP, WA)								
Pseudaonidia trilobitiformis (EP, WA)								
Radionaspis indica								
Unaspis acuminata (EP)								
Moths [Lepidoptera: Pyralidae]								
Deanolis sublimbalis (EP)	Low	Moderate	**Low**	Moderate	Moderate	Low	Moderate	**Low**
Thrips [Thysanoptera: Thripidae]								
Rhipiphorothrips cruentatus (EP)	Moderate	Moderate	**Low**	High	High	Low	Low	**Very low**
Fungi [Myriangiales: Elsinoaceae]								
Elsinoë mangiferae (EP, WA)	Low	Moderate	**Low**	Moderate	Moderate	Low	Low	**Very low**

5 Pest risk management

This chapter provides information on the management of quarantine pests identified with an unrestricted risk exceeding Australia's appropriate level of protection (ALOP). The proposed phytosanitary measures are described in this chapter.

5.1 Pest risk management measures and phytosanitary procedures

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests for Australia where they have been assessed to have an unrestricted risk above Australia's ALOP. In calculating the unrestricted risk, existing commercial production practices in Indonesia, Thailand and Vietnam have been considered, as have post-harvest procedures and the packing of fruit.

In addition to existing commercial production practices of Indonesia, Thailand and Vietnam for mango fruit and minimum border procedures in Australia, specific pest risk management measures, including operational systems, are proposed to achieve Australia's ALOP.

In this chapter, the Australian Government Department of Agriculture has identified risk management measures that may be applied to consignments of fresh mango fruit sourced from Indonesia, Thailand and Vietnam.

5.1.1 Pest risk management for quarantine pests

The pest risk analysis identified the quarantine pests listed in Table 10 as having an unrestricted risk above Australia's ALOP.

Table 10 Phytosanitary measures proposed for quarantine pests for fresh mango fruit from Indonesia, Thailand and Vietnam

Pest	Common name	Measures
Mango weevils		
Sternochetus gravis (= *S. frigidus*) (EP)	Mango pulp weevil	Irradiation at a minimum of 400 Gy **a** OR Area freedom **b**
Sternochetus mangiferae (EP, WA)	Mango seed weevil	
Sternochetus olivieri	Mango seed boring weevil	
Fruit flies		
Bactrocera carambolae (EP)	Carambola fruit fly	Irradiation at a minimum of 150 Gy OR Vapour heat treatment (fruit pulp temperature) at either 46.5 °C for 30 minutes or 47.5 °C for 20 minutes
Bactrocera correcta (EP)	Guava fruit fly	
Bactocera dorsalis (EP)	Oriental fruit fly	
Bactrocera zonata (EP)	Peach fruit fly	
Mealybugs		
Dysmicoccus neobrevipes (EP)	Annona mealybug	Irradiation at a minimum of 400 Gy OR Visual inspection and if found remedial action **c**
Paracoccus marginatus (EP)	Papaya mealybug	
Planococcus lilacinus (EP)	Coffee mealybug	
Planococcus minor (EP, WA)	Pacific mealybug	
Pseudococcus cryptus (EP)	Citriculus mealybug	
Pseudococcus jackbeardsleyi (EP)	Jack Beardsley mealybug	
Rastrococcus iceryoides (EP)	Downy snowline mealybug	
Rastrococcus invadens (EP)	Mango mealybug	
Rastrococcus rubellus	Oriental mealybug	
Rastrococcus spinosus (EP)	Philippine mango mealybug	
Red-banded mango caterpillar		
Deanolis sublimbalis (EP)	Red-banded mango caterpillar	Irradiation at a minimum of 400 Gy OR Area freedom **b** OR Systems approach AND Visual inspection and if found remedial action **c**

a Gy abbreviation for gray, the SI unit of the absorbed dose of ionizing radiation. **b** Area freedom may include pest free areas, pest free places of production, pest free production sites. **c** Remedial action (depending on the location of the inspection) may include treatment of the consignment to ensure that the pest is no longer viable or withdrawing the consignment from export to Australia. **EP** (existing policy) pests that have previously been assessed by Australia and policy already exist. **WA** pests of quarantine concern for Western Australia.

This non-regulated analysis builds on the existing policy for mango fruit from Taiwan (Biosecurity Australia 2006b), India (Biosecurity Australia 2008a; Biosecurity Australia 2011c), Pakistan (Biosecurity Australia 2011b), the Philippines (Biosecurity Australia 2010), Haiti and Mexico. These policies include all of the pest groups identified in Table 10.

Trade in mangoes from Mexico, Pakistan and India has taken place over the last five years. The policies for fresh mango fruit from India and the Philippines were reviewed after India requested an alternative phytosanitary measure to irradiation and the Philippines requested access for the province of Davao del Sur based on area freedom for pests of quarantine concern to Australia and measures prescribed to maintain freedom from these pests.

Equivalent management measures have been considered for the same or similar pests and proposed in this report. Thus, the management options proposed in this report are consistent with the existing policies.

This draft non-regulated analysis report proposes that when the following pest management measures are applied, the unrestricted risk for all identified quarantine pests assessed achieves Australia's appropriate level of protection (ALOP). The draft report proposes a number of risk management measure options that include:

- irradiation for mango weevils, fruit flies, mealybugs and red-banded mango caterpillar
- vapour heat treatment for fruit flies
- visual inspection and remedial action for mealybugs
- systems approach and visual inspection and remedial action for red-banded mango caterpillar
- area freedom (including pest free areas, pest free places of production and pest free production sites) for mango weevils and red-banded mango caterpillar.

Management for mango weevils (*Sternochetus gravis*, *S. mangiferae and S. olivieri*)

Sternochetus gravis, *S. mangiferae* and *S. olivieri* were assessed to have an unrestricted risk estimate that exceeds Australia's ALOP. Measures are therefore required to manage the risk. *Sternochetus mangiferae* (mango seed weevil) is a quarantine pest only for Western Australia.

The Australian Government Department of Agriculture proposes the options of irradiation treatment or area freedom as management measures. The objective of either one of these measures is to reduce the likelihood of importation of *S. gravis*, *S. mangiferae* and *S. olivieri* to at least 'very low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Proposed measure 1. Irradiation treatment

The International Plant Protection Convention (IPPC) acknowledges the application of ionising irradiation as a phytosanitary treatment for regulated pests or articles in ISPM 18: Guidelines for the use of irradiation as a phytosanitary measure (FAO 2003). Irradiation dose rates up to a maximum of 1000 Gy are permitted for quarantine purposes for a range of tropical fruits, including mango, in the Food Standards Australia and New Zealand Code in Standard 1.5.3: Irradiation of Food (FSANZ 2015).

The objective of irradiation is to prevent the introduction or spread of the identified pests by causing inactivation or mortality of the pests; preventing their successful development; or ensuring their inability to reproduce (FAO 2003).

All consignments of fresh mango fruit are to be irradiated prior to export. Irradiation as a phytosanitary measure for fresh mango fruit from Indonesia, Thailand and Vietnam is to be applied to achieve a minimum response of sterility in the targeted pests.

Australia accepts irradiation as an effective phytosanitary measure for insect pests, including mango seed weevil and mango pulp weevil associated with mango fruits from India. Australia requires that mango fruit receive a minimum absorbed dose rate of 400 Gy and for this to be applied in accordance with ISPM 18 (FAO 2003). A minimum absorbed dose rate of 400 Gy is required for mango pulp weevil in view of the lack of specific data supporting a lower irradiation dose. The minimum absorbed dose rate of 400 Gy is considered sufficient to achieve sterility for all quarantine insect pests of mango identified in this review of policy. Note that lower irradiation doses would be appropriate for mango seed weevil (300 Gy) (Follett 2001). This is consistent with minimum dose rates approved by the United States (71 FR 4451-4464, Docket No. 03-077-2).

Australia also uses irradiation to mitigate the risk of fruit flies (150 Gy) (FAO 2009) and pests of Class Insecta (400 Gy–other than Lepidopteran pupae and adults) for the export of Australian mangoes to New Zealand and the United States. Australia also has access for mangoes to Indonesia under irradiation, as per The Regulation of Minister of Agriculture Number: 42/Permentan/OT.140/6/2012.

Proposed measure 2. Area freedom

The Australian Government Department of Agriculture proposes area freedom (including pest free areas, or pest free places of production or pest free production sites) or alternative measures proposed by Indonesia, Thailand and Vietnam and approved by the Australian Government Department of Agriculture as a measure to reduce the risks associated with these pests to at least 'very low', which would achieve Australia's ALOP.

The proposed measure is consistent with the existing policy for fresh mango fruit from the Philippines (Biosecurity Australia 2010) and India (Biosecurity Australia 2011c).

Area freedom (may include pest free areas, pest free places of production or pest free production sites) is a measure that might be applied to manage the risk posed by the three *Sternochetus* weevil species. The requirements for establishing pest free areas or pest free places of production are set out in ISPM 4: Establishment of pest free areas (FAO 1995) and ISPM 10: Requirements for the establishment of pest free places of production and pest free production sites (FAO 1999).

Mango fruit for export to Australia would need to be sourced from export orchards free of these pests. This measure would require systems to be put in place for the establishment, maintenance and verification of orchard freedom from *Sternochetus gravis*, *S. mangiferae* and *S. olivieri* under the supervision of the NPPO of the relevant country. The inspection and monitoring of trees in the export orchard at appropriate times to detect evidence of these pests must be undertaken and supported by appropriate documentation. The inspection method appropriate for these pests, including details of the timing and size of the sampling to be undertaken for each orchard, would be developed by the relevant country's NPPO and subject to approval by the Australian Government Department of Agriculture. Results of the inspections would subsequently be made available to the Australian Government Department of Agriculture for auditing purposes.

If *Sternochetus gravis*, *S. mangiferae* or *S. olivieri* is detected in any export orchard, fruit from that export orchard will not be eligible for the export program to Australia.

To manage any potential contamination from the processing of fruit destined to domestic or other export markets, processing equipment in packing houses must be suitably cleaned prior to the commencement of processing fruit for export to Australia.

Management for fruit flies (*Bactrocera carambolae*, *B. correcta*, *B. dorsalis*, *B. zonata*)

Bactrocera carambolae, *B. correcta*, *B. dorsalis* and *B. zonata* were assessed to have an unrestricted risk estimate that exceeds Australia's ALOP. Measures are therefore required to manage the risk.

The Australian Government Department of Agriculture proposes the options of irradiation treatment or vapour heat treatment as management measures. The objective of either one of these measures is to reduce the likelihood of importation of *Bactrocera carambolae*, *B. correcta*, *B. dorsalis* and *B. zonata* to at least 'extremely low'. The restricted risk would then be reduced to at least 'very low', which would achieve Australia's ALOP.

Proposed measure 1. Irradiation treatment

The Australian Government Department of Agriculture proposes that mango fruit receive a minimum absorbed dose rate of 150 Gy (see more detail above) as an effective disinfestation treatment for fruit flies. When a dose of 150 Gy is used for fruit flies, a measure other than irradiation is required to manage the risk of other pests of quarantine concern (for example, visual inspection and remedial action for mealybugs).

Proposed measure 2. Vapour heat treatment

Vapour heat treatment (VHT) is used as an effective disinfestation treatment for fruit fly species in certain fruits in international trade. Australia accepts VHT as an effective phytosanitary measure for the disinfestation of fruit flies on this pathway associated with mango fruits from India, the Philippines and Taiwan. Mango fruit from India may be treated at or above either 46.5 degrees Celsius (fruit pulp temperature) for 30 minutes or 47.5 degrees Celsius for 20 minutes. Mango fruit from Taiwan must be treated at or above 46.5 degrees Celsius (fruit pulp temperature) for a minimum of 30 minutes. Australia also uses VHT to mitigate the risk of fruit flies for the export of Australian mangoes to China and Japan.

The Australian Government Department of Agriculture understands that Vietnam has conducted VHT efficacy trials for the fruit flies of concern on the fresh mango fruit pathway. Evaluation of such a VHT treatment will require a submission that details the proposed VHT schedule and suitable information to support efficacy.

Management for mealybugs

Dysmicoccus neobrevipes, *Paracoccus marginatus*, *Planacoccus lilacinus*, *Pl. minor*, *Pseudococcus cryptus*, *Ps. jackbeardsleyi*, *Rastrococcus iceryoides*, *R. invadens*, *R. rubellus* and *R. spinosus* were assessed to have an unrestricted risk estimate that exceeds Australia's ALOP. Measures are therefore required to manage the risk. *Planococcus minor* (Pacific mealybug) is a quarantine pest only for Western Australia.

The Australian Government Department of Agriculture proposes the options of irradiation treatment or visual inspection and remedial action as management measures. The objective of either one of these measures is to reduce the likelihood of importation of the above listed mealybugs to at least ‘low’. The restricted risk would then be reduced to at least ‘very low’, which would achieve Australia’s ALOP.

Proposed measure 1. Irradiation treatment

The Australian Government Department of Agriculture proposes that mango fruit receive a minimum absorbed dose rate of 400 Gy (see more detail above) as an effective disinfestation treatment for mealybugs.

Proposed measure 2. Visual inspection and remedial action

The Australian Government Department of Agriculture proposes visual inspection as a measure for these pests. The objective of the proposed visual inspection is to detect consignments of mango fruit from Indonesia, Thailand and Vietnam infested with these pests are identified and subjected to appropriate remedial action. This measure is considered to reduce the risk associated with these pests to at least ‘very low’, which would achieve Australia’s ALOP.

The proposed measure is consistent with the existing policy for fresh mango fruit from Taiwan (Biosecurity Australia 2006b), the Philippines (Biosecurity Australia 2010), India (Biosecurity Australia 2011c) and Pakistan (Biosecurity Australia 2011b).

All mango fruit consignments for export to Australia must be inspected by the relevant country’s NPPO and found free of these quarantine arthropod pests. Export lots or consignments found to contain any of these pests must be subject to remedial action. Remedial action prior to export may include withdrawing the consignment from export to Australia or, if available, approved treatment of the export consignment to ensure that the pest is no longer viable.

Management for red-banded mango caterpillar (*Deanolis sublimbalis*)

Deanolis sublimbalis (Red-banded mango caterpillar) was assessed to have an unrestricted risk estimate that exceeds Australia’s ALOP. Measures are therefore required to manage the risk.

The Australian Government Department of Agriculture proposes the options of irradiation treatment, area freedom or a systems approach as management measures. The objective of either one of these measures is to reduce the likelihood of importation of *D. sublimbalis* to at least ‘very low’. The restricted risk would then be reduced to at least ‘very low’, which would achieve Australia’s ALOP.

Proposed measure 1. Irradiation treatment

The Australian Government Department of Agriculture proposes that mango fruit receive a minimum absorbed dose rate of 400 Gy (see more detail above) as an effective treatment for eggs and larvae of *Deanolis sublimbalis* (note: based on current information, irradiation at 400 Gy is not a suitable treatment for pupae and adults of this species).

Proposed measure 2. Area freedom

The Australian Government Department of Agriculture proposes area freedom (including pest free areas, or pest free places of production or pest free production sites) or alternative measures proposed by Indonesia, Thailand and Vietnam and approved by the Australian Government Department of Agriculture as a measure to reduce the likelihood of importation to 'very low' and the overall risk associated with this pest to at least 'very low', which would achieve Australia's ALOP.

Australia has previously assessed *Deanolis sublimbalis* in the policies for fresh mango fruit from India (Biosecurity Australia 2008a; Biosecurity Australia 2011c) and the Philippines (Guimaras Island) (AQIS 1999) (Davao del Sur, Mindanao Island) (Biosecurity Australia 2010). The proposed measure is consistent with the existing policy for fresh mango fruit from the Philippines (Biosecurity Australia 2010) and India (Biosecurity Australia 2011c).

The requirements for establishing pest free areas or pest free places of production are set out in ISPM 4: Establishment of pest free areas (FAO 1995) and ISPM 10: Requirements for the establishment of pest free places of production and pest free production sites (FAO 1999).

Proposed measure 3. Systems approach

The Australian Government Department of Agriculture proposes the following systems approach based on orchard control and surveillance, fruit bagging, and visual inspection and remedial actions to reduce the likelihood of importation to 'very low' and the overall risk associated with this pest to at least 'very low', which would achieve Australia's ALOP.

Component 1 of systems approach: Orchard monitoring and control

Registered growers are to implement an orchard control program (for example integrated pest management (IPM) programs) for export mangoes. Programs are to be approved by the relevant country's NPPO, and incorporate monitoring and appropriate pest management (for example, pesticide applications) for *Deanolis sublimbalis*.

The relevant country's NPPO is responsible for ensuring that export mango growers are aware of *Deanolis sublimbalis* and that the export orchards are subject to suitable management measures. Registered growers are required to keep records of control measures for auditing.

Component 2 of systems approach: Fruit bagging

The Australian Government Department of Agriculture proposes mandatory fruit bagging as a risk management measure (as part of the systems approach) for *Deanolis sublimbalis*.

For mangoes from Indonesia, Thailand or Vietnam fruit bagging is required with a bag to be placed over individual mango fruit at first fruit thinning, to minimise the risk of this pest against late season egg laying. Fruit infested prior to bagging will display obvious symptoms and would not mature to produce harvestable fruit. Pest control measures are applied at a suitable time prior to bagging to ensure that the orchards in general and the developing fruit in particular, are free from pests when bagged. Mango fruit must be harvested with the bags still attached and only be removed post harvest.

The Australian Government Department of Agriculture considers the systems approach will reduce the likelihood of importation to at least 'very low' and reduce the restricted risk estimate associated with this pest to a 'very low' level to meet Australia's ALOP.

5.1.2 Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2013), the Australian Government Department of Agriculture will consider any alternative measure proposed by the Indonesian Agricultural Quarantine Agency (IAQA), the Thailand Department of Agriculture (DOA) or the Plant Protection Department (PPD), Ministry of Agriculture and Rural Development, Vietnam, providing that it achieves Australia's ALOP. Evaluation of such measures or treatments will require a technical submission from the relevant country's NPPO that details the proposed treatment and including suitable information to support 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 mango fruit from Indonesia, Thailand and Vietnam. This is to ensure that the proposed risk management measures have been met and are maintained

5.2.1 A system of traceability to source orchards

The objectives of this proposed procedure are to ensure that:

- mangoes are sourced only from orchards producing commercial quality fruit
- orchards from which mangoes are sourced can be identified so investigation and corrective action can be targeted rather than applying it to all contributing orchards in the event that viable quarantine pests are intercepted.

It is proposed that the Indonesian Agricultural Quarantine Agency (IAQA), Thailand's Department of Agriculture (DOA) and Vietnam's Plant Protection Department (PPD) establish a system to enable traceability back to the orchards where mangoes for export to Australia are sourced from. The IAQA, DOA and PPD would be responsible for ensuring that export mango growers are aware of pests of quarantine concern to Australia and control measures.

5.2.2 Registration of packing house and treatment providers and auditing of procedures

The objectives of this recommended procedure are to ensure that:

- mangoes are sourced only from packing houses and treatment providers processing commercial quality fruit approved by the relevant NPPO
- references to the packing house and the orchards source (by name or a number code) are clearly stated on cartons of mangoes destined for export to Australia for trace back and auditing purposes
- treatment providers are capable of applying a treatment that suitably manages the target pest.

It is proposed that export packing houses and the relevant treatment providers (where applicable) are registered with IAQA, DOA and PPD before the commencement of harvest each season. The list of registered packing houses and treatment providers must be kept by IAQA, DOA and PPD.

IAQA, DOA and PPD would be required to ensure that packing houses and the registered providers are suitably equipped to carry out the specified phytosanitary activities and treatments. Records of IAQA, DOA and PPD audits would be made available to the Australian Government Department of Agriculture upon request.

Where mangoes undergo fruit treatment prior to export, this process can only be undertaken by treatment providers that have been registered with and approved by IAQA, DOA and PPD for the purpose.

Approval for treatment providers is subject to availability of suitable equipment and facilities to carry out the treatment.

All irradiation facilities must be audited by the Australian Government Department of Agriculture.

5.2.3 Packaging and labelling

The objectives of this recommended procedure are to ensure that:

- mangoes proposed for export to Australia and all associated packaging is not contaminated by quarantine pests or regulated articles
  - regulated articles are any items other than mango fruit. Regulated articles may include plant, plant product, soil and any other organisms, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved
  - in this report, mangoes are defined as mango fruit with or without stalk, but not other plant parts (section 1.2.2)
- unprocessed packing material (which may vector pests identified as not being on the pathway and pests not known to be associated with mango fruit) is not imported with the mango fruit
- all wood material used in packaging of mangoes complies with the Australian Government Department of Agriculture conditions
- secure packaging is used during storage and transport to Australia and must meet Australia's general import conditions for fresh fruits and vegetables, available on the Australian Government Department of Agriculture website
- the packaged mangoes are identifiable for the purposes of trace-back
- the phytosanitary status of mangoes must be clearly identified.

It is proposed that export packing houses and the relevant treatment providers (where applicable) ensure packaging and labelling are suitable to maintain phytosanitary status of the export consignments.

IAQA, DOA and PPD would be required to ensure all packing houses and the registered providers at the beginning of each export season are suitably equipped to carry out the specified packing and labelling requirements. Records of IAQA, DOA and PPD audits would be made available to the Australian Government Department of Agriculture upon request.

5.2.4 Specific conditions for storage and movement

The objectives of this recommended procedure are to ensure that:

- mangoes for export to Australia that have been treated and/or inspected are kept secure and segregated at all times from any fruit for domestic or other markets, untreated/non-certified product, to prevent mixing or cross-contamination
- the quarantine integrity of the consignment during storage and movement is maintained.

5.2.5 Freedom from trash

All mango fruit for export must be free from trash (for example, stem and leaf material, seeds, soil, animal matter/parts or other extraneous material) and foreign matter. Freedom from trash will be verified by the inspection procedures. Export lots or consignments found to contain trash or foreign matter should be withdrawn from export unless approved remedial action is available and applied to the export consignment and then re-inspected.

5.2.6 Pre-export phytosanitary inspection and certification by IAQA, DOA and PPD

The objectives of this recommended procedure are to ensure that:

- Australia's import conditions have been met
- all consignments have been inspected in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a 600 unit sampling rate per phytosanitary certificate or equivalent
- an international phytosanitary certificate (IPC) is issued for each consignment upon completion of pre-export inspection and treatment to verify that the relevant measures have been undertaken offshore
- each IPC includes:
  - a description of the consignment (including traceability information)
  - details of disinfestation treatments (for example, VHT) which includes date, temperature, duration, and/or attach treatment certificate (as appropriate)

and

- an additional declaration that *'The fruit in this consignment has been produced in* [insert country of origin] *in accordance with the conditions governing entry of fresh mango fruit to Australia and inspected and found free of quarantine pests'*.

5.2.7 Verification inspection by the Australian Government Department of Agriculture

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

- all consignments comply with Australian import requirements
- consignments are as described on the phytosanitary certificate and quarantine integrity has been maintained.

On-arrival in Australia, the Australian Government Department of Agriculture will undertake a documentation compliance examination to verify that the consignment is as described on the phytosanitary certificate, that required phytosanitary actions have been undertaken, and that product security has been maintained.

To verify that phytosanitary status of consignments of mangoes from Indonesia, Thailand and Vietnam meets Australia's import conditions, it is recommended that the Australian Government Department of Agriculture complete a verification inspection of all mango consignments. It is recommended that the department randomly sample 600 fruit from each consignment.

The detection of any quarantine pest or regulated article for Australia would require suitable remedial action.

5.2.8 Remedial action(s) for non-compliance

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

- any quarantine risk 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 treatment, if one is available, re-exported from Australia, or destroyed.

Separate to the corrective measures mentioned, there may be other breach actions necessary depending on the specific pest intercepted and the risk management strategy put in place against that pest in the protocol.

If product repeatedly fails inspection, the Department of Agriculture reserves the right to suspend the export program and conduct an audit of the risk management systems. The program will recommence only when the department is satisfied that appropriate corrective action has been taken.

5.3 Uncategorised pests

If an organism, including contaminant pests, is detected on mango fruit either in Indonesia, Thailand and Vietnam or on-arrival in Australia that has not been categorised, it will require assessment by the Department of Agriculture to determine its quarantine status and whether phytosanitary action is required.

Assessment is also required if the detected species was categorised as not likely to be on the import pathway. If the detected species was categorised as on the pathway but assessed as having an unrestricted risk that achieves Australia's ALOP due to the rating for likelihood of importation, then it may require reassessment. The detection of any pests of quarantine concern not already identified in the analysis may result in remedial action and/or temporary suspension of trade while a review is conducted to ensure that existing measures continue to provide the appropriate level of protection for Australia.

5.4 Review of processes

5.4.1 Verification of protocol

Prior to or during the first season of trade, the Australian Government Department of Agriculture will verify the implementation of agreed import conditions and phytosanitary measures including registration, operational procedures and treatment providers, where applicable. This may involve representatives from the Australian Government Department of Agriculture visiting areas in Indonesia, Thailand and Vietnam that produce mango fruit for export to Australia.

5.4.2 Review of policy

The Australian Government Department of Agriculture reserves the right to review the import policy after the first year of trade or when there is reason to believe that the pest or phytosanitary status relevant to mango in Indonesia, Thailand and Vietnam has changed.

IAQA, DOA and PPD must inform the Australian Government Department of Agriculture immediately on detection in country of any new pests of mango fruit that are of potential quarantine concern to Australia.

5.5 Meeting Australia's food standards

Imported food for human consumption must satisfy Australia's food standards. Australian law requires that all food, including imported food, meets the standards set out in the Australia New Zealand Food Standards Code (hereafter referred to as 'the Code'). Food Standards Australia New Zealand (FSANZ) is responsible for developing and maintaining the Code, including Standard 1.4.2, maximum residue limits (MRLs), available on the ComLaw website. The standards apply to all food in Australia, irrespective of whether it is grown domestically or imported.

If a specific chemical is used on imported foods to control pests and diseases, then any resulting residues must not exceed the specific MRLs in Standard 1.4.2 of the Code for that food.

If there is no MRL listed in the Code for a specific food (or a composite, processed food), then there must be no detectable residues in that specific food.

Where an exporting country uses a chemical for which there is no current listed Australian MRL, there are mechanisms to consider establishing an Australian MRL by harmonising with an MRL established by the Codex Alimentarius Commission (Codex) or by a regulatory authority in a recognised jurisdiction. The mechanisms include applications, submissions or consideration as part of a FSANZ proposal to vary the Code. The application process, including the explanation of establishment of MRLs in Australia, is described at the Food Standards Australia New Zealand website.

6 Conclusion

The findings of this *Draft report for the non-regulated analysis of existing policy for fresh mango fruit from Indonesia, Thailand and Vietnam* are based on a comprehensive scientific analysis of relevant literature.

The Australian Government Department of Agriculture considers that the risk management measures proposed in this report will provide an appropriate level of protection against the pests identified as associated with the trade of fresh mango fruit from Indonesia, Thailand and Vietnam.

Appendix A Initiation and categorisation for pests of fresh mango fruit from Indonesia, Thailand and Vietnam

The steps in the initiation and categorisation processes are considered sequentially, with the assessment terminating at 'Yes' for column 5 (except for pests that are present, but under official control and/or pests of regional concern) or the first 'No' for columns 6, 7 or 8.

In the final column of the table the acronyms EP, NT and WA are used. The acronym EP (existing policy) is used for pests that have previously been assessed by Australia and a policy already exists. The acronym for the state for which regional pest status is considered, such as NT (Northern Territory) or WA (Western Australia), is used to identify organisms that have been recorded in some regions of Australia, and due to interstate quarantine regulations are considered pests of regional concern.

Details of the method used in this risk analysis are given in Section 2: Method for pest risk analysis.

This pest categorisation table does not represent a comprehensive list of all the pests associated with the entire plant of an imported commodity. Reference to soilborne nematodes, soilborne pathogens, wood borer pests, root pests or pathogens, and secondary pests have not been listed or have been deleted from the table, as they are not directly related to the export pathway of fresh commodity fruit and would be addressed by Australia's current approach to contaminating pests.

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
ARTHROPODS								
Prostigmata								
Aceria mangiferae Sayed, 1946 [Eriophyidae] Mango bud mite	No records found	Yes (Waterhouse 1993; DOA Thailand 2005)	No records found	Yes. NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Brevipalpus californicus (Banks, 1904) [Tenuipalpidae] Citrus flat mite	No records found	Yes (Denmark 2012; CABI 2015a)	No records found	Yes. NSW, NT, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Brevipalpus obovatus Donnadieu, 1875 [Tenuipalpidae] Privet mite; Scarlet tea mite	Yes (Kalshoven 1981)	Yes (Beard *et al.* 2015)	No records found	Yes. NSW, Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Brevipalpus phoenicis (Geijskes, 1939) [Tenuipalpidae] Scarlet mite	Yes (CABI 2015a)	Yes (DOA Thailand 2005)	Yes (CABI 2015a)	Yes. NSW, NT, SA, WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Cisaberoptus kenyae Keifer, 1966 [Eriophyidae] Mango leaf coating mite	Yes (Knihinicki and Boczek 2002)	Yes (MAF New Zealand 1999)	No records found	Yes. NT, WA (Plant Health Australia 2001; Knihinicki and Boczek 2002)	Assessment not required	Assessment not required	Assessment not required	No
Oligonychus biharensis (Hirst, 1924) [Tetranychidae]	No records found	Yes (DOA Thailand 2005; Migeon and Dorkeld 2013)	No records found	Yes. Qld, WA (CSIRO 2005; Halliday 2013). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. On leaves (Jeppson *et al.* 1975; DOA Thailand 2005)	Assessment not required	Assessment not required	No
Oligonychus coffeae (Nietner, 1861) [Tetranychidae] Tea red spider mite	Yes (Waterhouse 1993; Migeon and Dorkeld 2013; CABI 2015a)	Yes (Waterhouse 1993; Migeon and Dorkeld 2013)	Yes (Waterhouse 1993; Migeon and Dorkeld 2013)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No
Oligonychus mangiferus Rahman & Sapra, 1940) [Tetranychidae] Mango red mite	No records found	Yes (Waterhouse 1993; DOA Thailand 2005; Migeon and Dorkeld 2013)	Yes (PPD 2009)	Yes. NSW, NT, Qld, WA (CSIRO 2005; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Panonychus ulmi (Koch, 1836) [Tetranychidae] European red spider mite	No records found	No records found	Yes (Migeon and Dorkeld 2013)	Yes. NSW, SA, Tas., Vic., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Polyphagotarsonemus latus (Banks, 1904) [Tarsonemidae] Broad mite leaf	Yes (Waterhouse 1993; CABI 2015a)	Yes (DOA Thailand 2005)	Yes (FAO 2004; CABI 2015a)	Yes. NSW, NT, SA, Vic., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Tetranychus cinnabarinus (Boisduval, 1867) [Tetranychidae] Carmine spider mite	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	No records found	Yes. All states and territories (CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Tetranychus fijiensis Hirst, 1924 [Tetranychidae] Fiji spider mite	No records found	Yes (DOA Thailand 2005)	No records found	Yes. NT (Plant Health Australia 2001). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2014).	No. On leaves (DOA Thailand 2005)	Assessment not required	Assessment not required	No
Tetranychus neocaledonicus (André, 1933) [Tetranychidae] Vegetable spider mite	No records found	Yes (Migeon and Dorkeld 2013)	No records found	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No
Tetranychus taiwanicus Ehara, 1969 [Tetranychidae] Spider mite	No records found	Yes (DOA Thailand 2005)	No records found	No records found	No. On leaves (DOA Thailand 2005)	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Tetranychus urticae Koch, 1836 Synonym: *Tetranychus bimaculatus* Harvey, 1892 [Tetranychidae] Two-spotted spider mite	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001; CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Coleoptera								
Alcidodes frenatus Faust, 1894 [Curculionidae]	No records found	Yes (FAO 2007a)	Yes (PPD 2009)	No records found	No. On shoots, leaves and twigs (FAO 2007a; PPD 2009)	Assessment not required	Assessment not required	No
Amblyrhinus poricollis Schoenherr, 1826 [Curculionidae] Flower eating weevil	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Leaf and flower eating weevil (Charernsom 2003).	Assessment not required	Assessment not required	No
Apoderus crenatus Jekel, 1860 [Attelabidae] Leaf twister	No records found	Yes (Waterhouse 1993; Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. This species attacks mango (PPD 2009) but feeds only on leaves (Waterhouse 1993; PPD 2009)	Assessment not required	Assessment not required	No
Apoderus javanicus Jekel, 1860 Synonym: *Apoderus javanus* Jekel, 1860 [Attelabidae]	Yes (Kalshoven 1981; Suputa *et al.* 2010)	No records found	No records found	No records found	No. Females form leaf rolls from young leaves in which eggs are laid; larvae develop inside rolls consuming most of the rotting leaf tissue (Kalshoven 1981).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Apoderus notatus Faust, 1893 [Attelabidae] Leafrolling weevil	No records found	Yes (DOA Thailand 2005)	Yes (PPD 2009)	No records found	No. On leaves (Waterhouse 1993; DOA Thailand 2005)	Assessment not required	Assessment not required	No
Carpophilus dimidiatus (Fabricius, 1792) [Nitidulidae] Cornsap beetle	No records found	Yes (Charernsom 2003)	No records found	Yes. NSW, NT, Qld, SA, Tas., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Carpophilus hemipterus (Linnaeus, 1758) [Nitidulidae] Cornsap beetle	Yes (CABI 2015a)	Yes (Charernsom 2003)	Yes (CABI 2015a)	Yes. NSW, NT, Qld, SA, Tas.,Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Deporaus marginatus (Pascoe, 1883) Synonym: *Eugnamptus marginatus* Pascoe, 1883 [Attelabidae] Mango leaf-cutting weevil	Yes (Suputa *et al.* 2010)	Yes (DOA Thailand 2005)	Yes (PPD 2009)	No records found	No. Eggs are laid in leaf tissue (CABI 2015a); larvae mine in leaves (Rafiquzzaman and Matiti 1998), while adults feed on young leaves (Zhang *et al.* 1991; DOA Thailand 2005; PPD 2009)	Assessment not required	Assessment not required	No
Hypomeces squamosus (Fabricius, 1792) [Curculionidae]	Yes (Waterhouse 1993; Nair 2001; IAQA 2011a)	Yes (DOA Thailand 2005)	Yes (PPD 2009)	No records found	No. Larvae feed on roots; adults feed on leaves and flowers (Kalshoven 1981; Waterhouse 1993; DOA Thailand 2005; PPD 2009; IAQA 2011a)	Assessment not required	Assessment not required	No
Platytrachelus paviei Marshall, 1917 [Curculionidae]	No records found	Yes (DOA Thailand 2005)	No records found	No records found	No. On leaf (DOA Thailand 2005).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Sternochetus gravis (Fabricius, 1775) Synonym: *Sternochetus frigidus* (Fabricius, 1787) [Curculionidae] Mango pulp weevil	Yes (Waterhouse 1993; IAQA 2011a).	Yes (DOA Thailand 2011; DOA Thailand 2014)	Yes (PPD 2009)	No records found	Yes. Larval damage is not apparent in infested fruits at harvest time (de Jesus and Gabo 2000; Velasco and Medina 2004; PPD 2009; DOA Thailand 2011).	Yes. Feeds on cultivated and wild species of mango and has been reported in many countries, including India, Myanmar, Malaysia and Papua New Guinea as well as Indonesia, Thailand and Vietnam (CABI 2015a). Host plants of this species are grown across northern Australia. The host range and current geographic distribution of this pest suggests that there are suitable environments for this pest to establish and spread in Australia.	Yes. This species infests the fruit of all varieties of mango and considerably reduces the value of the mango fruit. Rate of infestation may reach up to 80% (CABI 2015a).	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Sternochetus goniocnemis (Marshall, 1926) [Curculionidae] Mango twig weevil	Yes (Kalshoven 1981; Waterhouse 1993; Suputa *et al.* 2010; CABI 2015a)	No records found	No records found	No records found	No. Larvae make short tunnels in twigs for shelter and feed on young leaf tissue adjacent to mid rib; also feed on and bore into green bark, buds and twigs (Kalshoven 1981).	Assessment not required	Assessment not required	No
Sternochetus mangiferae (Fabricius, 1775) [Curculionidae] Mango seed weevil	Yes (Waterhouse 1993; CABI 2015a)	No. Although Waterhouse (1993) and CABI (2015a) state this pest is present in Thailand the Thai Department of Agriculture (2014) have provided evidence showing *S. mangiferae* is absent and previous reports are due to the presence of *S. frigidus* (=*S. gravis*) and *S. olivieri.*	No. Although Waterhouse (1993), CABI-EPPO (1997a) and EPPO (2011) state this pest is present, CABI (2015a) state this pest's presence in Vietnam is based on an unreliable record on the advice of the Ministry of Agriculture and Rural Development, Vietnam in 2009.	Yes (Zimmerman 1994; CSIRO 2005). Under official control in WA (Poole *et al.* 2012).	Yes. Eggs are laid in young mango fruit, and larvae burrow through the pulp into the developing seeds where they feed until full-grown then pupate on the seed (Kalshoven 1981; Zimmerman 1994). No external symptoms of attack are seen on infested fruits (Kalshoven 1981).	Yes. Feeds on cultivated and wild species of *Mangifera* and has been reported in many countries in southern Asia, Africa and Central America (CABI 2015a). The host range and current geographic distribution of this pest suggests that there are suitable environments for this pest to establish and spread in Australia.	Yes. This species has a major economic impact in India (DPP 2001). All varieties of *Mangifera indica* are infested and infestation significantly reduces fruit length and circumference (CABI 2015a).	Yes (EP, WA)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Sternochetus olivieri (Faust, 1892) [Curculionidae] Mango seed boring weevil	No records found	Yes (DOA Thailand 2011; DOA Thailand 2014)	Yes (EPPO 2011)	No records found	Yes. Feeds on seed of mango (DOA Thailand 2011)	Yes. This species feeds on the seed of mango fruit (DOA Thailand 2011). The host range and current geographic distribution of this pest suggests that there are suitable environments for this pest to establish and spread in Australia.	Yes. This species infests the fruit of mango (DOA Thailand 2011) considerably reducing the value of mango fruit. The economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets and from direct yield losses due to infested fruit.	Yes
Diptera								
Atherigona orientalis Schiner, 1968 [Muscidae] Pepper fruitfly; Tomato fly	Yes (Pont 1992; CABI 2015a)	Yes (Pont 1992; CABI 2015a)	No records found	Yes. NT, Qld (Plant Health Australia 2001; CSIRO 2005). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2014).	No. Larvae are saprophagous, found in damaged plant material, including fruits that have been damaged by other pests that have initially caused a soft rot of the fruit (Pont 1992).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera carambolae Drew & Hancock, 1994 [Tephritidae] Carambola fruit fly	Yes (Drew and Hancock 1994; IAQA 2011a; CABI 2015a)	Yes (DOA Thailand 2011; Drew and Romig 2013)	Yes (Clarke *et al.* 2005; Hoa *et al.* 2010)	No records found	Yes. Eggs laid beneath the skin of mango fruit. Larvae burrow into interior of the fruit to feed on the pulp before leaving the fruit to pupate in the soil (DOA Thailand 2011; IAQA 2011b; CABI 2015a).	Yes. This species is polyphagous feeding on commercial and endemic rainforest fruits, including avocado, carambola, custard apple, guava, mango and papaya (Drew and Hancock 1994; Allwood *et al.* 1999). It is distributed throughout Andaman Islands and South-East Asia (Hoa *et al.* 2010; Drew and Romig 2013). The host range and current geographic distribution of this pest suggests that there are suitable environments for this pest to establish and spread in Australia.	Yes. This species has a very extensive host range, including many economically important hosts (CABI 2015a). The economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets and from direct yield losses due to infested fruit.	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera correcta (Bezzi, 1916) [Tephritidae] Guava fruit fly	No records found	Yes (DOA Thailand 2011; Drew and Romig 2013)	Yes (PPD 2009)	No records found	Yes. Eggs laid beneath the skin of mango; larvae bore into and develop inside the fruit (PPD 2009; DOA Thailand 2011; CABI 2015a).	Yes. A polyphagous species feeding on several economic crops including carambola, cashew, cherry, longan, guava, mango, melons, papaya, peach and plantain (CABI 2015a). It has a wide distribution in Asia ranging from China, Japan, India, Sri Lanka and Pakistan to Thailand, Myanmar and Vietnam (Drew and Romig 2013). The host range and current geographic distribution of this pest suggests that there are suitable environments for this pest to establish and spread in Australia.	Yes. Recorded from a wide range of commercial/edible host fruits (Allwood *et al.* 1999) and considered a serious pest (CABI 2015a). The economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets and from direct yield losses due to infested fruit.	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera cucurbitae (Coquillett, 1899) Note: Some researchers consider this species to belong to a separate genus, *Zeugodacus* (Virgilio *et al.* 2015) [Tephritidae] Melon fly	Yes (Drew 1982; Waterhouse 1993; CABI 2015a)	Yes (DOA Thailand 2011; Drew and Romig 2013)	Yes (Waterhouse 1993; PPD 2012; CABI 2015a)	No records for mainland Australia (Hardy and Foote 2011).	No. Adult flies of this species have been observed roosting in mango trees where they feed on honey dew produced by aphids and mealybugs (Dhillon *et al.* 2005). White and Elson-Harris (1992) considered that many host records might be based on casual observations of adults resting on plants or caught in traps set in non-host plant species. Further consideration and review of the available literature has found that there are no valid records of *B. cucurbitae* laying eggs on, or larvae developing within, commercial mango fruits.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera dorsalis (Hendel, 1912) Synonyms: *Bactrocera papayae* Drew & Hancock, 1994 (Papaya fruit fly). This species as well as *Bactrocera invadens* Drew, Tsuruta & White, 2005 and *B. philippinensis* Drew & Hancock, 1994 have recently been synonymised with *B. dorsalis* (Schutze *et al.* 2014). [Tephritidae] Oriental fruit fly	No. While some reports (Waterhouse 1993) list *B. dorsalis* as present in Indonesia, these likely refer to records before reviews of the *B. dorsalis* species complex (Clarke *et al.* 2005; Stephens *et al.* 2007).	Yes (DOA Thailand 2011; Drew and Romig 2013).	Yes (Waterhouse 1993; PPD 2009).	No. Eradicated from mainland Australia (Hancock *et al.* 2000).	Yes. Eggs are laid below the skin of the host fruit; larvae feed internally on pulp (DOA Thailand 2011; CABI 2015a).	Yes. Large host range feeding on many commercial crops including apple, guava, mango, peach and pear (CABI 2015a) and a tolerance of both forest and non-forest habitats (Allwood *et al.* 1999). Restricted to mainland Asia (except southern Thailand and West Malaysia), plus Taiwan and introduced to Hawaii (Drew and Hancock 1994; Drew and Romig 2013). The incursion of this pest (as *B. papayae*) into north Qld, which demonstrates a potential for establishment and spread during the mid-1990s, was subsequently eradicated (Cantrell *et al.* 2002).	Yes. This species is one of the most serious fruit fly pests in the Asian region with a very wide host range, including many cultivated crops such as banana, carambola, guava, mango and papaya (CABI 2015a). Damage levels range from 4–30% to as much as 100% of unprotected fruit (Peña and Mohyuddin 1997; CABI 2015a). The economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets and from direct yield losses due to infested fruit.	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera latifrons (Hendel, 1915) [Tephritidae] Solanum fruit fly	Yes (Waterhouse 1993) although no area is specified. Given that this species has been found in Sabah and West Malaysia it may at least be expected in Kalimantan and Sumatra (CABI 2015a).	Yes (Drew and Romig 2013; CABI 2015a)	Yes (Drew and Hancock 1994; CABI 2015a)	No records found	No. The report of *B. latifrons* attacking mango in Malaysia (Vijaysegaran 1991) was considered by Liquido *et al.* (1994) to be questionable and in need of verification citing a pers. comm. from R. Drew (Queensland Department of Primary Industries) who contends that this is an erroneous record based on misidentification of *B. dorsalis*. White and Elson-Harris (1992) also considered mango a doubtful record. Mango was also not found as a host based on extensive field studies conducted in Thailand and Malaysia from 1986–1994 (Allwood *et al.* 1999).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera tau (Walker, 1849) Note: Some researchers consider this species to belong to a separate genus, *Zeugodacus* (Virgilio *et al.* 2015) [Tephritidae]	Yes (Mahmood 1999; Hasyim *et al.* 2008)	Yes (Sumrandee *et al.* 2011; Drew and Romig 2013)	Yes (CABI 2015a)	No records found	No. The record of this species attacking mango fruit cited by Peña and Mohyuddin (1997) is a misinterpretation of the results that Grewal and Kapoor (1986) found during surveys of various orchards in India. *Bactrocera dorsalis* and *B. zonata* were found infesting mango fruit while *B. tau* was only reared from pears.	Assessment not required	Assessment not required	No
Bactrocera tillyardi (Perkins, 1938) [Tephritidae]	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Although Charernsom (2003) records this species on mango fruit, no details of the host record are provided and review of available literature found there is no further information to support an association of this species with commercially grown mango fruit.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera tuberculata (Bezzi, 1916) [Tephritidae]	No records found	Yes (Charernsom 2003; Drew and Romig 2013)	Yes (CABI 2015a)	No records found	No. This species is known to be a pest of peach. There is a single record (Hancock pers. comm.) in White and Elson-Harris (1992) stating mango may be a host. However, no details of the host record are provided and there is no further information to support an association of this species with commercially grown mango fruit.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bactrocera zonata (Saunders, 1841) [Tephritidae] Peach fruit fly	Absent, unreliable record (CABI 2015b)	Yes (CABI 2015b)	Yes (CABI 2015b)	No records found	Yes. Eggs laid in batches under the skin of host fruit and larvae bore their way into the interior of the host fruit feeding internally on the pulp for 1–3 weeks before emerging to pupate in the ground (FAO-IAEA 2000; CABI 2015b).	Yes. Extremely wide host range feeding on plant hosts belonging to 19 genera in 15 families including apple, citrus, fig, guava, mango, papaya and peach (White and Elson-Harris 1992; Allwood *et al.* 1999; CABI 2015b). Widespread from the Indian subcontinent across South-East Asia (Drew and Romig 2013) and a known invasive species (CABI 2015b). Susceptible hosts are grown widely across Australia. This suggests that there are suitable environments for this pest to establish and spread in areas of Australia.	Yes. Known in India and South-East Asia as a serious pest of tropical and subtropical fruits (CABI 2015b). It causes crop losses of 25–100% in peach, apricot, guava and fig crops in India and 25–50% damage to guava fruit in Pakistan (Siddiqui *et al.* 2003). In Egypt infestation rates of 20% have been recorded in apricot and citrus. This species has increased its host range to a number of important commercial crops such as citrus, mango, eggplant, tomato, apple, loquat and potatoes (El-Samea and Fetoh 2006). The economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets and from direct yield losses due to infested fruit.	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Erosomyia sp. [Cecidomyiidae]	Yes (Suputa *et al.* 2010)	Uncertain	Uncertain	Uncertain	No. Forms blister-like galls on mango leaves (Suputa *et al.* 2010)	Assessment not required	Assessment not required	No
Procontarinia mangiferae (Felt, 1911) Synonyms: *Erosomyia indica* Grover & Prasad, 1966 [Cecidomyiidae] Blossom mango gall midge	No records found	Yes (Charernsom 2003; DOA Thailand 2005)	Yes (PPD 2009) (as *Erosomyia mangiferae*)	No records found	No. On buds, young shoots, leaves, inflorescences and young fruit (PPD 2009; Amouroux *et al.* 2013; CABI 2015a), although DOA Thailand (2005) lists this species as only on the inflorescence. Larvae enter the ovaries and develop inside newly forming fruits causing fruits to turn pale, become deformed and finally drop prematurely (Srivastava 1997).	Assessment not required	Assessment not required	No
Procontarinia matteiana Kieffer & Cecconi, 1906 [Cecidomyiidae] Mango gall midge	Yes (Suputa *et al.* 2010)	No records found	No records found	No records found	No. Forms solitary or grouped blister-like galls on the upper and lower surfaces of mango leaves (Mani 1952; Askari and Bagheri 2005; Suputa *et al.* 2010; Rehman *et al.* 2013).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Procontarinia echinogalliperda (Mani, 1947) Synonym: *Amradiplosis echinogalliperda* Mani, 1947 [Cecidomyiidae] Mango gall midge	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Eggs laid on underside of leaves; larvae bore into plant tissues causing galls on the upper surface of the leaves and inflorescences (Mani 1952; Ikisan 2000; NPQS 2010).	Assessment not required	Assessment not required	No
Hemiptera								

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Abgrallaspis cyanophylli (Signoret, 1869) Synonym: *Hemiberlesia cyanophylli* (Ferris, 1938) [Diaspididae] Cyanophyllum scale	Yes (Ben-Dov *et al.* 2015)	Yes (Charernsom 2003)	No records found	Yes. NSW, NT, Qld, SA, Tas. (Plant Health Australia 2001; CSIRO 2005). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. Feeds on fruits, leaves, stems and bark of mango (Srivastava 1997; Zamudio and Claps 2005; Martin Kessing and Mau 2007).	Yes. Highly polyphagous species feeding on plant hosts belonging to 75 genera in 44 families, including avocado, banana, citrus, mango, and potato (Watson 2005). Many susceptible hosts are widespread in WA. *Abgrallaspis cyanophylli* is established in several Australian states except WA. It occurs in many parts of Asia, Europe, Africa and North and South America, indicating that the Western Australian environment would be suitable for its establishment and spread.	Yes. A pest of bananas worldwide, and of tea in Taiwan (Chua and Wood 1990). Feeds on several other commercially grown fruits including avocado, custard apple, guava, macadamia, mango and olive (Martin Kessing and Mau 2007). The potential economic consequences would only apply to WA should this species enter, establish and spread.	Yes (EP, WA)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Acanthocoris scabrator (Fabricius, 1803) [Coreidae] Squash bug	Yes (Basu and Mitra 1977; CABI 2015a)	Yes (Charernsom 2003)	Yes (Waterhouse 1993)	No records found	No. Eggs laid on under surface of leaves; adults and nymphs feed externally on young unripe mango fruits that fall from tree before maturity (Koshy *et al.* 1977; Koshy *et al.* 1978).	Assessment not required	Assessment not required	No
Aleurocanthus mangiferae Quaintance & Baker, 1917 [Aleyrodidae] Mango whitefly	No records found	Yes (Charernsom 2003)	No records found	No records found	No. On leaves (Charernsom 2003; USDA-APHIS 2006; NPQS 2010)	Assessment not required	Assessment not required	No
Aleurocanthus woglumi Ashby, 1915 [Aleyrodidae] Citrus blackfly	Yes (Kalshoven 1981; CABI 2015a)	Yes (DOA Thailand 2005)	Yes (CABI 2015a)	No records found	No. Eggs, immature instars and pupa attached to undersides of leaves (Peña *et al.* 2002; DOA Thailand 2005; CABI 2015a).	Assessment not required	Assessment not required	No
Aleuroctarthrus destructor (Mackie, 1912) Synonym: *Aleurodicus destructor* Mackie, 1912 [Aleyrodidae] Coconut whitefly	Yes (CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aleurodicus dispersus Russell, 1965 [Aleyrodidae] Spiralling whitefly	Yes (CABI 2015a)	Yes (Charernsom 2003)	Yes (CABI 2015a)	Yes. NT, Qld (Plant Health Australia 2001; CSIRO 2005). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Eggs laid in loose spiral on underside of leaves; immature stages develop on lower leaf surfaces (NPQS 2010; CABI 2015a).	Assessment not required	Assessment not required	No
Aleurolobus marlatti (Quaintance, 1903) Synonym: *Aleurolobus niloticus* Priesner & Hosny, 1934 [Aleyrodidae] Marlatt whitefly	Yes (Evans 2008)	Yes (Evans 2007)	Yes (Evans 2007)	Yes. NSW, NT (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Eggs preferentially laid on the undersurface of leaves; immature stages develop on both sides of leaves (Mahagna and Gerling 2008).	Assessment not required	Assessment not required	No
Amrasca splendens (Ghauri, 1967) [Cicadellidae]	Yes (Fletcher 2009)	Yes (DOA Thailand 2005)	No records found	No records found	No. On inflorescences (flowers) and leaves; adults and nymphs cluster on lower side of tender leaves to suck sap from midrib and side veins (DOA Thailand 2005; Rudresh *et al.* 2010)	Assessment not required	Assessment not required	No
Aonidiella aurantii (Maskell, 1879) [Diaspididae] Red scale	Yes (Ben-Dov *et al.* 2015; CABI 2015a)	Yes (Ben-Dov *et al.* 2015; CABI 2015a)	Yes (Ben-Dov *et al.* 2015; CABI 2015a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aonidiella citrina (Coquillett, 1891) [Diaspididae] Yellow scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes. NSW, Vic, SA, WA (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Aonidiella inornata McKenzie, 1938 [Diaspididae] Inornate scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	No records found	Yes. NT, Qld, WA (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Aonidiella orientalis (Newstead, 1894) [Diaspididae] Oriental red scale	Yes (Ben-Dov *et al.* 2015)	Yes (DOA Thailand 2005; Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes. NT, Qld, WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Aphis craccivora Koch, 1854 [Aphididae] Groundnut aphid	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aphis gossypii Glover, 1877 [Aphididae] Cotton aphid	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aphis spiraecola Patch, 1877 [Aphididae] Spirea aphid	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aspidiotus destructor Signoret, 1869 [Diaspididae] Coconut scale	Yes (Kalshoven 1981; IAQA 2011a; Ben-Dov *et al.* 2015)	Yes (DOA Thailand 2011)	Yes (PPD 2009)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001; Poole 2010; Ben-Dov *et al.* 2015).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aulacaspis tubercularis Newstead, 1906 [Diaspididae] White mango scale	Yes (Williams and Miller 2010; Ben-Dov *et al.* 2015)	Yes (DOA Thailand 2011)	Yes (PPD 2009)	Yes. NT, Qld, WA (Plant Health Australia 2001). Not a regulated pest for Tas. (DPIPWE Tasmania 2014).	Assessment not required	Assessment not required	Assessment not required	No
Aulacaspis vitis (Green, 1896) [Diaspididae] Mango snow scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	No records found	No. Occurs in large colonies and causes conspicuous discoloured spots and blotches on host leaves (Ben-Dov *et al.* 2015).	Assessment not required	Assessment not required	No
Calophya brevicornis (Crawford, 1919) Synonym: *Pauropsylla brevicornis* Crawford, 1919 [Psyllidae] Gall psyllid; Mango shoot gall psylla	Yes (Burckhardt and Basset 2000; Ouvrard 2015)	No records found	No records found	No (Burckhardt and Basset 2000)	No. Eggs laid in leaves; nymphs feed on stems, leaf stalks and leaf veins (Srivastava 1997; Raman *et al.* 2009).	Assessment not required	Assessment not required	No
Calophya mangiferae Burckhardt & Basset, 2000 Synonym: *Calophya nigra* (Crawford, 1919) [Psyllidae]	Yes (Ouvrard 2015)	No records found	No records found	Yes. NT (Plant Health Australia 2001)	No. On leaves (Raman *et al.* 2009)	Assessment not required	Assessment not required	No
Ceroplastes actiniformis Green, 1896 [Coccidae]	Yes (Ben-Dov 2014a)	No records found	No records found	Yes. NT (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. On leaves (Srivastava 1997; USDA-APHIS 2006)	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceroplastes ceriferus (Fabricius, 1798) [Coccidae] Indian wax scale	Yes (Ben-Dov 2014a; CABI 2015a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. NSW, Qld, WA (Qin and Gullan 1994; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Ceroplastes floridensis Comstock, 1881 [Coccidae]	Yes (Ben-Dov 2014a; CABI 2015a)	Yes (Charernsom 2003)	Yes (PPD 2009)	Yes. NSW, Qld (Qin and Gullan 1994; Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Occurs on the foliage, stems and branches (CABI 2015a). Note that PPD (2009) lists *C. floridensis* as on fruit, leaf and stem and cited the CABI datasheet as the only source. The mention of fruit as part of the plant part affected by this species in CABI most likely refers to the impact of honeydew deposited on the fruit, which serves as a medium for the growth of black sooty moulds (CABI 2015a).	Assessment not required	Assessment not required	No
Ceroplastes rubens Maskell, 1893 [Coccidae] Red wax scale	Yes (Kalshoven 1981; Ben-Dov 2014a)	Yes (DOA Thailand 2005; DOA Thailand 2011)	Yes (PPD 2009)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Qin and Gullan 1994; Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceroplastes rusci (Linnaeus, 1758) [Coccidae] Fig wax scale	Yes (CABI 2015a)	No records found	Yes (Vu *et al.* 2006; CABI 2015a)	No. This species does not occur in Australia. Its presence in Australia was based on a misidentification of *C. floridensis* (Qin and Gullan 1994). Absent, invalid record (CABI 2015a).	Yes. Infestations usually occur on foliage, stems and branches (CABI 2015a) but occasionally on fruits (Malumphy and Anderson 2011). It has been intercepted on mango fruit from the Dominican Republic in the UK (Malumphy 2010).	Yes. This pest is highly polyphagous, recorded on host plants belonging to 77 genera in 49 plant families, including avocado, banana, cotton, fig, grape, mango, orange, pear and many ornamentals (Ben-Dov 2014a). Many of these hosts are widespread throughout Australia. It is distributed throughout the Mediterranean basin, Europe, parts of Africa, the Caribbean, Indonesia, Vietnam and Florida, USA (Malumphy and Anderson 2011; Ben-Dov 2014a). This suggests that there are suitable environments for this pest to establish and spread in areas of Australia.	Yes. It is a serious pest of fruit trees in many countries including Vietnam (Vu *et al.* 2006). A pest of cultivated fig and citrus in the Mediterranean Basin and is occasionally a serious pest of citrus in Israel (Ben-Dov 1988). It is the main pest of fig trees in western Turkey (Önder and Soydanbay 1984) and a pest of kiwi fruit in Italy (Pellizzari and Camporese 1994).	Yes

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceroplastes stellifer (Westwood, 1871) Synonym: *Vinsonia stellifera* (Westwood, 1871) [Coccidae] Star scale	Yes (Kalshoven 1981; Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. NT (Qin and Gullan 1994; Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Found on the leaves of economically important trees and shrubs (Williams and Watson 1990).	Assessment not required	Assessment not required	No
Chrysomphalus aonidum (Linnaeus, 1758) [Diaspididae] Circular black scale	Yes (Ben-Dov *et al.* 2015)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. NSW, NT, Qld, Tas., WA (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Chrysomphalus dictyospermi (Morgan, 1889) [Diaspididae] Spanish red scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes (PPD 2009; Ben-Dov *et al.* 2015)	Yes. NSW, NT, Qld, SA (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. On leaves and stems; leaves are preferred feeding site (PPD 2009).	Assessment not required	Assessment not required	No
Coccus discrepans (Green, 1904) [Coccidae]	Yes (Ben-Dov 2014a)	No records found	No records found	No records found	No. On stem and leaves (USDA-APHIS 2006)	Assessment not required	Assessment not required	No
Coccus formicarii (Green, 1896) Synonym: *Taiwansaissetia formicarii* (Green, 1896) [Coccidae]	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	No records found	No records found	No. Occurs on leaves and stems of hosts (USDA-APHIS 2006)	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Coccus hesperidum Linnaeus, 1758 [Coccidae] Brown soft scale	Yes (Ben-Dov 2014a; CABI 2015a)	Yes (DOA Thailand 2011)	Yes (Ben-Dov 2014a)	Yes. All states and territories (Plant Health Australia 2001; CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Coccus longulus (Douglas, 1887) [Coccidae] Long soft scale	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	No records found	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Coccus viridis (Green, 1889) [Coccidae] Soft green scale	Yes (Kalshoven 1981; Ben-Dov 2014a; CABI 2015a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Dialeuropora decempuncta (Quaintance & Baker, 1917) [Aleyrodidae]	Yes (Suputa *et al.* 2010)	Yes (Evans 2008)	No records found	Yes. NSW, NT, Qld, Vic., WA (Martin 1999; Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Dysmicoccus brevipes (Cockerell, 1893) [Pseudococcidae] Pineapple mealybug	Yes (Kalshoven 1981; Williams and Watson 1988b; Williams 2004; Ben-Dov 2015)	Yes (Charernsom 2003; Ben-Dov 2015)	Yes (PPD 2009; Ben-Dov 2015)	Yes. NSW, NT, Qld, SA, Tas., WA (Plant Health Australia 2001; CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Dysmicoccus neobrevipes Beardsley, 1959 [Pseudococcidae] Annona mealybug	No records found	Yes (DOA Thailand 2011; Ben-Dov 2015)	Yes. Although CABI (2015a) list no records for Vietnam, Williams (2004) has examined specimens on several hosts from Vietnam.	No records found	Yes. On fruit, leaves and branches (DOA Thailand 2011)	Yes. This species feeds on a wide range of host plants and has wide distribution, being reported in Asia, the Pacific, South America and Europe (Ben-Dov 2015). The host plants and suitable climatic conditions are available in Australia for its establishment and spread.	Yes. A polyphagous species that has been reported as being a pest of pineapple in Hawaii where it is associated with pineapple wilt disease (Williams and Watson 1988b; Williams 2004).	Yes (EP)
Eucalymnatus tessellatus (Signoret, 1873) [Coccidae] Tessellated scale; Palm scale	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. NSW, NT, Qld, SA (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. On leaves and stems (USDA-APHIS 2006; NPQS 2010)	Assessment not required	Assessment not required	No
Ferrisia virgata (Cockerell, 1893) [Pseudococcidae] Striped mealybug	Yes (Williams and Watson 1988b; Williams 2004; Ben-Dov 2015)	Yes (DOA Thailand 2011)	Yes (Ben-Dov 2015)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Geococcus coffeae Green, 1933 [Pseudococcidae] Coffee root mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes. NT, SA, Tas., Vic. (Williams 1985). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Hypogeal species occurring on the roots of its host plants (Williams 2004).	Assessment not required	Assessment not required	No
Hemiberlesia lataniae (Signoret, 1869) [Diaspididae] Latania scale	Yes (Ben-Dov 2014b)	Yes (Ben-Dov 2014b)	Yes (Ben-Dov 2014b)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Hemilecanium mangiferae Kondo & Williams, 2005 [Coccidae]	No records found	Yes (Kondo and Williams 2005)	No records found	No records found	No. On surface of trunk, branches and twigs of mango (Kondo and Williams 2005).	Assessment not required	Assessment not required	No
Icerya aegyptiaca (Douglas, 1890) [Monophlebidae] Egyptian fluted scale; Breadfruit mealybug	Yes (Ben-Dov 2014c)	Yes (Ben-Dov 2014c)	No records found	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No
Icerya pulchra (Leonardi, 1907) [Monophlebidae] Fluted scale	Yes (Ben-Dov 2014c)	Yes (Charernsom 2003)	No records found	No records found	No. On leaves, shoots and stems (USDA-APHIS 2006)	Assessment not required	Assessment not required	No
Icerya purchasi Maskell, 1879 [Monophlebidae] Cottony cushion scale	Yes (CABI 2015a)	Yes (Charernsom 2003)	Yes (Ben-Dov 2014c)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Icerya seychellarum (Westwood, 1855) [Monophlebidae] Seychelles scale	Yes (Ben-Dov 2014c; CABI 2015a)	Yes (DOA Thailand 2005; Ben-Dov 2014c)	No (Ben-Dov 2014c)	Yes. NT, Qld, WA (Poole 2010; Ben-Dov 2014c; CABI 2015a).	Assessment not required	Assessment not required	Assessment not required	No
Idioscopus clavosignatus Maldonado-Caprile, 1974 [Cicadellidae]	Yes (Maldonado Capriles 1974)	Yes (Charernsom 2003)	No records found	No records found	No. *Idioscopus* species suck sap from inflorescences, tender shoots and leaves (Srivastava 1997).	Assessment not required	Assessment not required	No
Idioscopus clypealis (Lethierry, 1889) [Cicadellidae] Mango leafhopper	Yes (Waterhouse 1993; IAQA 2011a)	Yes (Waterhouse 1993; DOA Thailand 2005; CABI 2015a)	Yes (Waterhouse 1993; CABI 2015a)	Yes. Qld (Fletcher and Watson 2009). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Feeds by preference on flowers and new leaves of mango, causing wilting and flower drop (Fletcher and Dangerfield 2002; IAQA 2011a).	Assessment not required	Assessment not required	No
Idioscopus nagpurensis (Pruthi, 1930) [Cicadellidae] Mango leafhopper	No records found	Yes (Hongsaprug 1992; CABI 2015a)	No records found	No records found	No. Nymphs and adults suck phloem sap from inflorescences and leaves (CABI 2015a).	Assessment not required	Assessment not required	No
Idioscopus nitidulus (Walker, 1870) [Cicadellidae] Mango leafhopper	Yes (Waterhouse 1993; IAQA 2011a)	Yes (Charernsom 2003)	Yes (PPD 2009)	Yes. NT, Qld (Fletcher and Watson 2009). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. This species feeds by preference on new leaves and flowers of mango, causing wilting and flower drop (Fletcher and Dangerfield 2002; PPD 2009; IAQA 2011a).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Idioscopus niveosparsus (Lethierry, 1889) [Cicadellidae] Mango leafhopper	Yes (Waterhouse 1993)	Yes (Waterhouse 1993; DOA Thailand 2005)	Yes (Waterhouse 1993; Duc and Hao 2001)	No records found	No. On inflorescences and leaves (DOA Thailand 2005)	Assessment not required	Assessment not required	No
Ischnaspis longirostris (Signoret, 1882) [Diaspididae] Brown scale; Black thread scale	Yes (IAQA 2011a)	No records found	No records found	Yes. NT, Qld, SA (Plant Health Australia 2001) (Watson 2005). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Usually feeds on leaves (IAQA 2011a) and occasionally also on bark and fruit (Watson 2005).	Assessment not required	Assessment not required	No
Lawana candida (Fabricius, 1798) [Flatidae] Plant hopper	Yes (IAQA 2011a)	No records found	No records found	No records found	No. On leaves and flowers (IAQA 2011a)	Assessment not required	Assessment not required	No
Lawana conspersa (Walker, 1851) [Flatidae] Cacao planthopper	Yes (Bourgoin 2014)	Yes (Charernsom 2003)	Yes (PPD 2009; Bourgoin 2014)	No records found	No. On leaves and shoots (PPD 2009).	Assessment not required	Assessment not required	No
Lepidosaphes beckii (Newman, 1869) [Diaspididae] Purple scale	Yes (Watson 2005; CABI 2015a)	Yes (Watson 2005; CABI 2015a)	Yes (Watson 2005; CABI 2015a)	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Lepidosaphes gloverii Packard, 1869 [Diaspididae] Glover's Scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	No records found	Yes. NSW, NT, Qld, Vic. (Plant Health Australia 2001). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2014).	Assessment not required	Assessment not required	Assessment not required	No
Lepidosaphes tapleyi Williams, 1960 [Diaspididae] Glover's Scale	Yes (Ben-Dov *et al.* 2015)	No records found	No records found	No records found	No. On stem and leaf (USDA-APHIS 2006)	Assessment not required	Assessment not required	No
Leptocorisa acuta (Thunberg, 1783) [Coreidae] Rice seed bug; Paddy bug	Yes (CABI 2015a)	Yes (Charernsom 2003)	Yes (Waterhouse 1993)	Yes. NSW, NT, Qld, Tas., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Maconellicoccus hirsutus (Green, 1908) [Pseudococcidae] Pink hibiscus mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes. NT, Qld, SA, Vic., WA (Plant Health Australia 2001; Goolsby *et al.* 2002; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Mictis longicornis Westwood, 1842 Synonym: *Mictis conjunctus* Herrich-Schäffer, 1850 [Coreidae] Twig wilter; Rose coreid	Yes (Waterhouse 1993; Suputa *et al.* 2010)	Yes (CoreoideaSF Team 2015)	Yes (CoreoideaSF Team 2015) (as *Mictis conjunctus*)	No records found	No. Feeds on shoots (Kalshoven 1981).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Milviscutulus mangiferae (Green, 1889) Synonym: *Protopulvinaria mangiferae* (Green, 1889) [Coccidae] Mango shield scale	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. Qld, WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Morganella longispina (Morgan, 1889) [Diaspididae] Plumose scale	Yes (Watson 2005; Ben-Dov *et al.* 2015)	No records found	No records found	Yes. Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Frequently infests the bark of its host plants (Watson 2005) and a pest of the trunk, branches and buds of mango; severe infestations are manifested by cracking of the bark, exudation of sap and decline of upper branches (Peña 1994).	Assessment not required	Assessment not required	No
Mycetaspis personata (Comstock, 1883) [Diaspididae] Masked scale	Yes (Watson 2005; Ben-Dov *et al.* 2015)	No records found	No records found	No records found	No. Feeds on roots, stems, twigs, leaves and flowers of host plant (Srivastava 1997; NPQS 2010); occurs on the leaves (Watson 2005).	Assessment not required	Assessment not required	No
Neomelicharia sparsa (Fabricius, 1803) Synonym: *Flata sparsa* Fabricius, 1803 [Flatidae]	Yes (Medler 1999; Suputa *et al.* 2010)	No records found	No records found	No records found	No. The adults and immature stages feed on leaves, twigs and flower stalks (Suputa *et al.* 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Nezara viridula (Linnaeus, 1758) [Pentatomidae] Green stink bug	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001; CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Nipaecoccus nipae (Maskell, 1983) [Pseudococcidae] Spiked mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Charernsom 2003)	Yes (Ben-Dov 2015)	No records found	No. Occurring on the foliage of its host plants (Ben-Dov 2015). No report of this species attacking mango fruit.	Assessment not required	Assessment not required	No
Nipaecoccus viridis (Newstead, 1894) [Pseudococcidae] Spherical mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Charernsom 2003; Williams 2004)	Yes (Williams 2004; Ben-Dov 2015)	Yes. NT, Qld, WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Paracoccus marginatus Williams & Granara de Willink, 1992 [Pseudococcidae] Papaya mealybug	Yes (Herlina 2011; CABI 2015a)	Yes (Saengyot and Burikam 2011; CABI 2015a)	No records found	No records found	Yes. Occurs on leaves, stems and fruit of its host plants, including mango (Heu *et al.* 2007; Walker *et al.* 2014).	Yes. Widely distributed in Asia, North, Central and South America and some Pacific Islands. A wide range of hosts including: Acacia, garden dahlia, frangipani, gardenia, hibiscus, privet, avocado, bean, capsicum, citrus, cocoa, coffee, cotton, mango, mulberry, papaya, pineapple and tomato (CABI 2015b). The current distribution and wide host range suggest that this pest could establish and spread in Australia.	Yes. Recognised as a pest of papaya, cassava, hibiscus, eggplant, avocado, custard apple and sweet potato. Heavily infested papaya is inedible (Pantoja *et al.* 2007). Heavy infestations cause deformation of new growth, leaf yellowing, leaf curl and early fall of fruit (CABI 2015b). It has caused significant yield losses in papaya and 60 other crops (Myrick *et al.* 2014).	Yes (EP)
Parasaissetia nigra (Nietner, 1861) [Coccidae] Nigra scale	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Parlatoria camelliae Comstock, 1883 [Diaspididae] Camellia parlatoria scale	Yes (Ben-Dov *et al.* 2015)	No records found	No records found	No records found	No. On leaves (Peña and Mohyuddin 1997)	Assessment not required	Assessment not required	No
Parlatoria cinerea Hadden, 1909 [Diaspididae] Tropical grey chaff scale; Apple parlatoria	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	No records found	No. On leaves and twigs (Peña and Mohyuddin 1997).	Assessment not required	Assessment not required	No
Parlatoria pergandii Comstock, 1881 [Diaspididae] Chaff scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	No records found	Yes. NSW, Qld, Vic. (Plant Health Australia 2001; CSIRO 2005). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Recorded damaging mango plants up to 3 years of age (Chua and Wood 1990). *Parlatoria* species affect the leaves of mango (Peña and Mohyuddin 1997). Other *Parlatoria* species commonly occur on the trunk, branches, twigs and buds of mango (Peña 1993; Peña and Mohyuddin 1997).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Parlatoria pseudaspidiotus Lindinger, 1905 [Diaspididae] Vanda orchid scale; Vanda scale	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes (Ben-Dov *et al.* 2015)	Yes. NT, Qld (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. On the leaves and stems of its host plants (Peña and Mohyuddin 1997; Watson 2005).	Assessment not required	Assessment not required	No
Phenacoccus solenopsis Tinsley, 1898 [Pseudococcidae] Cotton mealybug	Yes (Muniappan *et al.* 2009; Ben-Dov 2015)	Yes (Hodgson *et al.* 2008; Muniappan *et al.* 2009)	Yes. Localised in Ho Chi Minh City (Nguyen and Huynh 2008; CABI 2015a)	Yes. Qld (Plant Health Australia 2001; Charleston and Murray 2010). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Although Germain (2010) recorded this species on mango trees, no evidence was provided for its presence on fruit. It was also not reported on mango during an extensive survey of host plants (Abbas *et al.* 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pinnaspis aspidistrae (Signoret, 1869) [Diaspididae] Aspidistra scale; Fern scale	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	No records found	Yes. ACT, NSW, Qld, SA, Tas. (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. On leaves and occasionally fruit (Miller and Davidson 1990). Mango is a host (Ben-Dov *et al.* 2015).	Yes. This species is widely distributed across Asia, Europe, North, Central and South America and Africa (Ben-Dov 2015) and is already established in parts of Australia (Plant Health Australia 2001). This species is recorded infesting hosts of 147 genera representing 66 families (Ben-Dov *et al.* 2015). The current distribution and wide host range suggest that this pest could establish and spread in Western Australia.	Yes. This species is a serious economic pest of ferns and palms and can cause economic damage to citrus, coconut and bananas (Miller and Davidson 1990). The potential economic consequences would only apply to WA should this species enter, establish and spread.	Yes (EP, WA)
Pinnaspis strachani (Cooley, 1898) [Diaspididae] Cotton white scale; Lesser snow scale	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Planococcus citri (Risso, 1813) [Pseudococcidae] Citrus mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Ben-Dov 2015)	Yes (Ben-Dov 2015)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Planococcus lilacinus (Cockerell, 1905) [Pseudococcidae] Coffee mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; CABI 2015a)	Yes (Williams 2004; CABI 2015a)	No records for mainland Australia (Ben-Dov 2015). Although detected in the Torres Strait Islands in 2008, there are quarantine measures in place to prevent its spread onto mainland Australia (Australian Government Department of Agriculture 2014).	Yes. On fruits, inflorescences, leaves and stems (Entwistle 1972).	Yes. Occurs in the Neotropical region, throughout the South Pacific, Africa (Kenya) and is widespread in South and South-East Asia (Williams 2004). Wide host range (MacLeod 2006) recorded infesting hosts of 69 genera in 35 families (Ben-Dov 2015). Susceptible hosts are present in Australia. The current distribution and wide host range suggest that this pest could establish and spread in Australia.	Yes. This species is a pest of cocoa throughout the Oriental region and also damages a wide variety of economically important crops such as Citrus, coconut, coffee, custard apple, grape, guava, mango and tamarind (MacLeod 2006; CABI 2015a).	Yes (EP)

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Planococcus minor (Maskell, 1897) [Pseudococcidae] Pacific mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes. Although CABI (2015a) list no records for Vietnam, Williams (2004) has examined specimens on several hosts from Vietnam.	Yes. ACT, NSW, NT, Qld, SA (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. This species is often intercepted on fruit imports and mango is a host (Venette and Davis 2004).	Yes. This species has a wide host range which includes agricultural crops such as banana, citrus, corn, grape, mango, potato and soybean (Venette and Davis 2004; Francis *et al.* 2012) and has a history of establishing in new regions when introduced (Venette and Davis 2004). The current distribution and wide host range suggest that this pest could establish and spread in Western Australia.	Yes. This species is common on many economically important plants, particularly cocoa, throughout its geographic range and has been recorded as a pest of cotton in Brazil (Ben-Dov 2015). The potential economic consequences would only apply to WA should this species enter, establish and spread.	Yes (EP, WA)
Pochazia antica (Gray, 1832) Synonym: *Pochazia fuscata* (Fabricius, 1794) [Ricaniidae]	Yes (Suputa *et al.* 2010) (Keuchenius 1914)	No records found	Yes (Bourgoin 2014)	No records found	No. Eggs laid on the mid-rib on the undersurface of leaves and stems. Adults and nymphs suck sap from stems and branches (Keuchenius 1914; Suputa *et al.* 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Prococcus acutissimus (Green, 1896) [Coccidae] Banana-shaped scale	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	No records found	No. Generally infests the underside of leaves, taking position alongside the leaf veins (Gill *et al.* 1977; Peña and Mohyuddin 1997).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudaonidia trilobitiformis (Green, 1896) [Diaspididae] Trilobite scale	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes. NT, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. Usually occurs on the underside of leaves (Watson 2005). However, this scale is often intercepted on mango fruit imported into the US (USDA-APHIS 2006).	Yes. Highly polyphagous species recorded from hosts belonging to 42 plant families (Watson 2005). This species probably originated in southern Asia where it is widespread and has subsequently spread (Watson 2005). It is recorded from Africa, South America, the Caribbean and South Pacific islands (Watson 2005). This species has shown an ability to establish and spread when introduced into tropical areas (Williams and Watson 1988a). The current distribution and wide host range suggest that this pest could establish and spread in Western Australia.	Yes. This species is a pest of several commercially grown commodities (USDA-APHIS 2006). The potential economic consequences would only apply to WA should this species enter, establish and spread.	Yes (EP, WA)

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Pseudaulacaspis cockerelli (Cooley, 1897) [Diaspididae] False oleander scale	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudaulacaspis pentagona (Targioni-Tozzetti, 1886) Synonym: *Diaspis pentagona* Targioni-Tozzetti, 1886 [Diaspidae] White peach scale	Yes (Kalshoven 1981; Watson 2005; Ben-Dov *et al.* 2015)	No records found	Yes (Watson 2005; Ben-Dov *et al.* 2015)	Yes. NSW, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. Occurs on stems, bark and fruit, rarely on the leaves or roots of its hosts (Miller and Davidson 1990; Watson 2005).	Yes. Polyphagous species feeding on hosts of 115 genera in 55 plant families (Watson 2005) including apple, cane berries, capsicum, citrus, currants, grape, mango, papaya, peach, persimmon, plum and several widely grown ornamental trees and shrubs (Watson 2005; Ben-Dov *et al.* 2015). This species is already established in parts of Australia (Plant Health Australia 2001). The current distribution and wide host range suggest that this pest could establish and spread in Western Australia.	Assessment not required. This pest has previously been assessed as having very low consequences (Poole *et al.* 2011).	No

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Pseudococcus cryptus Hempel, 1918 [Pseudococcidae] Citriculus mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes (PPD 2012). Although CABI (2015a) list no records for Vietnam, Williams (2004) has examined specimens on several hosts from Vietnam.	Yes. Detected at the tip of Cape York in 2007 and now present around Cairns, Qld which is south of Queensland's legislated Cape York Peninsula Pest Quarantine Area. Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. This species feeds on the branches, buds and fruit of its hosts (PPD 2012; Ben-Dov 2015).	Yes. Wide host range feeding on host plants in 41 plant families including avocado, banana, citrus, guava, lychee, mango and grape as well as several widely grown ornamental shrubs and trees (Ben-Dov 2015). Widespread in South-East Asia, east Africa, Central and South America and the Pacific (Williams 2004). The current distribution and wide host range suggest that this pest could establish and spread in Australia.	Yes. This species rapidly became a serious pest of citrus when accidentally introduced into Israel (Ben-Dov 1988; Blumberg *et al.* 1999; Williams 2004).	Yes (EP)

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Pseudococcus jackbeardsleyi Gimpel & Miller, 1996 [Pseudococcidae] Jack Beardsley mealybug	Yes (Williams 2004; Ben-Dov 2015)	Yes (Williams 2004; Ben-Dov 2015)	Yes (PPD 2012). Although CABI (2015a) list no records for Vietnam, Williams (2004) has examined specimens on several hosts from Vietnam.	No (Ben-Dov 2015). Although detected in the Torres Strait Islands in 2010 and at Weipa in 2013, there are quarantine measures in place to prevent its further spread on mainland Australia (Australian Government Department of Agriculture 2014).	Yes. On leaves, fruits, branches and trunks of its host (PPD 2012; CABI 2015a).	Yes. Wide host range feeding on 93 host plants including banana, capsicum, potato, tomato, hibiscus and orchids (Ben-Dov 2015). This invasive species of neotropical origin has spread to South East Asia and India (Williams 2004; Mani *et al.* 2013). The current distribution and wide host range suggest that this pest could establish and spread in Australia.	Yes. Reported from many vegetable, fruit and ornamental crop species (Ben-Dov 2015) and a common pest of banana, tomato, potato, pepper (Gimpel Jr and Miller 1996) and papaya (Mani *et al.* 2013). Mealybugs can directly harm hosts through their feeding.	Yes (EP)
Pseudococcus longispinus (Targioni Tozzetti, 1867) [Pseudococcidae] Long-tailed mealybug	Yes (Williams 2004; CABI 2015a)	Yes (Williams 2004)	Yes (Williams 2004)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Pulvinaria psidii Maskell, 1893 [Coccidae] Green shield scale	Yes (Ben-Dov 2014a; CABI 2015a)	Yes (CABI 2015a)	No records found	Yes. ACT, NSW, NT, Qld, SA, WA (Qin and Gullan 1992; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Radionaspis indica (Marlatt, 1908) [Diaspididae] Mango scale	Yes (Watson 2005; Ben-Dov 2014b)	No records found	No records found	No records found	Yes. Occurs on the bark (Watson 2005) but attacks fruit and buds as well as the trunks and branches of mango (Peña 1994).	Yes. Host range limited to hosts belonging to the plant family Anacardiaceae (mango), soursop and an annual herb cobbler's pegs (*Bidens pilosa*) (Watson 2005). This species probably originated from the Indian subcontinent, but has spread more widely via commerce. It has not been recorded from Europe, most of Africa, much of Asia, South America, Australia, or from many Pacific islands (Watson 2005). The current distribution and host range suggest that this pest could establish and spread in Australia.	Yes. Considered a pest of mango; it assumed greater importance on mango in USA (Florida) in recent years (Ebeling 1959; Peña 1994). The potential economic impact to Australia would arise both from quarantine restrictions imposed by important domestic and foreign markets where this pest is absent and from direct yield losses due to infested fruit.	Yes

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rastrococcus iceryoides (Green, 1908) [Pseudococcidae] Downy snowline mealybug	Yes (Waterhouse 1993; CABI 2015a)	Yes (Charernsom 2003; Williams 2004; Ben-Dov 2015)	No records found	No records found	Yes. Adults and nymphs suck the sap from the leaves, terminal shoots, inflorescences and fruit of mango (Butani 1993; Srivastava 1997; CABI 2015a).	Yes. Polyphagous species, feeding on plant hosts belonging to 72 genera in 35 families, including banana, camellia, citrus, cotton, custard apple, *Cycas*, fig, grape, frangipani, guava, mango, rambutan, rose, and sapodilla (Ben-Dov 2015). It is widespread throughout southern Asia, China and east Africa (Ben-Dov 2015; CABI 2015a). Host plants and suitable climatic conditions are available in many northern regions of Australia for its establishment and spread.	Yes. Of major economic importance in India causing damage to mango and citrus (DPP 2001) and is a pest of cotton and kapok (CABI 2015a).	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rastrococcus invadens Williams, 1986 [Pseudococcidae] Mango mealybug	Yes (Williams 2004; Ben-Dov 2015; CABI 2015a)	Yes (Charernsom 2003; Williams 2004; Ben-Dov 2015; CABI 2015a)	Yes (Williams 2004; PPD 2009; Ben-Dov 2015)	No records found	Yes. On fruit, the underside of leaves often near the mid-rib, inflorescences, trunk, and branches (Narasimham and Chacko 1991; Peña and Mohyuddin 1997; PPD 2009; CABI 2015a).	Yes. A wide host range feeding on several plant hosts belonging to 52 genera in 28 families, including Acacia, avocado, banana, breadfruit, custard apple, citrus, fig, frangipani, guava, mango and papaya. These host plants are present throughout Australia. This species is widespread throughout the tropics and subtropics of the Oriental Region and West Africa (Ben-Dov 2015). Many northern regions of Australia have similar climatic conditions to these areas suitable for the establishment and spread of this species.	Yes. A pest of economic significance on mango, citrus and other fruit trees in West Africa (Williams 1986) where it was accidentally introduced (Williams 2004; Germain *et al.* 2010). In Ghana, losses of up to 80% on mango are reported as well as losses in avocado production (Agounké *et al.* 1988).	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rastrococcus rubellus Williams, 1989 [Pseudococcidae] Oriental mealybug	Yes (Williams 2004)	No records found	No records found	No records found	Yes. On leaves and fruits of mango (Galanihe and Watson 2012).	Yes. Host range includes mango, citrus (such as orange, calamondin and grapefruit), fig, frangipani and *Mallotus paniculatus* (Ben-Dov 2015). These host plants are present throughout Australia. It is known from China (Hong Kong), Laos, Malaysia, Sri Lanka and Indonesia but may have a wider distribution in southern Asia (Williams 2004; Galanihe and Watson 2012). Tropical regions of Australia have similar climatic conditions to these areas suitable for the establishment and spread of this species.	Yes. Although a pest of mangoes in Sri Lanka it has not caused any significant economic damage to mango or other fruit trees (Galanihe and Watson 2012). The potential economic impact to Australia would arise from quarantine restrictions imposed by important domestic and foreign markets where this pest is absent.	Yes

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rastrococcus spinosus (Robinson, 1918) [Pseudococcidae] Philippine mango mealybug	Yes (Williams 2004; IAQA 2011a)	Yes (Williams 2004; DOA Thailand 2011; Ben-Dov 2015)	Yes. Although CABI (2015a) list no records for Vietnam, Williams (2004) has examined specimens on *Citrus* hosts from Vietnam.	No records found	Yes. On fruit, leaves, buds and stems (Peña and Mohyuddin 1997; Williams 2004; DOA Thailand 2011; IAQA 2011a).	Yes. Recorded on host plants belonging to 24 genera in 18 plant families including cashew, citrus, cocoa, coconut, custard apple, fig, guava, mango and mangosteen (Ben-Dov 2015). Many of these hosts are available in Australia. It is distributed throughout the subtropics and tropics of south and southeast Asia (Ben-Dov 2015). Northern regions of Australia have similar climatic conditions to these areas suitable for the establishment and spread of this species.	Yes. Other *Rastrococcus* species are of major economic importance on mango in India (DPP 2001). The potential economic impact to Australia would arise from quarantine restrictions imposed by important domestic and foreign markets where this pest is absent.	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Russellaspis pustulans (Cockerell, 1892) Synonym: *Asterolecanium pustulans* (Cockerell, 1893) [Asterolecaniidae] Oleander pit scale; Akee fringed scale	Yes. There is one Indonesian record for Irian Jaya (West Papua) (Williams and Watson 1990; Ben-Dov *et al.* 2015).	No records found	No records found	No records found	No. The Indonesian mango market access request is restricting the export area to Java where commercially grown mangoes are grown.	Assessment not required	Assessment not required	No
Rusostigma radiiruigosa Quaintance & Baker, 1917 [Aleyrodidae]	Yes (Evans 2008)	Yes (Evans 2008)	No records found	No records found	No. Whiteflies typically feed on the undersides of plant leaves (CSIRO 1991).	Assessment not required	Assessment not required	No
Saissetia coffeae (Walker, 1852) [Coccidae] Hemispherical scale	Yes (Kalshoven 1981; Ben-Dov 2014a; CABI 2015a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Saissetia miranda (Cockerell & Parrott, 1899) [Coccidae] Mexican black scale	Yes (Ben-Dov 2014a)	No records found	No records found	Yes. NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Saissetia oleae (Olivier, 1791) [Coccidae] Black scale	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes (Ben-Dov 2014a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Toxoptera aurantii Boyer De Fonscolombe, 1841 [Aphididae]	Yes (Waterhouse 1993; CABI 2015a)	Yes (Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001; Hollis and Eastop 2005)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Toxoptera odinae (van der Goot, 1917) [Aphididae] Mango aphid	Yes (CABI 2015a)	Yes (CABI 2015a)	No records found	No records found	No. Feeds on the undersides of young leaves, petioles, young shoots, branches and flowers (Srivastava 1997; CABI 2015a).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Unaspis acuminata (Green, 1896) [Diaspididae] Unaspis scale	No records found	Yes (Ben-Dov *et al.* 2015)	No records found	No records found	Yes. Mango listed as host (Ben-Dov *et al.* 2015). Other *Unaspis* species such as *U. citri*, usually occur on the trunk and main limbs, but spread to the twigs, leaves and fruit in heavy infestations (Watson 2005).	Yes. Feeds on several plant hosts belonging to 14 genera in 12 families, including fruit trees such as mango, citrus and fig and ornamentals such as *Cycas revoluta*, *Severinia buxifolia*, and *Leea* sp. (Ben-Dov *et al.* 2015). These host plants are distributed throughout Australia. This species occurs throughout China, India, Sri Lanka and Thailand (Ben-Dov *et al.* 2015). Many northern regions of Australia have similar climatic conditions to these areas suitable for establishment and spread.	Yes. Although there is no information available on the economic impact of this species, other *Unaspis* species have a high impact on their hosts (Watson 2005). As scale insects have significant impacts on their hosts (Gill 1997; Watson 2005) it is likely this species will also have a high economic impact.	Yes (EP)
Xenolecanium mangiferae Takahashi, 1942 [Coccidae]	No records found	Yes (Kondo *et al.* 2005)	No records found	No records found	No. On branches of mango (Kondo *et al.* 2005).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hymenoptera								
Oecophylla smaragdina (Fabricius, 1775) [Formicidae] Green tree ant; Weaver ant	Yes (CABI 2015a)	Yes (Offenberg *et al.* 2013)	Yes (Duc and Hao 2001; Offenberg *et al.* 2013)	Yes. NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Pheidole megacephala (Fabricius, 1793) [Formicidae] Coastal brown ant; Madeira ant	Yes (CABI 2015a)	No records found	No records found	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001; CSIRO 2005)	Assessment not required	Assessment not required	Assessment not required	No
Solenopsis geminata (Fabricius, 1804) [Formicidae] Tropical fire ant	Yes (CABI 2015a)	Yes (Graham 2011; GISD 2015)	Yes (CABI 2015a)	Yes. NT, WA (CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Lepidoptera								
Achaea janata (Linnaeus, 1758) [Noctuidae] Castor oil looper	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Acherontia styx Westwood, 1844 [Sphingidae] Indian death's head hawk moth	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	No records found	No. Eggs are laid on leaves. Larvae feed on leaves and young shoots of mango (CABI 2015a).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Acrocercops zygonoma Meyrick, 1921 [Gracillariidae] Mangosteen leaf miner	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae mine in young leaves (including petioles) and shoots of mango; pupation occurs on the lower leaf surface (Srivastava 1997).	Assessment not required	Assessment not required	No
Adoxophyes perstricta Meyrick, 1928 [Tortricidae]	Yes (Kalshoven 1981; Suputa *et al.* 2010)	No records found	No records found	No records found	No. This species is very similar to *A. privatana*. Eggs are laid in batches on leaves and larvae web leaves together or sometimes against other plant organs such as fruits, flowers and shoots in which to feed (Kalshoven 1981; Meijerman and Ulenberg 2000). Surface feeding of the fruit will result in obvious damage and non-commercial fruit. These fruit will be removed during harvesting and packing house procedures.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Adoxophyes privatana (Walker, 1863) [Tortricidae] Apple leaf-curling moth	Yes (Kalshoven 1981; Meijerman and Ulenberg 2000)	Yes. (Charernsom 2003)	Yes (Waterhouse 1993; Vang *et al.* 2013)	No records found	No. Eggs are laid in batches on the upper and lower surfaces of the leaves (Meijerman and Ulenberg 2000). Larvae web several leaves, or leaves and fruit, together to form a nest. The larvae feed on the plant parts enclosed by their nests. They are very active and will wriggle away or drop to the ground when disturbed (Meijerman and Ulenberg 2000). Therefore, this species will not be associated with harvested fruit.	Assessment not required	Assessment not required	No
Agrius convolvuli (Linnaeus, 1758) [Sphingidae] Convolvulus hawk moth	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. All states and territories (Common 1990; Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Amsacta lactinea (Cramer, 1777) [Noctuidae] Red tiger moth	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	No records found	No. Larvae feed on mango leaves (Srivastava 1997).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Antitrygodes divisaria (Walker, 1861) [Geometridae]	Yes (Holloway 1997; Suputa *et al.* 2010)	No records found	No records found	No records found	No. Larvae prefer to feed on young leaves (Holloway 1997).	Assessment not required	Assessment not required	No
Altha adala Moore, 1859 [Limacodidae] Slug caterpillar	Yes (Holloway 2009)	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Anisodes illepidaria Guenée, 1857 [Geometridae] Looper	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on young mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Anthene emolus emolus (Godart, 1823) [Lycaenidae] Ciliate blue	No records found	Yes (Kuroko and Lewvanich 1993)	Yes (Inayoshi 2014)	No records found	No. Larvae feed on inflorescences and young leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Anuga constricta Guenée, 1852 [Noctuidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Archips micaceanus (Walker, 1863) [Tortricidae] Soyabean leafroller	No records found	Yes (Kuroko and Lewvanich 1993; Waterhouse 1993)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Larvae feed on young mango leaves (Waterhouse 1993; PPD 2009).	Assessment not required	Assessment not required	No
Arhopala aberrans (de Niceville, 1889) [Lycaenidae] Pale bushblue	No records found	Yes (Charernsom 2003; Inayoshi 2014)	Yes (Inayoshi 2014)	No records found	No. Recorded on mango; larvae of other *Arhopala* species feed on mango inflorescences (Kuroko and Lewvanich 1993; Charernsom 2003).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Arhopala centaurus nakula (Felder & Felder, 1860) Synonym: *Arhopala pseudocentaurus nakula* (Felder & Felder, 1860) [Lycaenidae] Centaur oakblue	Yes (Vane-Wright and Gaonkar 2006)	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango inflorescences and leaves (Kuroko and Lewvanich 1993; Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Attacus atlas (Linnaeus, 1758) [Saturniidae] Atlas moth	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Larvae feed on mature leaves of host plants, rarely attacking developing leaves (PPD 2009; CABI 2015a).	Assessment not required	Assessment not required	No
Biston suppressaria Guenée, 1858 Synonym: *Biston luculentus* Inoue, 1992 [Geometridae] Tea looper	Yes (Jiang *et al.* 2011; CABI 2015a)	No records found	No records found	No records found	No. Eggs laid in crevices in the bark of shade trees; larvae eat irregular holes along the margins of young mango leaves; pupation occurs on the surface of the soil (Srivastava 1997; CABI 2015a).	Assessment not required	Assessment not required	No
Cadra cautella Walker, 1863 [Pyralidae] Tropical warehouse moth; Almond moth	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Calliteara horsfieldii Saunders, 1851 [Lymantriidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Chalcoscelides albiguttata Snellen, 1879 [Limacodidae]	No records found	Yes (Holloway 1986; Charernsom 2003)	No records found	Yes. Qld (Holloway 1986). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae feed on leaves (USDA-APHIS 2006).	Assessment not required	Assessment not required	No
Chalcoscelides castaneipars (Moore, 1866) [Limacodidae]	Yes (Kalshoven 1981; Holloway 1986; Cock *et al.* 1987)	No records found	No records found	No records found	No. Larvae feed on leaves (USDA-APHIS 2006).	Assessment not required	Assessment not required	No
Cheromettia lohor Moore, 1859 [Limacodidae]	Yes (Kalshoven 1981)	No records found	No records found	No records found	No. Eggs laid on leaves. Limacodid (slug and nettle) caterpillars are leaf feeders. First instar larvae feed on the leaf surface while later instars switch to eating through the whole leaf (Kalshoven 1981).	Assessment not required	Assessment not required	No
Cheromettia sumatrensis (Heylaerts, 1884) [Limacodidae] Gelatin slug caterpillar moth	Yes (Cock *et al.* 1987; Robinson *et al.* 2010)	Yes (Charernsom 2003; Robinson *et al.* 2010)	No records found	No records found	No. Eggs laid on leaves. Limacodid caterpillars feed on mature firm leaves initially scarifying the surface then later eating holes through the leaves (Kalshoven 1981; Cock *et al.* 1987).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Chlumetia euthysticha (Turner, 1942) [Noctuidae] Mango tip borer	Yes (Holloway 1985)	No records found	No records found	Yes. Qld (Holloway 1985; CSIRO 2005). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae tunnel in mango shoot tips (Holloway 1985).	Assessment not required	Assessment not required	No
Chlumetia transversa Walker, 1863 [Noctuidae] Mango shoot borer	Yes (Holloway 1985; CABI 2015a)	Yes (Waterhouse 1993; DOA Thailand 2005)	Yes (Duc and Hao 2001; PPD 2009)	Yes. Qld (BOLD 2014; Herbison-Evans and Crossley 2015). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae tunnel into flower panicles and young shoots of mango as well as feeding on leaves (Holloway 1985; DOA Thailand 2005; PPD 2009).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Citripestis eutraphera (Meyrick, 1933) [Pyralidae] Fruit borer	Yes (Kalshoven 1981; CABI 2015a)	No records found	No records found	Yes. NT (IPPC 2009). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae feed on the soft piths of young mango fruit causing fruit to drop prematurely (Kalshoven 1981; CABI 2015a). Infested fruits have bored holes with frass. Young larvae scrape the skin of the mango fruit causing characteristic scabs to form (Jayanthi *et al.* 2014). These damaged mango fruit are easily detected and are unlikely to be harvested (Jayanthi *et al.* 2014).	Assessment not required	Assessment not required	No
Clethrogyna turbata (Butler, 1879) Synonym: *Orgyia turbata* Butler, 1879 [Lymantriidae] Tussock moth	Yes (Robinson *et al.* 2010)	Yes (DOA Thailand 2005)	Yes (Waterhouse 1993)	No records found	No. Larvae feed on mango leaves (DOA Thailand 2005; Chung *et al.* 2013).	Assessment not required	Assessment not required	No
Cnesteboda celligera (Meyrick, 1918) [Tortricidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Comostola laesaria Walker, 1861 [Geometridae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	Yes. NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Conogethes punctiferalis (Guenée, 1854) [Pyralidae] Durian fruit borer	Yes (Waterhouse 1993; CABI 2015a)	Yes (Charernsom 2003)	Yes (Waterhouse 1993)	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Creatonotus transiens (Walker, 1855) [Arctiidae]	Yes (Dubatolov and Holloway 2007)	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Cricula trifenestrata (Helfer, 1837) [Saturniidae] Net cocoon silkworm	Yes (Waterhouse 1993; CABI 2015a)	Yes (Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Larvae usually eat only tender mango leaves and soft parts of other leaves (PPD 2009; CABI 2015a).	Assessment not required	Assessment not required	No
Cryptoblabes gnidiella Milliére, 1867 [Pyralidae] Honeydew moth	Yes (CAPS 2013)	Yes (Charernsom 2003; CAPS 2013)	No records found	No records found	No. Eggs are laid on tender leaves, branches and fruit of mango (CAPS 2013). Young larvae initially feed solely on honeydew from mealybugs and insect remnants. Mature larvae nibble superficially on the skin of the fruit of its host plants (CAPS 2013).	Assessment not required	Assessment not required	No
Cryptothelea fuscescens (Snellen, 1879) [Psychidae] Bagworm	Yes (Kalshoven 1981; Suputa *et al.* 2010)	Yes (Charernsom 2003) (as *Clania fuscescens* Dudgeon)	No records found	No records found	No. Larvae of *Cryptothelea* species feed on leaves of host plants (Kalshoven 1981).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Dasychira mendosa Hübner, 1823 Synonym: *Olene mendosa* Hübner, 1823) [Lymantriidae] Tussock moth	Yes (Kalshoven 1981)	Yes (Kuroko and Lewvanich 1993; Nair 2001)	Yes (PPD 2009)	Yes. NT, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Dappula tertia (Templeton, 1847) [Psychidae] Bagworm	Yes (Kalshoven 1981; Suputa *et al.* 2010)	No records found	No records found	No records found	No. Larvae feed on leaves (Kalshoven 1981).	Assessment not required	Assessment not required	No
Darna trima (Moore, 1859) [Limacodidae] Nettle caterpillar	Yes (Kalshoven 1981; Cock *et al.* 1987; CABI 2015a)	Yes (Charernsom 2003)	No records found	No records found	No. Eggs are laid on the underside of leaflets; first instar larvae feed on the leaf epidermis while later instar larvae eat young leaflets often stripping them to their midribs (Kalshoven 1981; Cock *et al.* 1987; CABI 2015a).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Deanolis sublimbalis Snellen, 1899 Synonym: *Deanolis albizonalis* (Hampson, 1903); *Noorda albizonalis* Hampson, 1903 [Pyralidae] Red banded mango caterpillar; Mango seed borer	Yes (Waterhouse 1993; Zhang 1994; IAQA 2011a; CABI 2015a) (as *Noorda albizonalis*)	Yes (Kuroko and Lewvanich 1993) (DOA Thailand 2011) (as *Noorda albizonalis*)	Yes (PPD 2009)	Yes. Qld (CSIRO 2005) (as *Deanolis sublimbalis*). Under official control in Qld (QDAF 2013).	Yes. Eggs are laid on the fruit stalk at the base of the fruit under the dried sepals (Krull and Basedow 2006). Larvae tunnel into the fruit flesh and then into the seed (Kuroko and Lewvanich 1993; Krull and Basedow 2006; PPD 2009; DOA Thailand 2011; IAQA 2011a) causing the fruit to rot and fall off the tree (QDAF 2013). Larvae pupate in dead wood on the tree, or in cracks and crevices on the bark of infested trees (Krull and Basedow 2006) or in the soil (QDAF 2013).	Yes. Main host plants are species of mango (*Mangifera indica* and *M. odorata* (kurwini mango)) (CABI 2015a). Reported in India, Indonesia, Nepal, Philippines, Thailand and Vietnam (CABI 2015a). This pest is under official control in Qld, demonstrating that suitable hosts and climatic conditions exist in Australia.	Yes. A major pest of mango in India (CABI 2015a) and tropical parts of Asia where it causes commercial losses in the order of 10–15 per cent (QDAF 2013) to as high as 40 per cent in parts of Andhra Pradesh, India (CABI 2015a).	Yes (EP)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Deudorix isocrates (Fabricius, 1793) Synonym: *Virachola isocrates* (Fabricius, 1793) [Lycaenidae] Common guava blue	No records found	Yes (Inayoshi 2014)	No records found	No records found	No. Eggs are laid on young leaves, stalks and flower buds. Larvae bore into young fruits feeding on the pulp and seed hollowing the fruit from the inside, causing the fruit to rot and drop from the tree prematurely (Srivastava 1997). The larval entry hole is surrounded by frass and any damaged fruit left on the tree are visibly unmarketable and not of a commercial quality. Therefore, this moth will not be associated with harvested fruit.	Assessment not required	Assessment not required	Assessment not required
Dudua aprobola (Meyrick, 1886) Synonym: *Argyroploce aprobola* (Meyrick, 1886) [Tortricidae]	Yes (Razowski 2009)	Yes (Kuroko and Lewvanich 1993; Razowski 2009)	Yes (PPD 2009; Razowski 2009)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae feed on the young leaves, buds and inflorescences of mango and occasionally bore into new mango shoots (Aiyar 1943; PPD 2009).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Dysphania sagana (Druce, 1882) Synonyms: *Euschema sagana* Druce, 1882; *Euschema selangora* Swinhoe, 1893 [Geometridae]	No records found	Yes (Charernsom 2003) (as *Duliophyle militaris selangorg* (Swinhoe))	No records found	No records found	No. Larvae feed on inflorescences (Charernsom 2003).	Assessment not required	Assessment not required	No
Estigena pardalis Walker, 1855 Synonym: *Gastropacha pardale* (Walker, 1855) [Lasiocampidae]	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on mango leaves (Charernsom 2003).	Assessment not required	Assessment not required	No
Etanna basalis Walker, 1862 Synonym: *Etanna mackwoodi* (Hampson, 1902) [Nolidae]	Yes (Holloway 2003)	Yes (Kuroko and Lewvanich 1993)	No records found	Yes. Qld (Nielsen *et al.* 1996; Holloway 2003; ABRS 2009). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae feed on the flowers of mango (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Etanna breviuscula (Walker, 1863) Synonym: *Nanaguna breviuscala* Walker, 1863 [Nolidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	Yes. NT, WA (Plant Health Australia 2001; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Eteoryctis syngramma (Meyrick, 1914) Synonym: *Acrocercops syngramma* Meyrick, 1914 [Gracillariidae] Cashew leafminer	Yes (Waterhouse 1993; Suputa *et al.* 2010; CABI 2015a)	Yes (CABI 2015a)	No records found	No records found	No. Eggs are laid in young leaves; larvae mine the leaves and tender twigs of mango; pupation occurs within the larval tunnels in the leaves (Srivastava 1997; CABI 2015a).	Assessment not required	Assessment not required	No
Eublemma abrupta (Walker, 1865) Synonym: *Autoba abrupta* (Walker, 1865) [Noctuidae]	No records found	Yes (Waterhouse 1993; DOA Thailand 2005)	No records found	Yes. NT (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae feed on the flowers of mango (Kuroko and Lewvanich 1993; Waterhouse 1993; Charernsom 2003).	Assessment not required	Assessment not required	No
Eublemma brachygonia Hampson, 1910 Synonym: *Autoba brachygonia* (Hampson, 1910) [Noctuidae]	No records found	Yes (Kuroko and Lewvanich 1993; Waterhouse 1993)	No records found	No records found	No. Larvae feed on the inflorescences of mango (Butani 1993; Waterhouse 1993).	Assessment not required	Assessment not required	No
Eublemma commoda (Walker, 1864) Synonym: *Vescisa commoda* Walker, 1864 [Noctuidae]	Yes (Holloway 2010)	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on the flowers of mango favouring the buds (Charernsom 2003; Holloway 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Eublemma versicolor (Walker, 1864) Synonym: *Autoba versicolor* Walker, 1864 [Noctuidae]	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; DOA Thailand 2005; CABI 2015a)	No (Waterhouse 1993)	Yes. NT, WA (Flanagan *et al.* 1990; Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Eudocima fullonia (Clerck, 1764) Synonym: *Othreis fullonia* Clerck, 1764 [Noctuidae]	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; DOA Thailand 2011)	Yes (Waterhouse 1993; PPD 2010)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Eudocima materna (Linnaeus, 1767) Synonym: *Phalaena materna* Linnaeus, 1767 [Noctuidae]	No records found	Yes (Charernsom 2003)	No records found	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Eudocima salaminia (Cramer, 1777) Synonyms: *Phalaena salaminia* Cramer, 1777; *Ophideres atkinsoni* Scott, 1890 [Noctuidae]	No records found	Yes (Charernsom 2003)	Yes (PPD 2009)	Yes NSW, NT, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae feed on leaves and pupate inside a folded leaf (Srivastava 1997; Charernsom 2003). Adults are nocturnal fruit-piercing moths which suck juices from fleshy fruits (QDAF 2012a). Therefore, this moth will not be associated with harvested fruit.	Assessment not required	Assessment not required	No
Eumeta minuscula Butler, 1881 [Psychidae] Tea bag worm	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves (Charernsom 2003).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Eumeta variegata (Snellen, 1879) Synonym: *Clania variegata* (Snellen, 1879) [Psychidae] Cotton bag worm	Yes (Waterhouse 1993)	Yes (Kuroko and Lewvanich 1993)	Yes (Waterhouse 1993; CABI 2015a)	Yes. NT, WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Euproctis flava (Fabricius, 1775) [Lymantriidae] Oriental tussock moth	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves (Butani 1993; Charernsom 2003).	Assessment not required	Assessment not required	No
Euproctis fraterna Moore, 1883 [Lymantriidae] Coffee hairy caterpillar	No records found	Yes (DOA Thailand 2005)	Yes (Robinson *et al.* 2010)	No records found	No. Larvae feed on mango leaves (DOA Thailand 1965; DOA Thailand 2005).	Assessment not required	Assessment not required	No
Euproctis lunata Walker, 1855 [Lymantriidae] Castor hairy caterpillar	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves (Butani 1993) and inflorescences (Verghese and Jayanthi 1999).	Assessment not required	Assessment not required	No
Euproctis plana Fawcett, 1915 [Lymantriidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango inflorescences (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Euthalia aconthea (Cramer, 1777) Synonym: *Euthalia aconthea garuda* (Moore, 1857) [Nymphalidae] Mango butterfly	Yes (Kalshoven 1981; Waterhouse 1993; Suputa *et al.* 2010)	Yes (Kuroko and Lewvanich 1993; Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Eggs are laid on the undersides of mango leaves; larvae feed on mango leaves (Kalshoven 1981; Kuroko and Lewvanich 1993; Waterhouse 1998; PPD 2009).	Assessment not required	Assessment not required	No
Euthalia alpheda (Godart, 1824) [Nymphalidae] Streaked baron	Yes (Kalshoven 1981)	Yes (Charernsom 2003)	Yes (Inayoshi 2014)	No records found	No. Eggs deposited on the undersides of leaves; larvae feed on mango leaves (Kalshoven 1981).	Assessment not required	Assessment not required	No
Gastropacha pardale Walker, 1855 [Lasiocampidae] Lappet moth	Yes (Kalshoven 1981; Robinson *et al.* 2010)	Yes (Robinson *et al.* 2010)	No records found	No records found	No. Larvae feed on mango leaves (Haseeb *et al.* 2006).	Assessment not required	Assessment not require	No
Gatesclarkeana idia Diakonoff, 1973 [Tortricidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango flowers (Kuroko and Lewvanich 1993; Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Gymnoscelis imparatalis Walker, 1865 [Geometridae] Leaf-eating caterpillar	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on young mango leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Helicoverpa armigera (Hübner, 1808) [Noctuidae] Cotton bollworm	Yes (Waterhouse 1993; CABI 2015a)	Yes (DOA Thailand 2011)	Yes (Waterhouse 1993)	Yes. All states and territories (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hemithea tritonaria (Walker, 1863) [Geometridae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on young mango leaves and flowers (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Herculia suffusalis (Walker, 1866) [Pyralidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Homodes bracteigutta (Walker, 1862) [Noctuidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	Yes. NT, Qld (Plant Health Australia 2001; ALA 2015). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae feed on mango leaves, flowers and externally on mango fruit (Common 1990; Robinson *et al.* 2010; Herbison-Evans and Crossley 2015). Larvae are strikingly modified (mimicking green tree ants) and highly visible (Holloway 2010) and would not be associated with harvested fruit.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Homona coffearia (Nietner, 1861) [Tortricidae] Coffee tortrix	Yes. Irian Jaya, Java, Moluccas (Waterhouse 1993; CABI 2015a)	Yes (Kuroko and Lewvanich 1993)	Yes (Waterhouse 1993; CABI 2015a)	No. *Homona coffearia* does not occur in Australia and Australian records under this name should be referred to as *Homona spargotis* (Whittle *et al.* 1987).	No. Feeds on leaves (Kuroko and Lewvanich 1993). Eggs laid on upper surfaces of mature leaves; larvae feed on leaves, especially at the growing points of plants, which are webbed together in untidy larval nests (CABI 2015a).	Assessment not required	Assessment not required	No
Hyalospila leuconeurella Ragonot, 1888 [Pyralidae]	No records found	Yes (Robinson *et al.* 2010)	No records found	No records found	No. Larvae bore into developing fruits and tunnel into the pulp causing it to rot. Infested fruits are easily distinguished by the presence of galleries of chewed particles and frass that accumulates around bore holes. (Ponnuswami 1971). Therefore, this moth will not be associated with harvested fruit.	Assessment not required	Assessment not required	No
Hypatima spathota (Meyrick, 1913) [Gelechiidae] Lobster clawed moth	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves and inflorescences (Patel *et al.* 1997; Charernsom 2003).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hyposidra talaca Walker, 1860 [Geometridae] Leaf-eating looper	Yes (Kalshoven 1981; Waterhouse 1993; Suputa *et al.* 2010)	Yes (Kuroko and Lewvanich 1993)	No records found	Yes (Herbison-Evans and Crossley 2015). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae feed on mango leaves; eggs laid on twigs (Beeson 1941; Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Ischyja manlia (Cramer, 1776) [Noctuidae]	Yes (Ades and Kendrick eds 2004)	Yes (Bänziger 1982; Kuroko and Lewvanich 1993)	No records found	Yes. Qld (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae feed on leaves and adults are nocturnal fruit piercing moths (Walker 2007). Therefore, this moth will not be associated with harvested fruit.	Assessment not required	Assessment not required	No
Lobesia genialis Meyrick, 1912 [Tortricidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango flowers (inflorescences) (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Lymantria beatrix (Stoll, 1790) Synonym: *Porthetria beatrix* Stoll, 1791 [Lymantriidae]	Yes (Holloway 1999)	Yes (Charernsom 2003; Robinson *et al.* 2010)	No records found	No records found	No. Larvae feed on mango leaves and flowers (Robinson *et al.* 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Lymantria lunata (Stoll, 1782) [Lymantriidae] Luna gypsy moth	Yes (Waterhouse 1993)	No records found	No records found	Yes. NT, Qld (Plant Health Australia 2001; ALA 2015). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Eggs are laid on leaves; larvae preferentially feed on mango flower inflorescences and newly formed fruits and did not feed on the leaves (Pogue and Schaefer 2007). Larvae feed at night and rest on tree trunks during the day on conspicuous mats of silk (Corbet 1963).	Assessment not required	Assessment not required	No
Lymantria marginata Walker, 1855 Synonym: *Lymantria nigra* Moore, 1888 [Lymantriidae]	Yes (Pogue and Schaefer 2007)	Yes (Kuroko and Lewvanich 1993; Charernsom 2003)	No records found	No records found	No. Eggs laid on bark or in crevices or hollows of host trees (Singh and Goel 1986). Larvae feed on mango leaves (Singh and Goel 1986; Goel *et al.* 1986; Singh and Goel 1991; Srivastava 1997).	Assessment not required	Assessment not required	No
Maruca vitrata (Fabricius, 1787) [Pyralidae] Bean pod borer	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. NT, NSW, Qld, WA (Plant Health Australia 2001; ALA 2015).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Melanitis leda ismene (Cramer, 1775) [Nymphalidae] Rice butterfly	Yes (Kalshoven 1981)	Yes (Charernsom 2003; CABI 2015a)	Yes (CABI 2015a)	No records for the subspecies *ismene* found. This subspecies is absent from Australia. However, the subspecies *bankia* is recorded from NSW, NT, Qld and WA and is not associated with mango.	No. Eggs are laid on the underside of leaves; larvae feed on leaves of host plants (CABI 2015a).	Assessment not required	Assessment not required	No
Monopis longella (Walker, 1863) [Tineidae]	No records found	Yes (Charernsom 2003; Huang *et al.* 2011)	Yes (Huang *et al.* 2011)	No records found	No. Larvae bore inside mango twigs (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Neostauropus alternus (Walker, 1855) Synonym: *Stauropus alternus* Walker, 1855 [Notodontidae] Lobster moth	Yes (Kalshoven 1981; Holloway 1983)	Yes (Charernsom 2003)	Yes (Waterhouse 1993)	No records found	No. Eggs are laid on the edges of leaves; larvae feed on mango leaves and pupate in cocoons on branches and on the underside of leaves or are laid between two leaves spun together (Kalshoven 1981; Holloway 1983)	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oraesia emarginata (Fabricius, 1794) [Noctuidae]	No records found	Yes (Charernsom 2003)	No records found	Yes. NSW, Qld (Plant Health Australia 2001; ALA 2015). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Larvae feed on leaves (Srivastava 1997). Adults are fruit-piercing moths which suck juices from fleshy fruits at night (Bänziger 1982). Therefore, this moth will not be associated with harvested fruit.	Assessment not required	Assessment not required	No
Orgyia osseata Walker, 1862 Synonym: *Dasychira osseata* (Walker, 1862) [Lymantriidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993)	Assessment not required	Assessment not required	No
Orgyia postica (Walker, 1855) [Lymantriidae] Cocoa tussock moth	Yes (Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; DOA Thailand 2005)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Larvae feed on the leaves, panicles, stalk, skin and pulp of mangoes and on new flushes of leaves; damaged fruit drops from the tree prematurely and damaged fruit left on the tree are visibly unmarketable and not of a commercial quality (Gupta and Singh 1986; Wakamura *et al.* 2005; DOA Thailand 2005; PPD 2009).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Orthaga euadrusalis Walker, 1863 [Pyralidae]	Yes (CABI 2015a)	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Eggs are laid on leaves. Larvae web mango leaves and terminal shoots into clusters to feed on leaf surface before eating the leaf lamina (Kuroko and Lewvanich 1993; Srivastava 1997; CABI 2015a). Larvae pupate in the soil under infested trees (Singh 1988).	Assessment not required	Assessment not required	No
Orthaga exvinacea (Hampson, 1891) [Pyralidae] Mango leaf webber	No records found	Yes (MAF New Zealand 1999)	No records found	Yes (Nielsen *et al.* 1996). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Eggs are laid on leaves in clusters. Larvae web mango leaves and terminal shoots into clusters to feed on the leaves and inflorescences. Pupation takes place within these webbed leaves (Srivastava 1997; CABI 2015a).	Assessment not required	Assessment not required	No
Orthaga icarusalis (Walker, 1859) [Pyralidae] Mango webworm	Yes (NPQS 2010)	Yes (MAF New Zealand 1999; CABI 2015a)	No records found	No records found	No. Larvae web mango leaves together feeding on the entire leaf (Srivastava 1997).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Orthaga leucatma (Meyrick, 1932) [Pyralidae]	No records found	Yes (Kuroko and Lewvanich 1993)	No records found	No records found	No. Larvae web old mango leaves and twigs together to feed (Kuroko and Lewvanich 1993; Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Orvasca subnotata Walker, 1865 Synonym: *Porthesia subnotata* (Walker, 1865) [Lymantriidae]	No records found	Yes (Charernsom 2003; Robinson *et al.* 2010)	No records found	No records found	No. Larvae feed on mango leaves (Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Parasa lepida (Cramer, 1799) [Limacodidae]	Yes (Cock *et al.* 1987; Waterhouse 1993; CABI 2015a)	Yes (Waterhouse 1993; DOA Thailand 2005)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Larvae feed on mango leaves (Cock *et al.* 1987; Waterhouse 1993; DOA Thailand 2005; PPD 2009; CABI 2015a).	Assessment not required	Assessment not required	No
Penicillaria jocosatrix (Guenée, 1852) [Noctuidae] Mango shoot caterpillar	Yes (CABI 2015a)	Yes (DOA Thailand 2005)	Yes (PPD 2009)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; QDAF 2012b)	Assessment not required	Assessment not required	Assessment not required	No
Perina nuda (Fabricius, 1787) [Lymantriidae]	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves (Srivastava 1997).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phalanta phalantha Drury, 1773 [Nymphalidae] Common leopard	Yes (Inayoshi 2014)	Yes (Kuroko and Lewvanich 1993) (as *Phalanta pharantha*) (Inayoshi 2014)	Yes (Inayoshi 2014)	Yes. NT (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Eggs are laid on leaves and green twigs. Larvae feed on mango leaves (Kuroko and Lewvanich 1993; Rayalu *et al.* 2014).	Assessment not required	Assessment not required	No
Phocoderma velutina Kollar, 1844 [Limacodidae] Giant slug caterpillar	Yes (Solovyev 2008; Holloway 2009)	Yes (Kuroko and Lewvanich 1993; Solovyev 2008)	No records found	No records found	No. Larvae feed on mango leaves; pupation occurs on soil surface (Holloway 1986; Kuroko and Lewvanich 1993; Solovyev 2008; Holloway 2009).	Assessment not required	Assessment not required	No
Pleuroptya balteata (Fabricius, 1798) [Pyralidae]	Yes (CABI 2015a)	Yes (Kuroko and Lewvanich 1993)	No records found	Yes. Qld (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Praesetora albitermina Hering, 1931 Synonym: *Praesetora divergens* Moore, 1879 [Limacodidae]	Yes (Holloway 1986)	No records found	No records found	No records found	No. Larvae feed on mature firm leaves initially scarifying the surface later making holes (Kalshoven 1981).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudonirmides cyanopasta (Hampson, 1910) Synonym: *Belippa cyanopasta* Hampson, 1910 [Limacodidae] Leaf-eating caterpillar	No records found	Yes (Kuroko and Lewvanich 1993)	Yes (Solovyev and Witt 2009)	No records found	No. Larvae feed on leaves of host plants (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Rapala iarbus (Fabricius, 1787) [Lycaenidae] Common red flash	Yes (Kalshoven 1981)	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves of mango (Butani 1993).	Assessment not required	Assessment not required	No
Rapala manea (Hewitson, 1863) [Lycaenidae] Slate flash	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves and flowers of mango (Johnson *et al.* 1980; Butani 1993).	Assessment not required	Assessment not required	No
Rapala pheretima petosiris (Hewitson, 1863) [Lycaenidae]	No records found	Yes (Kuroko and Lewvanich 1993; Inayoshi 2014)	Yes (Inayoshi 2014)	No records found	No. Larvae feed on mango flowers (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Roeselia aperta (Walker, 1865) Synonym: *Evonima aperta* Walker, 1865 [Nolidae]	Yes (Van Eecke 1926; Holloway 2003)	Yes (Charernsom 2003)	Yes (Holloway 2003)	No records found	No. Larvae feed on mango inflorescences (Charernsom 2003).	Assessment not required	Assessment not required	No
Scirpophaga excerptalis (Walker, 1863) [Pyralidae] White top borer	Yes (Lewvanich 1981; CABI 2015a)	Yes (Lewvanich 1981; Waterhouse 1993; Charernsom 2003)	Yes (Lewvanich 1981; Waterhouse 1993)	Yes. Qld (Lewvanich 1981). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Eggs are laid in clusters on younger leaves; larvae feed on leaves and stems (CABI 2015a).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Scopelodes testacea Butler, 1886 [Limacodidae]	No records found	Yes (Kuroko and Lewvanich 1993)	Yes (Waterhouse 1993)	No records found	No. Larvae feed on mango leaves (Kuroko and Lewvanich 1993).	Assessment not required	Assessment not required	No
Setomorpha rutella Zeller, 1852 Synonym: *Setomorpha calcularis* Meyrick, 1906 [Tineidae] Tropical tobacco moth	Yes (CABI 2015a)	Yes (Kuroko and Lewvanich 1993)	Unconfirmed record (CABI 2015a)	Yes. Qld, WA (Robinson and Nielsen 1993; Plant Health Australia 2001) (as *S. calcularis*)	Assessment not required	Assessment not required	Assessment not required	No
Setora nitens Walker, 1855 [Limacodidae]	Yes (Cock *et al.* 1987; Waterhouse 1993)	Yes (Waterhouse 1993; Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	No (Nielsen *et al.* 1996)	No. Larvae feed on mango leaves (Cock *et al.* 1987; Waterhouse 1993; PPD 2009)	Assessment not required	Assessment not required	No
Somena scintillans (Walker, 1856) Synonym: *Euproctis scintillans* (Walker, 1856) [Lymantriidae]	Yes (Kalshoven 1981; CABI 2015a)	Yes (Charernsom 2003; Robinson *et al.* 2010; CABI 2015a) (as *Somena scintillans*)	Yes (PPD 2009; CABI 2015a) (as *Euproctis scintillans*)	No records found	No. Larvae feed on mango leaves and inflorescences) (Srivastava 1997; DOA Thailand 2005; Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Spodoptera litura (Fabricius, 1775) [Noctuidae] Taro caterpillar	Yes (Waterhouse 1993)	Yes (Waterhouse 1993; Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	Yes. ACT, NSW, NT, Qld, Tas., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Sphrageidus virguncula (Walker, 1855) Synonym: *Euproctis virguncula* (Walker, 1855) [Lymantriidae]	Yes (Kalshoven 1981)	Yes (Charernsom 2003; Robinson *et al.* 2010)	No records found	No records found	No. Larvae feed on flowers and leaves of host plants (Kalshoven 1981).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Sphrageidus xanthorrhoea (Kollar, 1848) Synonym: *Euproctis xanthorrhoea* (Kollar, 1848) [Lymantriidae]	Yes (Kalshoven 1981)	No records found	No records found	No records found	No. Larvae feed on flowers and leaves of host plants (Kalshoven 1981)	Assessment not required	Assessment not required	No
Spulerina isonoma (Meyrick, 1916) Synonym: *Acrocercops isonoma* Meyrick, 1916 [Gracillariidae] Mango stem miner	Yes (Suputa *et al.* 2010)	Yes (Kuroko and Lewvanich 1993; Charernsom 2003)	No records found	Yes. NT (Plant Health Australia 2001; Chin *et al.* 2010; QDAFF 2012). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. Larvae mine mango leaves formed during new growth flushes forming blister like patches on the leaves; fruit is not affected (Srivastava 1997; QDAF 2015).	Assessment not required	Assessment not required	No
Stathmopoda auriferella (Walker, 1864) Synonym: *Stathmopoda crocophanes* Meyrick, 1897 [Oecophoridae] Apple heliodinid	No records found	Yes (Charernsom 2003)	No records found	Yes. SA, Tas., Vic., WA (Plant Health Australia 2001; CSIRO 2005).	Assessment not required	Assessment not required	Assessment not required	No
Strepsicrates rhothia (Meyrick, 1910) [Tortricidae] Eucalyptus leafroller	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on leaves (Butani 1993; Robinson *et al.* 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Thalassodes depulsata Walker, 1861 [Geometridae]	Yes (Holloway 1996)	No records found	No records found	No records found	No. Mango is listed as a host plant of this species (Yunus and Ho 1980). Larvae feed on mango leaves and inflorescences (NPQS 2010; Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Thalassodes falsaria Prout, 1912 [Geometridae]	No records found	Yes (Charernsom 2003)	Yes (PPD 2009)	No records found	No. Larvae feed on mango leaves and inflorescences (Kuroko and Lewvanich 1993; PPD 2009).	Assessment not required	Assessment not required	No
Thalassodes immissaria Walker, 1861 [Geometridae]	Yes (Holloway 1996; Han and Xue 2011)	Yes (Han and Xue 2011)	Yes (Han and Xue 2011)	No records found	No. Larvae feed on buds and leaves (Beeson 1941). Mango is listed as a host plant of this species (Robinson *et al.* 2010).	Assessment not required	Assessment not required	No
Thalassodes opalina Butler, 1880 [Geometridae]	Yes (Han and Xue 2011)	Yes (Han and Xue 2011)	Yes (Han and Xue 2011)	No records found	No. Larvae feed on mango leaves and inflorescences (NPQS 2010).	Assessment not required	Assessment not required	No
Thalassodes quadraria Guenée, 1857 [Geometridae]	No records found	Yes (Charernsom 2003)	No records found	No records found	No. Larvae feed on mango leaves and inflorescences (NPQS 2010).	Assessment not required	Assessment not required	No
Thosea sinensis (Walker, 1855) [Limacodidae]	Yes (Waterhouse 1993)	Yes (Charernsom 2003)	Yes (Waterhouse 1993; PPD 2009)	No records found	No. Larvae feed on mango leaves (Waterhouse 1993; PPD 2009)	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Thyas coronata (Fabricius, 1775) Synonym: *Ophiusa coronata* (Fabricius, 1775); *Ophiodes ponderosa* Mabille, 1879 [Noctuidae]	Yes (Van Hall 1919)	Yes (Bänziger 1982; Charernsom 2003)	Yes (Waterhouse 1993)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Tirathaba mundella Walker, 1865 Synonyms: *Melissoblaptes fructivora* Meyrick, 1933; *Tirathaba fructivora* (Meyrick, 1933) [Pyralidae] Oil palm bunch moth	Yes (Kalshoven 1981; Waterhouse 1993; CABI 2015a)	Yes (Charernsom 2003)	No records found	No records found	No. A single record of larvae feeding on the pulp and stone of a new mango species in India, causing premature fruit drop (Bhumannavar and Jacob 1990).	Assessment not required	Assessment not required	No
Orthoptera								
Aularches miliaris (Linnaeus, 1758) [Acrididae] Spotted grasshopper	Yes (Kalshoven 1981; Suputa *et al.* 2010)	Yes (CABI 2015a)	No records found	No records found	No. Polyphagous species that feeds on leaves (Kalshoven 1981)	Assessment not required	Assessment not required	No
Patanga succincta (Johannson, 1763) [Acrididae] Bombay locust	Yes (Suputa *et al.* 2010; Eades *et al.* 2015)	Yes (Charernsom 2003)	No records found	No records found	No. Adults and immature stages feed on mango leaves (Kalshoven 1981).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Valanga nigricornis (Burmeister, 1838) [Acrididae] Valanga grasshopper	Yes (Kalshoven 1981; Waterhouse 1993)	Yes (Charernsom 2003; CABI 2015a)	Yes (Waterhouse 1993)	Yes. Qld (Eades *et al.* 2015). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Feeds on mango leaves (Kalshoven 1981; Suputa *et al.* 2010).	Assessment not required	Assessment not required	No
Valanga transiens (Walker, 1870) [Acrididae]	Yes (Kalshoven 1981)	No records found	No records found	No records found	No. Adults and immature stages feed on mango leaves (Kalshoven 1981)	Assessment not required	Assessment not required	No
Thysanoptera								
Anaphothrips sudanensis Trybom, 1911 Synonyms: *Neophysopus flavicinctus* Karny, 1912; *Anaphothrips citricintus* Bagnall, 1919 [Thripidae]	Yes (ThripsWiki 2015)	No records found	No records found	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Frankliniella occidentalis (Pergande, 1895) [Thripidae] Western flower thrips	Yes (Waterhouse 1993)	Yes (Waterhouse 1993)	Yes (Waterhouse 1993)	Yes. Present in every state and ACT (Plant Health Australia 2001) but is absent from NT (Mound *et al.* 2015). Regulated for the NT (Northern Territory Government 2011).	No. Eggs are laid in mango inflorescences; adults and nymphs feed in inflorescences (Srivastava 1997). Damage to mango fruit in 1989 attributed to this pest (Wysoki *et al.* 1993) was not observed subsequently (Ben-Dov *et al.* 1992). No stage attacks the fruit internally and it is unlikely to be on the fresh mango fruit pathway.	Assessment not required	Assessment not required	No
Haplothrips ceylonicus Schmutz, 1913 [Phlaeothripidae] Mango inflorescence thrips	Yes (ThripsWiki 2015)	Yes (Charernsom 2003)	No records found	No records found	No. Feeds on inflorescences (flowers) and leaves (Charernsom 2003; NPQS 2010).	Assessment not required	Assessment not required	No
Haplothrips ganglbaueri Schmutz, 1913 Synonym: *Haplothrips vernoniae* Priesner, 1921 [Phlaeothripidae]	Yes (ThripsWiki 2015)	No records found	No records found	No records found	No. Feeds on inflorescences (flowers) and leaves (NPQS 2010).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Heliothrips haemorrhoidalis (Bouché, 1833) [Thripidae] Greenhouse thrips; Black tea thrips	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No
Megalurothrips distalis (Karny, 1913) [Thripidae] Blossom thrips	Yes (CABI 2015a)	Yes (CABI 2015a)	No records found	Yes. Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Occurs on flowers damaging the anthers and stigma also reported feeding on leaves (CABI 2015a)	Assessment not required	Assessment not required	No
Rhipiphorothrips cruentatus Hood, 1919 [Thripidae] Mango thrips	No records found	Yes (Waterhouse 1993; CABI 2015a)	No records found	No records found	Yes. This species affects foliage causing dark spots and scars from feeding activity (Srivastava 1997). It also feeds on mango fruit (Lee and Wen 1982).	Yes. This thrips is present in Afghanistan, Bangladesh, China, India, Myanmar, Pakistan, Oman and Thailand (CABI 2015a). The host plants and suitable climatic conditions are available in Australia for its establishment and spread.	Yes. An important pest not only of mango but also table grapes. In grapes this pest is known to cause considerable damage by retarding the development of shoots and flowers and attacking the leaves (Bournier 1977).	Yes (EP)
Scirtothrips dorsalis Hood, 1919 [Thripidae] Chilli thrips; Strawberry thrips	Yes (Waterhouse 1993; IAQA 2011a; CABI 2015a)	Yes (Waterhouse 1993; DOA Thailand 2005)	Yes (CABI 2015a)	Yes NSW, NT, Qld, WA (Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Selenothrips rubrocinctus Giard, 1901 [Thripidae] Red-banded thrips	Yes (CABI 2015a)	Yes (DOA Thailand 2005)	No records found	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2001; Poole 2010; Mound 2012)	Assessment not required	Assessment not required	Assessment not required	No
Thrips coloratus Schmutz, 1913 [Thripidae] Loquat thrips	No records found	Yes (DOA Thailand 2005)	No (Mirab-balou *et al.* 2011)	Yes. NSW, NT, Qld (Plant Health Australia 2001; Mound 2012). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. This species feeds and breeds in flowers (Mound and Masumoto 2005; Mound *et al.* 2015).	Assessment not required	Assessment not required	No
Thrips hawaiiensis Morgan, 1913 [Thripidae] Hawaiian flower thrips	Yes (CABI 2015a)	Yes (Charernsom 2003)	Yes (PPD 2009)	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001; Poole 2010)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Thrips palmi Karny, 1925 [Thripidae] Melon thrips	Yes (Waterhouse 1993; CABI 2015a)	Yes (CABI-EPPO 1997b)	No records found	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Poole 2010). Under official control within NT (DPIF 2013; QDAF 2015), SA (QDAF 2015) and listed as an unwanted quarantine pest for Tas. (DPIPWE Tasmania 2014). Listed as a Declared Pest (Prohibited (section 22)) for WA (Government of Western Australia 2014).	No. Eggs are deposited in leaf tissue; larvae feed in groups especially on the undersides of leaves (Capinera 2013). Feeding usually occurs on foliage but on less suitable hosts flowers are preferred but fruit may also be damaged resulting in fruit aborting or developing scar tissue (QDAF 2015). No stage attacks the fruit internally and it is unlikely to be on the fresh mango fruit pathway.	Assessment not required	Assessment not required	No
Thrips tabaci Lindeman, 1888 [Thripidae] Onion thrips	Yes (Waterhouse 1993; CABI 2015a)	Yes (Charernsom 2003)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Xylaplothrips pictipes (Bagnall, 1919) Synonym: *Haplothrips pictipes* Bagnall, 1919 [Phlaeothripidae]	Yes (ThripsWiki 2015)	No records found	No records found	No records found	No. On leaves (NPQS 2010)	Assessment not required	Assessment not required	No
ALGAE								

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Cephaleuros virescens Künze [Trentepohliales: Trentepohliaceae] Algal leaf spot	Yes (IAQA 2011a)	Yes (DOA Thailand 2005)	Yes (PPD 2009)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
BACTERIA								
Pectobacterium carotovorum subsp. *carotovora* Synonym: *Erwinia carotovora* subsp. *carotovora* (Jones 1901) Bergey *et al.* 1923 [Enterobacteriales: Enterobacteriaceae]	Yes (CABI 2015a)	Yes (Vareket *et al.* 2005)	No records found	Yes. NSW, Qld, Vic. (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Pseudomonas syringae pv. *syringae* van Hall 1902 [Pseudomonadals: Pseudomonaceae] Bacterial canker	No records found	Yes (CABI 2015a)	No records found	Yes. All states and territories (Wimalajeewa *et al.* 1991; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No
Ralstonia solanacearum (Smith 1896) Yabuuchi *et al.* 1996 Synonym: *Pseudomonas solanacearum* (Smith 1896) Smith 1914 [Burkholderiales: Ralstoniaceae] Bacterial wilt	Yes (CABI 2015a)	Yes (Seal *et al.* 1993)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rhizobium radiobacter (Beijerink & van Delden) Young *et al.* 2001 Synonym: *Agrobacterium tumefaciens* (Smith and Townsend 1907) Conn 1942 [Rhizobiales: Rhizobiaceae]	Yes (CABI 2015a)	Yes (Giatgong 1980)	Yes (WFCC-MIRCEN WDCM: VTCC 2012)	Yes. All states and territories (Bradbury 1986; Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Rhizobium rhizogenes (Riker *et al.* 1930) Young *et al.* 2001 Synonym: *Agrobacterium rhizogenes* (Riker *et al.* 1930) Conn 1942 [Rhizobiales: Rhizobiaceae]	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. NSW,SA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Xanthomonas axonopodis pv. *mangiferaeindicae* (Patel *et al.* 1948) Ah-You *et al.* 2007 Synonyms: *Xanthomonas citri* pv. *mangiferaeindicae* Ah-You *et al.* 2009; *Xanthomonas campestris* pv. *mangiferaeindicae* (Patel *et al.* 1948) Robbs *et al.* 1974; *Pseudomonas mangiferaeindicae* (Patel *et al.* 1948) Robbs *et al.* 1974 [Xanthomonadales: Xanthomonadaceae] Mango bacterial canker	Yes (Semangun 1992)	Yes (Gagnevin and Pruvost 2001)	Yes (PPD 2009)	Yes. All states and territories (Bradbury 1986; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
CHROMALVEOLATA								
Phytophthora cactorum (Lebert & Cohn) J. Schröt. [Peronosporales: Peronosporaceae]	Yes (CABI 2015a)	Yes (Soytong *et al.* 2001)	Yes (CABI 2015a)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora capsici Leonian [Peronosporales: Peronosporaceae]	Yes (CABI 2015a)	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes. NSW, Qld, WA (Plant Health Australia 2001; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phytophthora citrophthora (Sm. & Sm.) Leonian [Peronosporales: Peronosporaceae]	Yes (CABI 2015a)	Yes (USDA-APHIS 2005; CABI 2015a)	Yes (CABI 2015a)	Yes. ACT, NSW, Qld, SA, Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora palmivora (E.J. Butler) E.J. Butler [Peronosporales: Peronosporaceae]	Yes (McMahon and Purwantara 2004)	Yes (CABI 2015a)	Yes (PPD 2009; CABI 2015a)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2001; Stukely 2012)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora nicotianae Breda de Haan [Peronosporales: Peronosporaceae] Black shank	Yes (Farr and Rossman 2015; CABI 2015b)	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
FUNGI								
Albonectria rigidiuscula (Berk. & Broome) Rossman & Samuels Synonyms: *Calonectria rigidiuscula* B. & Br.) Sacc.; Anamorph: *Fusarium decemcellulare* C. Brick [Hypocreales: Nectriaceae] Green point gall	Yes (CABI 2015a)	Yes (Farr and Rossman 2015)	Yes (Burgess and Burgess 2009)	Yes. NSW, Qld (Plant Health Australia 2001). No records for WA, however, WA permits the import of mango from eastern Australia.	Assessment not required	Assessment not required	Assessment not required	No
Alternaria alternata (Fr.) Keissl. [Pleosporales: Pleosporaceae] Alternaria leaf spot	Yes (Semangun 1992)	Yes (Ploetz *et al.* 1994; CABI 2015a)	Yes (PPD 2009)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aspergillus fumigatus Fresen. [Eurotiales: Trichocomaceae]	Yes (Semangun 1992)	Yes (USDA-APHIS 2005)	Yes (Farr and Rossman 2015)	Yes. NSW, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aspergillus nidulans (Eidam) Winter Synonym: *Emericella nidulans* (Eidam) Vuillemin [Eurotiales: Trichocomaceae]	Yes (Semangun 1992; IAQA 2011a)	Yes (USDA-APHIS 2005)	Yes (Diep *et al.* 2001)	Yes. NSW, NT, SA, Vic. (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aspergillus niger Tiegh. Synonym: *Aspergillus brasiliensis* Varga, Frisvad & Samson [Eurotiales: Trichocomaceae] Collar rot, Black rot	Yes (IAQA 2011a; CABI 2015a)	Yes (CABI 2015a)	Yes (Burgess and Burgess 2009; CABI 2015a)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Aspergillus terreus Thom & Church [Eurotiales: Trichocomaceae]	Yes (Dewi *et al.* 2012)	Yes (DOA Thailand 2005)	Yes (WFCC-MIRCEN WDCM: VTCC 2012)	Yes. All states and territories (Plant Health Australia 2001; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No
Athelia rolfsii (Curzi) C. C. Tu & Kimbr. Synonyms: *Corticium rolfsii* Curzi; *Sclerotium rolfsii* Sacc. [Stereales: Atheliaceae]	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Botryosphaeria parva Pennycook & Samuels Synonyms: *Dothiorella dominicana* Petr. & Cif; *Fusicoccum parvum* Pennycook & Samuels [Botryosphaeriales: Botryosphaeriaceae]	No records found	Yes (Giatgong 1980)	No records found	Yes. All states and territories (Plant Health Australia 2001; Slippers *et al.* 2005)	Assessment not required	Assessment not required	Assessment not required	No
Botryosphaeria ribis Grossenb & Duggar. [Botryosphaeriales: Botryosphaeriaceae] Fruit rot	Yes (CABI 2015a)	Yes (DOA Thailand 2005; DOA Thailand 2011)	Yes (Old *et al.* 2003)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Capnodium mangiferae Cooke Synonym: *Dimerosporium mangiferum* (Cooke) Sacc. [Capnodiales: Capnodiaceae] Sooty mould of mango	Yes (IAQA 2011a)	Yes (DOA Thailand 2005; DOA Thailand 2011)	Yes (PPD 2009)	No records found	No. *Capnodium* species form a black, velvety coating (sooty mould) on leaves, twigs and fruit (Lim and Khoo 1985). Saprophytic using nutrients derived from honeydew (insect excreta). Easily removed by washing and brushing after harvest (Cooke *et al.* 2009).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceratobasidium noxium (Donk) P. Roberts Synonym: *Corticium koleroga* (Cooke) Höhn. [Corticiales: Corticiaceae] Thread blight	Yes (Lim and Sangchote 2003; CABI-EPPO 2007)	Yes (Visarathanonth and Jermsiri 1998)	Yes (CABI-EPPO 2007; CABI 2015a)	No records found	No. Infects leaves, branches, stems, twigs and young fruits of trees in shaded and humid areas (Mathew 1954; Yaacob and Tindall 1995). Filaments covering the infected fruit are highly visible (Almeyda and Martin 1976). Visibly damaged and unsightly fruits will be culled during harvest and processing.	Assessment not required	Assessment not required	No
Ceratocystis fimbriata (Ellis & Halst.) Sacc. [Microscales: Ceratocystidaceae] Mango decline	Yes (CABI 2015a)	Yes (Farr and Rossman 2015)	Yes (PPD 2009)	Yes. NSW, Qld, SA, Vic. (Plant Health Australia 2001). Listed as a Declared Organism (Permitted (section 11)) for WA (Government of Western Australia 2014).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceratocystis manginecans M. van Wyk, Al Adawi & M.J. Wingf. [Microscales: Ceratocystidaceae] Mango decline	Yes (Farr and Rossman 2015)	No records found	No records found	No records found	No. This species has been recorded as a causal agent of mango sudden decline disease (Van Wyk *et al.* 2007). It is not known to be associated with with fruit and is not considered to be on the fruit pathway.	Assessment not required	Assessment not required	No
Ceratocystis paradoxa (Dade) C. Moreau [Microscales: Ceratocystidaceae] Mango decline	Yes (CABI 2015a)	Yes (Giatgong 1980)	Yes (PPD 2009)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Cercospora mangiferae Cooke & Broome Synonym: *Stigmina mangiferae* (Koord.) M.B.Ellis [Capnodiales: Mycosphaerellaceae] Black angular leaf spot	Yes (IAQA 2011a)	Yes (Giatgong 1980)	No records found	Yes. NT (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. On leaves (Ploetz and Prakash 1997; IAQA 2011a).	Assessment not required	Assessment not required	No
Cladosporium cladosporioides (Fresen.) De Vries [Capnodiales: Davidiellaceae] Black mould	Yes (Bensch *et al.* 2010)	Yes (Bensch *et al.* 2010)	No records found	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Cladosporium herbarum (Pers.:Fr) Fr. [Capnodiales: Davidiellaceae] Black mould	Yes (Farr and Rossman 2015)	No (Plakthongdee *et al.* 2013)	Yes (PPD 2009)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum acutatum J.H. Simmonds [Glomerellales: Glomerellaceae] Strawberry black spot	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (Nguyen *et al.* 2010)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum asianum Prihast., L. Cai & K.D. Hyde [Glomerellales: Glomerellaceae]	Yes (Northern Territory Government 2012)	Yes (Weir *et al.* 2012)	No records found	Yes. All states and territories (Weir *et al.* 2012; Northern Territory Government 2012)	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. Synonym: *Glomerella cingulata* (Stoneman) Spauld. & H Schrenk [Glomerellales: Glomerellaceae] Leaf necrosis; Anthracnose; Pepper spot	Yes (CABI 2015a)	Yes (DOA Thailand 2005; DOA Thailand 2011)	Yes (PPD 2010)	Yes. All states and territories (Chakraborty *et al.* 1998; Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum truncatum (Schwein.) Andrus & W.D. Moore Anamorph [Glomerellales: Glomerellaceae] Leaf spot of peppers	Yes (Farr and Rossman 2015) Sumatra (CABI 2015a)	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Corynespora cassiicola (Berk. & MA Curtis) CT Wei [Pleosporales: Corynesporascaceae] Leaf spot	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. All states and territories (Plant Health Australia 2001; Liberato and McTaggart 2006).	Assessment not required	Assessment not required	Assessment not required	No
Cronartium kemangae Racib. Synonym: *Crossopsora kemangae* (Racib.) Syd. & P. Syd. [Pucciniales: Phakopsoraceae]	Yes (Semangun 1992)	No records found	No records found	No records found	No. Stem rust (Semangun 1992) and infects leaves (Farr and Rossman 2015).	Assessment not required	Assessment not required	No
Curvularia lunata (Wakker) Boedijn [Pleosporales: Pleosporaceae]	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes (CABI 2015a)	Yes. ACT, NSW, NT, Qld, Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Elsinoë mangiferae Bitan. & Jenkins Synonym: *Denticularia mangiferae* (Bitanc. & Jenkins) Alcorn, Grice & R.A. Peterson; *Sphaceloma mangiferae* Bitanc. & Jenkins [Myriangiales: Elsinoaceae] Mango scab	Yes (Suputa *et al.* 2010)	Yes (CABI 2015a)	Yes (PPD 2009)	Yes. NT, Qld (Conde *et al.* 2007). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	Yes. Stems, flowers and young fruit can be infected (Gagnevin and Pruvost 2001; Conde *et al.* 2007).	Yes. This species is already established in parts of Australia and conidia are spread via wind and rain (Conde *et al.* 2007).	Yes. Infection can make fruit unmarketable or entirely defoliate new shoots (Conde *et al.* 2007).	Yes (EP, WA)

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Erysiphe quercicola S. Takam. & U. Braun. Synonyms: *Oidium mangiferae* Berthet; Anamorph: *Oidium anacardii* F.Noack [Erysiphales: Erysiphaeceae] Powdery mildew	Yes (Semangun 1992)	Yes (DOA Thailand 2005)	Yes (Duc and Hao 2001)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No
Erythricium salmonicolor (Berk. & Broome) Burds. Synonyms: *Corticium salmonicolor* Berk & Broome; *Phanerochaete salmoneolutea* (Berk. & Broome) Julich [Corticiales: Corticiaceae]	Yes (Farr and Rossman 2015)	Yes (DOA Thailand 2005)	Yes (Duong *et al.* 1997; PPD 2009)	Yes. NSW, NT, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. This pathogen causes a wood disease called pink disease (Ploetz 2003). Not known to be associated with fruit.	Assessment not required	Assessment not required	No
Fusarium incarnatum (Desm.) Sacc. Synonyms: *Fusarium semitectum* Berk. & Ravenel; *Fusarium pallidoroseum* (Cooke) Sacc. [Hypocreales: Nectriaceae]	Yes (Supriaman and Palmer 1980; Semangun 1992)	Yes (Farr and Rossman 2015)	Yes (Du *et al.* 2001)	Yes. NSW, NT, Qld, SA, Vic., WA, Tas. (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fusarium mangiferae Britz, M.J. Wingf. & Marasas [Hypocreales: Nectriaceae] Mango malformation	Yes (Pinaria *et al.* 2010)	No records found	No records found	Yes. NT, Qld and under official control. This species is declared as a notifiable pest in the Northern Territory under section 6(4) of the Plant Health Act (DPIF 2013), under eradication in Queensland (IPPC 2010) and regulated as a prohibited disease in WA (Government of Western Australia 2014).	No. Previous policy considered that conidia may contaminate and survive on the fruit surface. However, available evidence indicates that *F. mangiferae* is generally restricted to apical and lateral bud areas of mango and localised infections of these buds take place. Outside of these pockets of susceptibility, the pathogen is not present or survives poorly (Freeman *et al.* 2014a; Freeman *et al.* 2014b). Youssef *et al.* (2007) did not detect the pathogen in seeds, seed coats or flesh of mango, so is not systemic.	Assessment not required	Assessment not required	No
Fusarium oxysporum Schlechtendahl Synonym: *Fusarium angustum* Sherb. [Hypocreales: Nectriaceae] Mango bunchy top	Yes (CABI 2015a)	Yes (Giatgong 1980)	Yes (Burgess *et al.* 2008)	Yes. All states and territories (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ganoderma australe (Fr.: Fr.) Pat. 1890 [Polyporales: Ganodermaceae]	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes (Ermilov and Anichkin 2013)	Yes. NSW, Qld, Tas., Vic., WA (Smith and Sivasithamparam 2000; Plant Health Australia 2001; Smith and Sivasithamparam 2003)	Assessment not required	Assessment not required	Assessment not required	No
Ganoderma applanatum (Pers.) Pat. Synonym: *Ganoderma lipsiense* (Batsch) G.F. Atk. [Polyporales: Ganodermaceae] Ornamentals white butt rot	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes (Dai Nguyen *et al.* 2013)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001; Moncalvo and Buchanan 2008)	Assessment not required	Assessment not required	Assessment not required	No
Geotrichum candidum Link [Saccharomycetales: Dipodascaceae] Sour rot	Yes (Semangun 1992)	Yes (USDA-APHIS 2005)	Yes Present in Vietnam on cheese (Oulahal *et al.* 2009) but no records cited of its presence on plants.	Yes. NSW, NT, Qld, Tas., Vic., WA All states and territories (Wade and Morris 1982; Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Golovinomyces cichoracearum (DC.) V.P. Heluta Synonym: *Erysiphe cichoracearum* DC. Teleomorph [Erysiphales: Erysiphaceae] Powdery mildew	Yes (Amano 1986)	Yes (Verma *et al.* 2005)	Yes (Oanh *et al.* 2006)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Guignardia mangiferae A.J. Roy Synonym: *Phyllosticta capitalensis* Henn. [Botryosphaeriales: Incertae sedis] Phyllosticta rot	Yes (Wulandari *et al.* 2009)	Yes (Wulandari *et al.* 2009)	No records	Yes. NSW, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Causes foliar spots on mango (Glienke *et al.* 2011). No report of an association with fruit found.	Assessment not required	Assessment not required	No
Gyrothrix podosperma (Corda) Rabenh. Synonym: *Campsotrichum podospermum* Corda [Hypocreales: Incertae sedis]	No records found	Yes (Farr and Rossman 2015)	No records found	No records found	No. On dead plant material, especially leaves and stems (Farr and Rossman 2015).	Assessment not required	Assessment not required	No
Helicoma recurvum (Petch) Linder Synonym: *Helicosporium recurvum* Petch [Tubeufiales: Tubeufiaceae]	Yes (Goos 1986)	No records found	No records found	No records found	No. On dead wood of mango. *Helicoma* species are mostly recorded on dead, decaying and fallen leaves and wood (Goos 1986).	Assessment not required	Assessment not required	No
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. Synonyms: *Botryodiplodia theobromae* Pat.; *Diplodia theobromae* (Pat.) W Nowell [Botryosphaeriales: Botryosphaeriaceae] Root rot; Collar rot disease; Bark canker	Yes (IAQA 2011a)	Yes (DOA Thailand 2005; DOA Thailand 2011)	Yes (PPD 2009; CABI 2015a)	Yes NT, Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Lophodermium mangiferae Koord. [Rhytismatales: Rhytismataceae] Ashy gray angular leaf spot; marginal blight	Yes (Cannon and Minter 1980)	No records found	No records found	No records found	No. On dead wood (Farr and Rossman 2015) and causes leaf spot (Cannon and Minter 1980).	Assessment not required	Assessment not required	No
Macrophoma mangiferae Hing. & O.P. Sharma [Botryosphaeriales: Botryosphaeriaceae] Macrophoma rot	No records found	Yes (Giatgong 1980)	Yes (PPD 2009)	No records found	No. Infects mango leaves and stems, particularly on young seedlings and young grafted plants (Okigbo and Osuinde 2003). Fruit rot rarely occurs in nature but may develop under storage post harvest (Prasad and Sinha 1980). Symptoms easily detected in field on mango leaves and stems (Okigbo and Osuinde 2003).	Assessment not required	Assessment not required	No
Macrophomina phaseolina (Tassi) Goid. [Botryosphaeriales: Botryosphaeriaceae] Charcoal rot	Yes (CABI 2015a)	Yes (Farr and Rossman 2015)	No records found of its presence in Vietnam, however it is very likely that it is present as it is reported present in negibouring countries like Thailand, Cambodia and China.	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Marasmiellus scandens (Massee) Dennis & D.A. Reid [Agaricales: Omphalotaceae] White thread blight	Yes (CABI 2015a)	Yes (USDA-APHIS 2005)	No records found	No records found	No. On leaves, stems and roots (CABI 2015a).	Assessment not required	Assessment not required	No
Marasmius crinis-equi F. Muell. ex Kalchbr. [Agaricales: Marasmiaceae] Horse hair blight	Yes (CABI 2015a)	Yes (Wannathes *et al.* 2009)	Yes (Kiet 1998)	Yes. Qld, Vic. (Plant Health Australia 2001).	No. Forms an irregular network of black mycelial hair-like strands entangling leaves, stems and twigs of living or dead trees (Wannathes *et al.* 2009).	Assessment not required	Assessment not required	No
Meliola mangiferae Earle [Meliolales: Meliolaceae] Black mildew	Yes (Suputa *et al.* 2010; Farr and Rossman 2015)	Yes (DOA Thailand 2005)	Yes (PPD 2009)	No records found	No. Infects both sides of living leaves (Rodríguez and Minter 1998), stems and fruits (Lim and Khoo 1985). It produces highly visible, dark-coloured, usually superficial growths on the surfaces of stems, leaves and fruit of mango (Lim and Khoo 1985). Visibly damaged and unsightly fruits will be culled during harvest and processing.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Monographella nivalis (Schaffnit) E.Müll. Synonyms: *Fusarium nivale* Ces. ex Berl. & Voglino; *Microdochium nivale* (Fr.) Samuels & I.C. Hallett [Xylariales: Amphisphaeriaceae]	No (IAQA 2009)	Yes (USDA-APHIS 2005)	No records found	Yes. NSW, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Neocosmospora haematococca (Berk. & Broome) Nalim, Samuels & Geiser Synonym: *Haematonectria haematococca* (Berk. & Broome) Samuels & Rossman; *Nectria haematococca* Berk & Broome [Hypocreales: Nectriaceae]	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	No records found	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Neocosmospora solani (Mart.) L. Lombard & Crous Synonym: *Fusarium solani* (Mart.) Sacc. [Hypocreales: Nectriaceae]	Yes (CABI 2015a)	Yes (Farr and Rossman 2015)	Yes (PPD 2010)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Neofusicoccum mangiferae (Syd. & P. Syd.) Crous Synonym: *Nattrassia mangiferae* (Syd & P. Syd) B. Sutton & Dyko [Botryosphaeriales: Botryosphaeriaceae] Dieback; Leaf spot; Stem end rot	No records found	Yes (FAO 2007a; Farr and Rossman 2015)	No records found	Yes. Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Pestalotiopsis mangiferae (Henn.) Steyaert Synonym: *Pestalotia mangiferae* Henn. [Xylariales: Amphisphaeriaceae] Grey leafspot of mango; Brown spot of mango	Yes (Suputa *et al.* 2010)	Yes (USDA-APHIS 2005)	Yes (PPD 2009)	Yes. NT, WA (Pitkethley 1998; Plant Health Australia 2001; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No
Phellinus noxius (Corner) G. Cunn. [Hymenochaetales: Hymenochataceae] Brown rot	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes (Kiet 1998)	Yes. Qld (Plant Health Australia 2001)	No. On roots and stems (Farr and Rossman 2015).	Assessment not required	Assessment not required	No
Phomopsis mangiferae Ahmad. [Diaporthales: Diaporthaceae] Black fruit spot	Yes (Semangun 1992)	Yes (DOA Thailand 2005; DOA Thailand 2011)	No records found	Yes. Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phyllosticta capitalensis Henn. Synonym: *Guignardia mangiferae* A.J. Roy [Botryosphaeriales: Botryosphaeriaceae] Phyllosticta rot Previously considered to be the anamorph of *G. mangiferae* A.J. Roy. Glienke (2011) treated this as a distinct species.	Yes (Glienke *et al.* 2011)	Yes (Wikee *et al.* 2013; Farr and Rossman 2015)	No records found	Yes. NSW, Qld (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. This species causes black spot on mango fruit (Hendricks *et al.* 2013) but rarely causes extensive losses. Affected fruit is obviously damaged and non-commercial. These fruit will be removed during harvesting and packing house procedures.	Assessment not required	Assessment not required	No
Phyllosticta mortoni Fairm. [Botryosphaeriales: Botryosphaeriaceae]	No records found	Yes (DOA Thailand 2005; DOA Thailand 2011)	No records found	No records found	No. On leaves (Prajapati *et al.* 1988).	Assessment not required	Assessment not required	No
Rhizoctonia solani Kuhn Synonym: *Thanatephorus cucumeris* (A.B.Frank) Donk [Cantharellales: Ceratobasidiaceae]	Yes (Prakash 2004)	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes. All states and territories (Pitkethley 1998; Plant Health Australia 2001; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rhizopus arrhizus A. Fisch. Synonym: *Rhizopus oryzae* Went & Prins. Geerl. [Mucorales: Mucoraceae]	Yes (Dwidjoseputro and Wolf 1970)	Yes (USDA-APHIS 2005)	No records found (Farr and Rossman 2015)	Yes. NSW, Vic. (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. This species causes soft rot in mango fruit and is usually seen in over ripe fruit as watery soaked lesions (Badyal and Sumbali 1990). Affected fruit is obviously damaged and non-commercial. These fruit will be removed during harvesting and packing house procedures.	Assessment not required	Assessment not required	No
Rhizopus stolonifer (Ehrenb.) Vuill. [Mucorales: Mucoraceae]	Yes (Astuti *et al.* 2000)	Yes (Farr and Rossman 2015)	No records found (Farr and Rossman 2015)	Yes. All states and territories (Plant Health Australia 2001; Government of Western Australia 2014)	Assessment not required	Assessment not required	Assessment not required	No
Rigidoporus microporus (Sw. : Fr.) Overeem Synonym: *Fomes lignosus* (Klotzsch) Bres. [Polyporales: Polyporaeceae] White root rot	Yes (CABI 2015a)	Yes (USDA-APHIS 2005; CABI 2015a)	Yes (CABI 2015a)	Yes. NSW (Plant Health Australia 2001). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. This species is a wood-inhabiting polypore (bracket fungus) that causes white root rot of mango (McMahon 2012; Fernando *et al.* 2012).	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rosellinia bunodes (Berk. & Broome) Sacc. [Xylariales: Xylariaceae] Black root rot	Yes (Suputa *et al.* 2010)	No records found	No records found	No records found	No. On roots and stems (CABI 2015a)	Assessment not required	Assessment not required	No
Rosellinia necatrix Berl.ex Prill. [Xylariales: Xylariaceae] White root rot	No (IAQA 2009)	Yes (Thienhirun and Whalley 2001; Farr and Rossman 2015)	Yes (Kiet 1998)	Yes. NSW,Qld, WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Schizophyllum commune Fr. : Fr. [Agaricales: Schizophyllaceae] Wood rot	Yes (Semangun 1992)	Yes (Farr and Rossman 2015)	No records found	Yes. NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2001)	Assessment not required	Assessment not required	Assessment not required	No
Sclerotium delphinii Welch Synonym: *Sclerotium rolfsii* var. *delphinii* (Welch) Boerema & Hamers [Agaricales: Typhulaceae]	No records found	Yes (USDA-APHIS 2005)	No records found	No records found	No. Causes rot around the base of mango seedlings (Ploetz and Prakash 1997)	Assessment not required	Assessment not required	No
Scolecostigmina mangiferae (Koord.) U. Braun & Mouch. Synonyms: *Cercospora mangiferae* Koord.; *Stigmina mangiferae* (Koord.) M.B. Ellis [Capnodiales: Mycosphaerellaceae] Mango leaf spot	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes (PPD 2009)	Yes. NT, Qld (Plant Health Australia 2001). Listed as a Declared Organism (Prohibited (section 12)) for WA (Government of Western Australia 2014).	No. Causes leaf spot (Crous 2009). No evidence of its presence on fruit.	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Setosphaeria rostrata K.J.Leonard Synonym: *Exserohilum rostratum* (Drechsler) K.J. Leonard & Suggs Anamorph [Pleosporales: Pleosporaceae] Leaf spot	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	Yes (Kew Royal Botanic Gardens 2014)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Stemphylium vesicarium (Wallr.) E.G. Simmons [Pleosporales: Pleosporaceae] Onion leaf blight	Yes (Semangun 1992)	Yes (USDA-APHIS 2005)	No records found	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No
Verticillium albo-atrum Reinke & Berthold [Incertae sedis: Plectosphaerellaceae] Verticillium wilt	No records found	Yes (Farr and Rossman 2015)	No records found	Yes. SA, Tas., Vic. (Walker 1990). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. This species causes *Verticillium* wilt resulting in necrosis of parts of the tree canopy and are not known to affect fruit (Ploetz and Prakash 1997).	Assessment not required	Assessment not required	No
Verticillium dahlia Kleb. [Incertae sedis: Plectosphaerellaceae]	No records found	No records found	No records found	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2001).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Indonesia	Present in Thailand	Present in Vietnam	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Vialaea minutella Petr. [Xylariales: Vialaeaceae]	No records found	Yes (Farr and Rossman 2015)	No records found	Yes. Qld (McTaggart *et al.* 2013). Under the BAM Act (section 14) this pest is an unlisted organism for WA and requires further assessment (Government of Western Australia 2014).	No. This species causes branch dieback of mango (McTaggart *et al.* 2013).	Assessment not required	Assessment not required	No
Zimmermanniella trispora P. Henn. [Phyllachorales: Phyllachoraceae] Tar spot of leaves; Crusty leaf spot	Yes (Cannon 1992)	Yes (Farr and Rossman 2015)	Yes (Farr and Rossman 2015)	No records found	No. Causes leaf spot (Cannon 1992).	Assessment not required	Assessment not required	No

Appendix B Biosecurity framework

Australia's biosecurity policies

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

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

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

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

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

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

Roles and responsibilities within Australia's quarantine system

Australia protects its human, animal and plant life or health through a comprehensive quarantine system that covers the quarantine continuum, from pre-border to border and post-border activities. The Australian Government Department of Health is responsible for human health aspects of quarantine. The Australian Government Department of Agriculture is responsible for animal and plant life or health.

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

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

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

Roles and responsibilities within the Department

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

The Department takes the lead in biosecurity and quarantine policy development and the establishment and implementation of risk management measures across the biosecurity continuum, and:

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

Roles and responsibilities of other government agencies

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

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

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

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

When undertaking risk analyses, the Department of Agriculture consults with the Department of the Environment about environmental issues and may use or refer to the Department of the Environment's assessment.

Australian quarantine legislation

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

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

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

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

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

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

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

  a) the probability of:

   i) a disease or pest being introduced, established or spread in Australia, the Cocos Islands or Christmas Island; and
   ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and

b) the probable extent of the harm.

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

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

The Regulations are available on the ComLaw website.

International agreements and standards

The process set out in the *Import Risk Analysis Handbook 2011* is consistent with Australia's international obligations under the SPS Agreement. It also takes into account relevant international standards on risk assessment developed under the International Plant Protection Convention (IPPC) and by the World Organisation for Animal Health (OIE).

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

Notification obligations

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

Risk analysis

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

In conducting a risk analysis, the Department of Agriculture:

- identifies the pests and diseases of quarantine concern that may be carried by the good

- assesses the likelihood that an identified pest or disease would enter, establish or spread
- assesses the probable extent of the harm that would result.

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

Risk analyses may be carried out by the Department of Agriculture's specialists, but may also involve relevant experts from state and territory agencies, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities and industry to access the technical expertise needed for a particular analysis.

Risk analyses are conducted across a spectrum of scientific complexity and available scientific information. An IRA is a type of risk analysis with key steps regulated under the Quarantine Regulations 2000. The Department of Agriculture's assessment of risk may also take the form of a non-regulated analysis of existing policy or technical advice. Further information on the types of risk analysis is provided in the *Import Risk Analysis Handbook 2011.*

Glossary

Term or abbreviation	Definition
Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2012).
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 2012).
Area of low pest prevalence	An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2012).
Arthropod	The largest phylum of animals, including the insects, arachnids and crustaceans.
Asexual reproduction	The development of new individual from a single cell or group of cells in the absence of meiosis.
Biosecurity	The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents to protect human, animal or plant health or life, and the environment (DAFF 2011).
Calyx	A collective term referring to all of the sepals in a flower.
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 2012).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2012).
Crawler	Intermediate mobile nymph stage of certain Arthropods.
Diapause	Period of suspended development/growth occurring in some insects, in which metabolism is decreased.
The department	The Commonwealth Department of Agriculture.
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 2012).
Endemic	Belonging to, native to, or prevalent in a particular geography, area or environment.
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 2012).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2012).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2012).
Fumigation	A method of pest control that completely fills an area with gaseous pesticides to suffocate or poison the pests within.
Genus	A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.
Host	An organism that harbours a parasite, mutual partner, or commensal partner, typically providing nourishment and shelter.
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2012).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2012).

Import risk analysis	An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication.
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 2012).
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 2012).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2012).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2012).
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPCC (FAO 2012).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2012).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians).
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin et cetera, forming part of a consignment (FAO 2012). Within this report a ‘lot’ refers to a quantity of fruit of a single variety, harvested from a single production site during a single pick and packed at one time.
Mature fruit	Commercial maturity is the start of the ripening process. The ripening process will then continue and provide a product that is consumer-acceptable. Maturity assessments include colour, starch, index, soluble solids content, flesh firmness, acidity, and ethylene production rate.
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2012).
Nymph	The immature form of some insect species that undergoes incomplete metamorphosis, It is not to be confused with larva, as its overall form is already that of the adult.
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 2012).
Orchard	A contiguous area of mango trees operated as a single entity. Within this report a single orchard is covered under one registration and is issued a unique indentifying number.
Pathogen	A biological agent that can cause disease to its host.
Pathway	Any means that allows the entry or spread of a pest (FAO 2012).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2012).
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 2012).
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 2012).
Pest free place of production	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2012).

Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2012).
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 2012).
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 2012).
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a pest in plants for planting affects the indented use of those plants with an economically unacceptable impact (FAO 2012).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2012).
Pest risk management (for regulated non-quarantine pests)	Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants (FAO 2012).
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2012).
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 2012).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2012).
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 2012).
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2012).
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 2012).
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 2012).
Practically free	Of a consignment, field or place of production, without pests (or a specific pests) in numbers or quantities in excess of those that can be expected to result from, and be consistent with good cultural and handling practices employed in the production and marketing of the commodity (FAO 2012).
Production site	In this report, a production site is a continuous planting of mango trees treated as a single unit for pest management purposes. If an orchard is subdivided into one or more units for pest management purposes, then each unit is a production site. If the orchard is not subdivided, then the orchard is also the production site.
Pupa	An inactive life stage that only occurs in insects that undergo complete metamorphosis, for example butterflies and moths (Lepidoptera), beetles (Coleoptera) and bees, wasps and ants (Hymenoptera).
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing or treatment (FAO 2012).
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 2012).
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 2012).
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO 2012).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2012).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Saprophyte	An organism deriving its nourishment from dead organic matter.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2012).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Surveillance	An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2012).
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.
Trash	Soil, splinters, twigs, leaves, and other plant material, other than fruit stalks.
Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2012).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.
Vector	An organism that does not cause disease itself, but which causes infection by conveying pathogens from one host to another.
Viable	Alive, able to germinate or capable of growth.

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