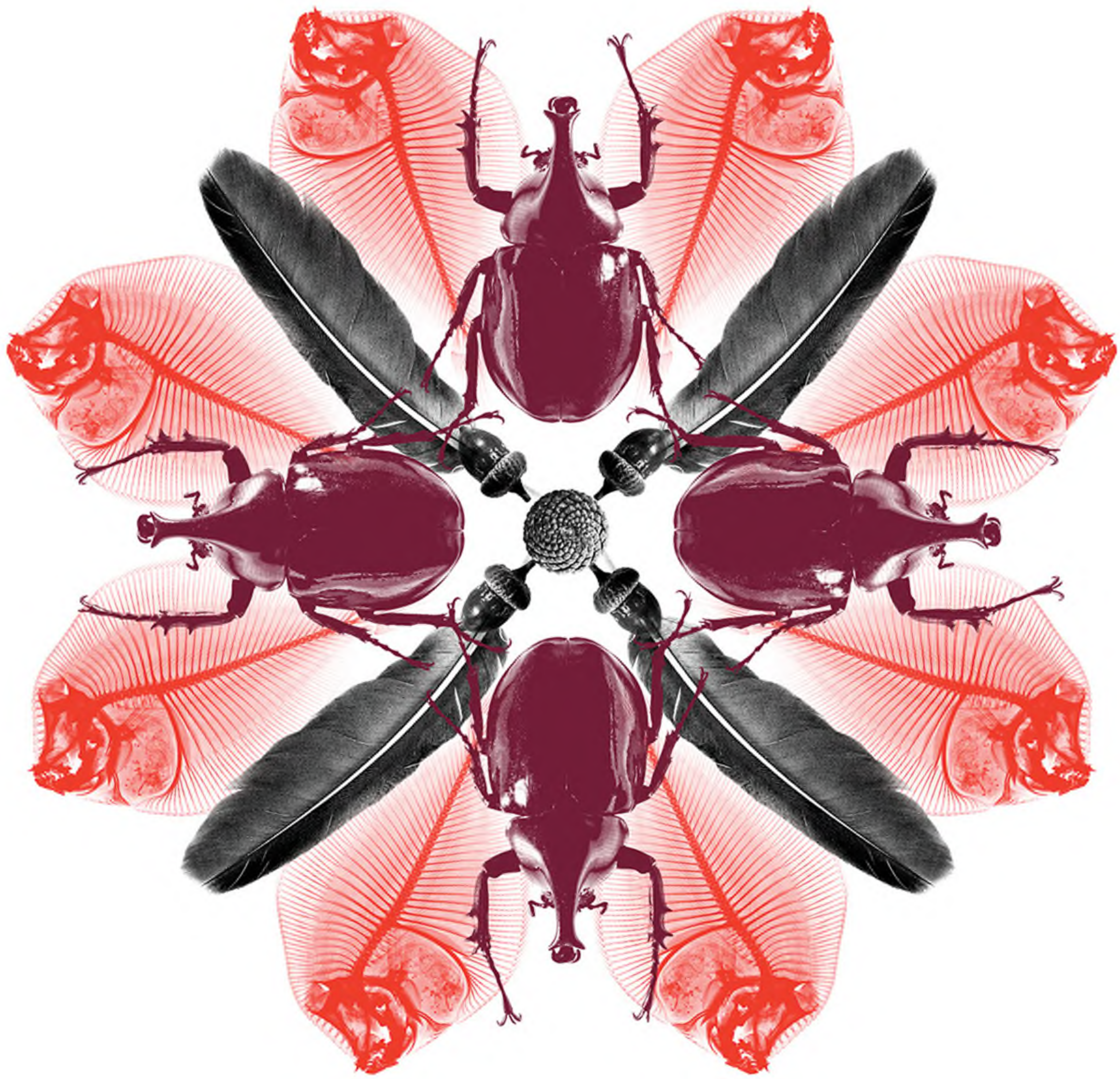
Australian Government
Department of Agriculture

Final report for the review of biosecurity import requirements for fresh avocados from Chile

December 2019



Cataloguing data

Department of Agriculture 2019, *Final report for the review of biosecurity import requirements for fresh avocados from Chile*, Department of Agriculture, Canberra.

This publication is available at agriculture.gov.au.

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Contents

Figures

Tables

Maps

Map 1 Map of Australia

Map 2 A guide to Australia's bio-climatic zones

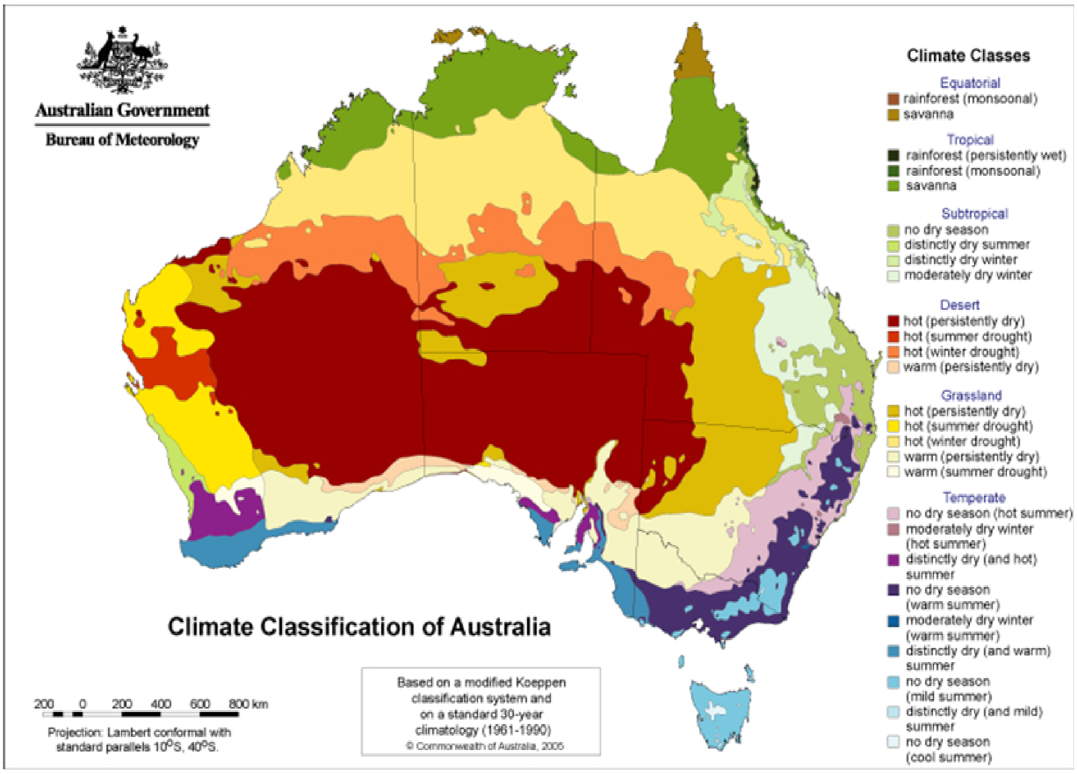
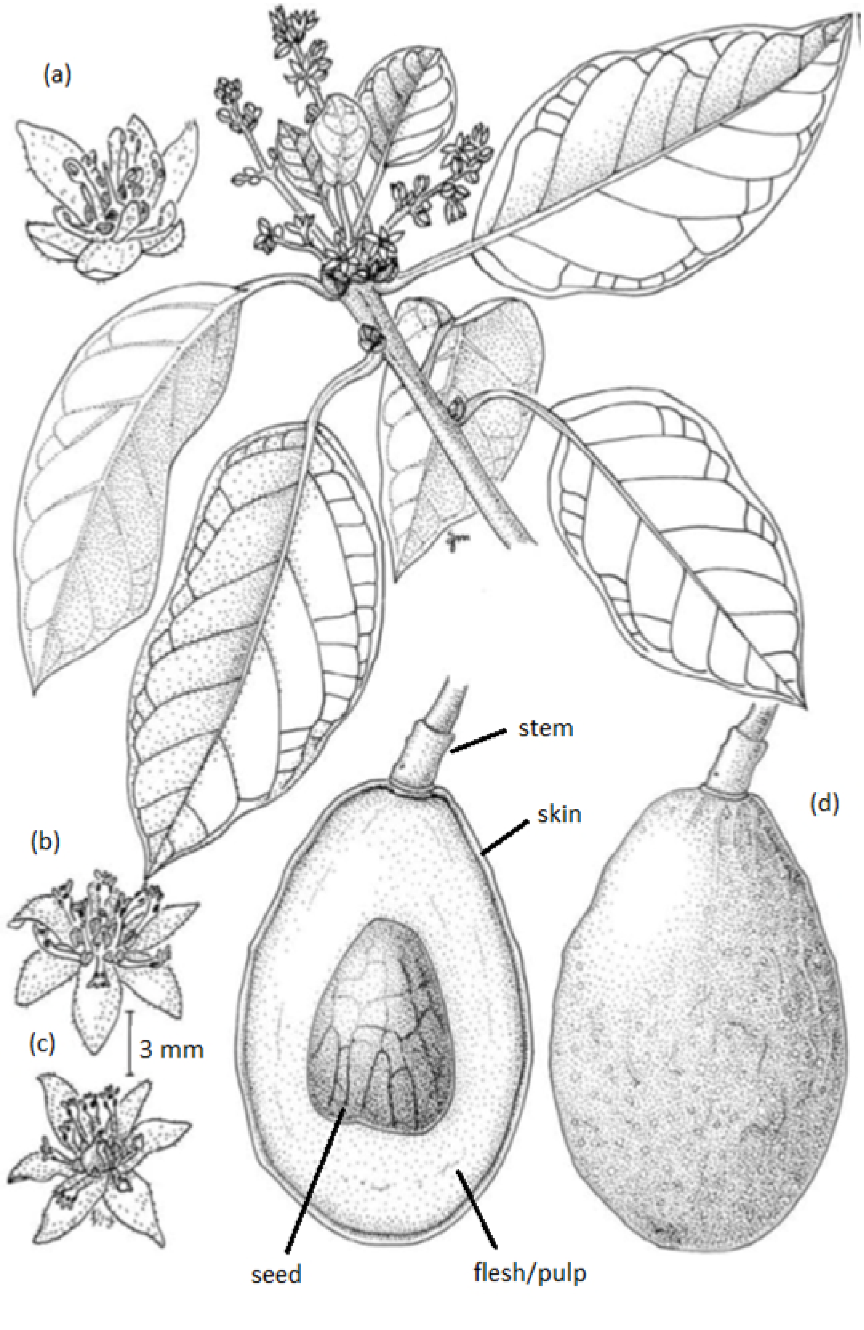


Figure 1 Diagram of avocado leaf, fruit and flower



Source: Adapted from Paull and Duarte (2011). Flower (a) is from the first opening stage and is female; (b) is the second opening and male, with the anthers semi-erect and dehisced; and (c) is a fully mature flower after dehiscence. Fruit (d).

Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BA	Biosecurity Advice
BICON	Australia's Biosecurity Import Conditions System
BIRA	Biosecurity Import Risk Analysis
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EP	Existing policy
FAO	Food and Agriculture Organization of the United Nations
FSANZ	Food Standards Australia New Zealand
GP	Group pest risk analysis
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
NSW	New South Wales
NAPPO	North American Plant Protection Organization (Mexico, USA, Canada)
NFFDS	National Fruit Fly Detection System
NPPO	National Plant Protection Organisation
NT	Northern Territory
PRA	Pest risk analysis
Qld	Queensland
SA	South Australia
SAG	Servicio Agrícola y Ganadero (Chile's Agriculture and Livestock Service)
SPS Agreement	WTO agreement on the Application of Sanitary and Phytosanitary Measures
Tas.	Tasmania
the department	The Department of Agriculture
ULDs	Unit Loading Devices
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

Summary

This risk analysis report considers the biosecurity risks for Australia associated with the importation of commercially produced fresh avocado fruit for human consumption from Chile.

Currently the importation of fresh avocado fruit for human consumption is permitted into Australia only from New Zealand, provided it meets Australian biosecurity import conditions.

This final report recommends that the importation of fresh avocado fruit to Australia from all commercial production areas of Chile be permitted, subject to it meeting a range of biosecurity requirements, as summarised in this report.

This final report contains details of all known pests with the potential to be associated with the importation of fresh avocado fruit from Chile that may be of biosecurity concern to Australia. It also provides risk assessments for identified quarantine pests, and recommends risk management measures to reduce the biosecurity risk to an acceptable level.

Seven quarantine pests have been identified in this risk analysis as requiring risk management measures. These pests are:

- Fruit fly: Mediterranean fruit fly (*Ceratitis capitata*)
- Mealybug: grape mealybug (*Pseudococcus maritimus*)
- Thrips: Chilean flower thrips (*Frankliniella australis*), tamarugo thrips (*Frankliniella gemina*) and western flower thrips (*Frankliniella occidentalis*)
- *Oligonychus* spider mites: avocado brown mite (*Oligonychus punicae*) and avocado red mite (*Oligonychus yothersi*).

These seven identified species are the same, or of the same pest groups, as those associated with other horticultural commodities that have been previously assessed by the department.

Recommended risk management measures take account of regional differences within Australia. One pest, western flower thrips (*Frankliniella occidentalis*), has been identified as a regional quarantine pest for the Northern Territory because interstate quarantine regulations and enforcement are in place for this species. Western flower thrips was also assessed as a regulated article for all of Australia, as it is capable of harbouring and spreading emerging orthotospoviruses that are quarantine pests for Australia, and therefore requires risk management measures for all of Australia.

This final report recommends a range of risk management measures, combined with an operational system, to ensure biosecurity standards are met. The recommended risk management measures will reduce the risks posed by the seven identified quarantine pests, so as to achieve the appropriate level of protection for Australia. These measures are:

- area freedom or fruit treatment (such as cold disinfestation treatment) for all cultivars, or hard condition of fruit for the Hass cultivar only, for Mediterranean fruit fly
- pre-export visual inspection and, if found, remedial action for grape mealybug, *Oligonychus* spider mites and thrips.

The department recognises Chile as free from Mediterranean fruit fly. However, in the case of an outbreak of Mediterranean fruit fly, should Chile wish to use one or more of the recommended measures of cold disinfestation treatment for all cultivars or hard condition of fruit for the Hass

cultivar only to manage the risk posed by Mediterranean fruit fly, SAG would need to provide an appropriate technical submission to the department for its consideration.

Upon finalisation of this policy, Chile must be able to demonstrate to the department that processes and procedures are in place to implement the recommended risk management measures. This will ensure safe trade in fresh avocados from Chile. Import conditions can then be published in the Australian Government's Biosecurity Import Conditions (BICON) system on the department's website, which can be accessed at bicon.agriculture.gov.au/BiconWeb4.0.

Written submissions on the draft report were received from seven stakeholders. In addition, a number of issues were raised by stakeholders through the risk analysis process. The department has made a number of changes to the report following consideration of all the technical comments raised by stakeholders, and subsequent review of the literature. These changes include:

- Amendments to 'Appendix A: Initiation and categorisation for pests of fresh avocado fruit from Chile' following review of further scientific literature and/or consultation with experts, including to the taxonomic status of some of the species of pathogens (*Neofusicoccum ribis*, *Dothiorella iberica* and *Calonectria cylindrospora*) and one mite (*Eotetranychus sexmaculatus*).
  - *Neofusicoccum ribis* has been removed from the pest categorisation on the basis that it only infects *Ribes* species and is not associated with avocado.
  - *Dothiorella iberica* has been added to the pest categorisation as it is present in Chile and can be associated with avocado fruit. This species was subsequently assessed as present in Australia and therefore was not assessed further.
  - The pest statuses of *Calonectria cylindrospora* and *Eotetranychus sexmaculatus* in Australia have been revised to 'not present', and as a result the potential of these pests to be on the pathway was assessed. Both pests were assessed as not being associated with the avocado fruit export pathway.
- Addition of further information in 'Section 4.3 Grape mealybug', following further consideration of the scientific literature on *Pseudococcus* species in Chile, to acknowledge contradictory evidence and uncertainty about the pest status of *Pseudococcus maritimus* in Chile.
- Addition of 'Appendix B: Issues raised in stakeholder comments' which summarises the key technical issues raised by stakeholders, and how they were considered by the department.
- Minor corrections, rewording, and editorial changes for consistency, clarity, and web–accessibility.

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 policy development. It enables the Australian Government to formally consider the level of biosecurity risk that may be associated with proposals to import goods into Australia. If the biosecurity risks do not achieve the appropriate level of protection (ALOP) for Australia, risk management measures are recommended to reduce the risks to an acceptable level. If the risks cannot be reduced to an acceptable level, the goods will not be imported into Australia until suitable measures are identified.

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

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

Risk analyses may take the form of a biosecurity import risk analysis (BIRA) or a review of biosecurity import requirements (such as scientific review of existing policy and import conditions, pest-specific assessments, weed risk assessments, biological control agent assessments or scientific advice).

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016* located on the Department of Agriculture website at http://www.agriculture.gov.au/biosecurity/risk-analysis/guidelines.

1.2 This risk analysis

1.2.1 Background

Chile's Servicio Agrícola y Ganadero (SAG, Chile's Agriculture and Livestock Service) formally requested market access to Australia for avocados for human consumption in a submission received in October 2006. This submission included information on the pests associated with avocado crops in Chile, including the plant part(s) affected, and the standard commercial production practices for fresh avocado fruit in Chile.

In January 2012 and October 2017, officers from the department visited avocado production areas in Chile. The objectives of these visits were to observe commercial production, pest management and other export practices.

On 23 March 2018, the department announced the commencement of this risk analysis, advising that it would be progressed as a review of biosecurity import requirements. This analysis has been conducted in accordance with the *Biosecurity Act 2015*.

1.2.2 Scope

The scope of this risk analysis is to consider the biosecurity risk that may be associated with the pathway of fresh avocado fruit (henceforth avocados) (*Persea americana*) grown in Chile using standard commercial production practices and packing procedures, as described in 'Chapter 3: Chile's commercial production practices for avocados', for import into Australia for human consumption.

For the purposes of this risk analysis, avocados are defined as the entire fruit with the skin, flesh, seed and a small portion of the stem (Figure 1). This risk analysis assesses commercially produced avocados of all cultivars/varieties from all regions of Chile in which they are grown for export.

1.2.3 Existing policy

International policy

Import policy exists for avocados from New Zealand into Australia. For Chile, import policy exists for table grapes (Biosecurity Australia 2005b). The potential pests of biosecurity concern identified for fresh avocado fruit from Chile are the same as, or similar to, those identified for commodities for which import conditions already exist.

The import requirements for these commodity pathways can be found at the department's Biosecurity Import Conditions (BICON) system on the department's website at https://bicon.agriculture.gov.au/BiconWeb4.0.

The department has considered all the pests and pest groups previously identified in existing policies and, where relevant, the information in those assessments has been taken into account in this risk analysis. The department has also reviewed the latest literature to ensure that information in previous assessments is still valid. The biosecurity risk posed by thrips, and the orthotospoviruses they transmit, from all countries was previously assessed in the *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017) (thrips Group PRA), which is applicable to avocados from Chile. The department has determined that the information in those assessments can be adopted for the species under consideration in this risk analysis.

The *Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut flower and foliage imports* was finalised in January 2019. As the group policy was finalised close to the release of the draft report for avocados from Chile, the group policy was not adopted for this risk analysis. However, its assessments and recommended risk management measures are consistent with the present analysis.

Domestic arrangements

The Australian Government is responsible for regulating the movement of goods such as 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. After imported plants and plant products have been cleared by Australian Government biosecurity officers, they may be subject to interstate movement regulations/arrangements. 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 avocados from Chile that are assessed in this risk analysis, other organisms may arrive with the imported commodity. These organisms may include pests considered not to be associated with the fruit pathway, pests of other crops, or predators and parasitoids of other arthropods. For example, brown marmorated stinkbug (*Halyomorpha halys*), which has recently been detected in Chile but is not considered associated with avocado fruit, could arrive with avocados from Chile as it may be associated with packaging material. The department considers these organisms to be contaminating pests that could pose sanitary risks (to human or animal life or health) or phytosanitary risks (to plant life or health). These risks are identified and addressed using existing operational procedures that require a random 600 unit inspection of all consignments on arrival, or equivalent procedures. The department will investigate if any pest identified through these processes may be of biosecurity concern to Australia, and thus may require remedial action.

1.2.5 Consultation

On 23 March 2018, the department notified stakeholders (Biosecurity Advice 2018/05) of the commencement of a review of biosecurity import requirements for fresh avocado fruit from Chile.

Prior to and after the announcement of this risk analysis, the department engaged with the Australian avocado industry regarding the process and technical aspects of this risk analysis.

The department has also consulted with Chile's SAG and Australian state and territory governments during the preparation of this report.

The draft report was released on 28 February 2019 (Plant Biosecurity Advice 2019/P03) for comment by stakeholders, for a consultation period of 60 days that concluded on 29 April 2019.

The department received seven written submissions on the draft report. All submissions received, and issues raised by domestic stakeholders during the consultation period, were carefully considered and, where relevant, changes were made to the final report. A summary of key technical stakeholder comments and how they were considered is provided in Appendix B.

1.2.6 Next Steps

The final report will be published on the department's website, along with a notice advising stakeholders of its release. The department will also notify Chile's SAG, registered stakeholders and the WTO Secretariat of the release of the final report. Publication of the final report represents the end of the risk analysis process.

Before any trade in fresh avocados from Chile commences, the department will verify that Chile can implement the required pest risk management measures, and the system of operational procedures necessary to maintain and verify the phytosanitary status of fresh avocados for export to Australia from Chile (as specified in Chapter 5: Pest risk management of this report). On verification of these requirements, the import conditions for fresh avocados from Chile will be published in the department's Biosecurity Import Conditions (BICON) system.

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 2016a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c) 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 2019b). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO 2019b). This definition is also applied in the *Biosecurity Act 2015*.

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

Unrestricted risk is estimated taking into account the existing commercial production practices of Chile and recognition that, on arrival in Australia, the department will verify that the consignment received is as described on the commercial documents and its integrity has been maintained.

Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is 'any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests' (FAO 2019b).

A glossary of the terms used in the risk analysis is provided at the end 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 biosecurity 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 in other risk assessments and for which import conditions already exist, this risk analysis considered 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, previous risk assessments were taken into consideration in this risk analysis.

A Group Pest Risk Analysis (Group PRA) has been applied in this risk analysis, as explained in Section 2.2.7.

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 2019b).

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 2019b).

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 4.1.

2.2.2 Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2019c). The SPS Agreement (WTO 1995) uses the term 'likelihood' rather than 'probability' for these estimates. In qualitative PRAs, the department uses the term 'likelihood' for the descriptors it uses for its estimates of likelihood of entry, establishment and spread. The use of the term 'probability' is limited to the direct quotation of ISPM definitions.

A summary of this process is given here, followed by a description of the qualitative methodology used in this risk analysis.

Likelihood of entry

The likelihood of entry describes the likelihood 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 likelihood 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 when estimating the likelihood of entry.

For the purpose of considering the likelihood of entry, the department divides this step into two components:

- **Likelihood of importation**—the likelihood that a pest will arrive in Australia when a given commodity is imported.
- **Likelihood of distribution**—the likelihood 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 to be considered in the likelihood of importation may 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 to be considered in the likelihood of distribution may 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.

Likelihood of establishment

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO 2019b). In order to estimate the likelihood 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 likelihood of establishment.

Factors to be considered in the likelihood of establishment in the PRA area may 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.

Likelihood of spread

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO 2019b). The likelihood 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 likelihood of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the likelihood of spread.

Factors to be considered in the likelihood of spread may 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 likelihoods for entry, establishment and spread

Likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 2.1). Definitions for these descriptors and their indicative probability ranges are given in Table 2.1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors 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 2.1 Nomenclature of likelihoods

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

Combining likelihoods

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

For example, if the 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 2.2 Matrix of rules for combining likelihoods

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

Time and volume of trade

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

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

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's method that uses the estimated volume of one year's trade are consistent with Australia's policy on appropriate level of protection and meet the Australian Government's requirement for ongoing quarantine protection. If there are substantial changes in the volume and nature of the trade in specific commodities then the department will review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this risk analysis, the department 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 potential 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 2019b) and ISPM 11 (FAO 2019c).

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
- non-commercial and environmental.

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 2.3. For example, a consequence with a magnitude of 'significant' at the 'district' level will have a consequence impact score of D.

Table 2.3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales

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

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

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

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

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

2.2.4 Estimation of the unrestricted risk

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

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

Table 2.5 Risk estimation matrix

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 The appropriate level of protection (ALOP) for Australia

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. The ALOP for Australia, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 2.5 marked 'very low risk' represents the ALOP for Australia.

2.2.6 Adoption of outcomes from previous assessments

Outcomes of previous risk assessments have been adopted in this assessment for pests for which the risk profile is assessed as comparable to previously assessed situations.

The prospective adoption of previous risk assessment ratings is considered on a case-by-case basis by comparing factors relevant to the current commodity/country pathway with those assessed previously. For assessment of the likelihood of importation, factors considered/compared include the commodity type, the prevalence of the pest and commercial production practices, whereas for assessment of the likelihood of distribution of a pest the factors include the commodity type, the time of year when importation occurs, and the availability and susceptibility of hosts at that time. After comparing these factors and reviewing the latest literature, previously determined ratings may be adopted if the department considers the likelihoods to be comparable to those assigned in the previous assessment(s).

The likelihoods of establishment and of spread of a pest species in the PRA area (in this instance, Australia) will be comparable between risk assessments, regardless of the commodity/country pathway through which the pest is imported, as these likelihoods relate specifically to conditions and events that occur in the PRA area, and are independent of the import pathway. Similarly, the estimate of potential consequences associated with a pest species is also independent of the import pathway. Therefore, the likelihoods of establishment and of spread of a pest, and the estimate of potential consequences, are directly comparable between assessments, and may be adopted with confidence.

2.2.7 Application of a Group PRA

Risk estimates derived from a Group PRA are 'indicative' in character. This is because the likelihood of entry (the combined likelihoods of importation and distribution) can be influenced by a range of pathway-specific factors, as explained in Section 2.2.6. Therefore, the indicative likelihood of entry from a Group PRA needs to be verified on a case-by-case basis.

In contrast, and as noted in Section 2.2.6, the risk factors considered in the likelihoods of establishment and spread, and the potential consequences associated with a pest species are not pathway-specific, and are therefore comparable across all import pathways within the scope of the Group PRA. This is because at these latter stages of the risk analysis the pest is assumed to have already found a host within Australia at or beyond its point of entry. Therefore, a Group PRA assessment can be applied as the default outcome for any pest species on a plant import pathway once the previously assigned likelihood of entry has been verified.

In a scenario where the likelihood of entry for a pest species on a commodity is assessed as different to the indicative estimate, the Group PRA-derived likelihoods of establishment and spread and the estimate of consequences can still be used, but the overall risk rating may change.

The Group PRA that was applied to this risk analysis is:

- *The Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017), which is referred to as the 'thrips Group PRA'.

The *Final group pest risk analysis for mealybugs and the viruses they transmit on fresh fruit, vegetable, cut flower and foliage imports* was finalised in January 2019. As the group policy was finalised close to the release of the draft report for avocados from Chile, the group policy was not adopted for this risk analysis. However, its assessments and recommended risk management measures are consistent with the present analysis.

2.3 Stage 3 Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve the ALOP for Australia, 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 does not achieve the ALOP for Australia, 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 the ALOP for Australia. The effectiveness of any recommended phytosanitary measures (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure the restricted risk for the relevant pest or pests achieves the ALOP for Australia.

ISPM 11 (FAO 2019c) 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 likelihood 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 level of biosecurity risk does not achieve the ALOP for Australia. These are presented in Chapter 5: Pest risk management, of this report.

3 Chile's commercial production practices for avocados

This chapter provides information on the pre-harvest, harvest and post-harvest practices considered to be standard practices in Chile for the production of avocados for export. The export capability of Chile is also outlined.

3.1 Considerations used in estimating unrestricted risk

Chile provided Australia with information on the standard commercial practices used in the production of avocados in different regions of Chile. This information has been complemented with data from other sources such as published literature and observations during visits to Chile, all of which have been taken into consideration when estimating the unrestricted risks of pests that may be associated with the import of this commodity.

In January 2012 and October 2017, officers from the department visited avocado production areas in Chile, in the regions of Valparaiso and Metropolitan. The objectives of these visits were to observe commercial production, pest management and other export practices. The department's observations and additional information provided during the visits confirmed the production and processing procedures described in this chapter as standard commercial production practices for avocados for export.

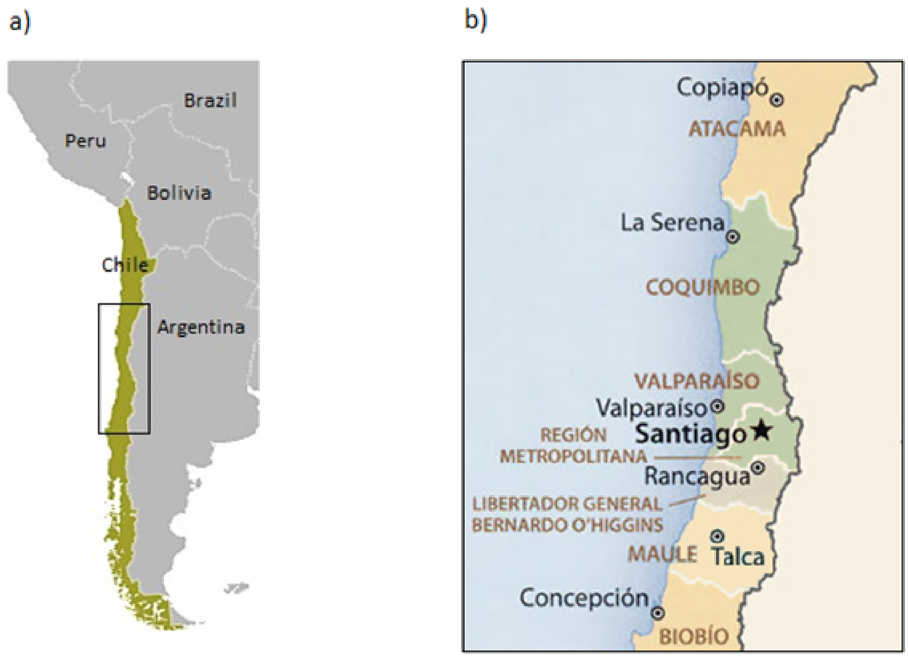
In estimating the likelihood of pest introduction to Australia it has been assumed that the pre-harvest, harvest and post-harvest production practices for avocado as described in this chapter are implemented for all regions and for all avocados within the scope of this analysis. Where a specific practice described in this chapter has not been used to estimate the unrestricted risk, it is clearly identified and explained in Chapter 4.

3.2 Avocado production areas

Chile's main avocado production areas are located in the regions of Valparaiso (accounting for over 65 per cent of the total area planted), Coquimbo (accounting for 15 per cent of the total area planted) and Metropolitan (accounting for 15 per cent of the total area planted).

The main avocado production regions are depicted in Map 3.

Map 3 Chile's major avocado production regions



a) Chile (in green) and neighbouring countries. The black box indicates the area enlarged in (b).
b) The three major avocado-producing regions, Coquimbo, Valparaiso and Metropolitan (Región Metropolitana), are shown in green.
Source: Adapted from www.wpclipart.com. Modified based on information from Gonzalez (2017).

3.3 Climate in production areas

Chile has 15 administrative regions with a distance of around 4,500 km from the northernmost to the southernmost point of the country. The main avocado production regions are Valparaiso, Metropolitan and Coquimbo which are located in the centre of the country.

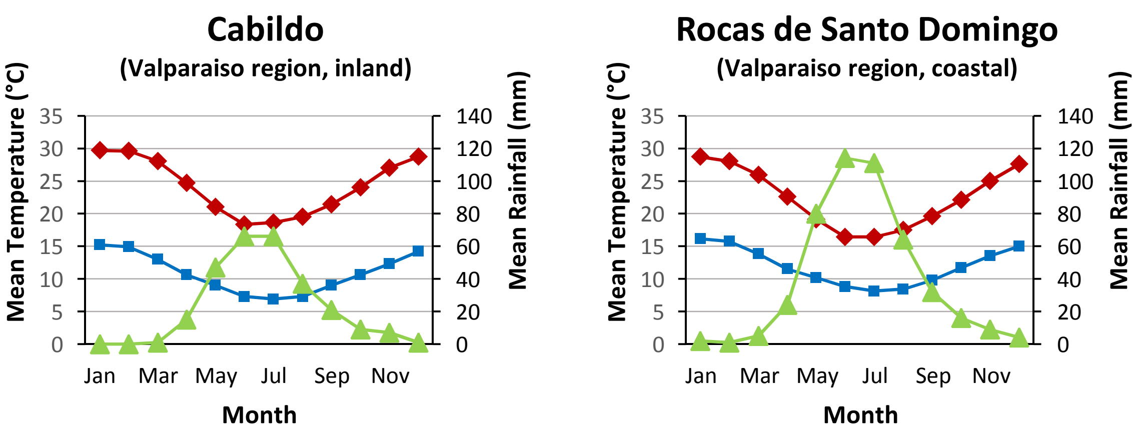
The climate in these regions is Mediterranean with long, warm to hot, dry summers (December, January, February) and rain mainly occurring during the cool winters (June, July, August). There is some variation in the climate from west to east, between areas close to the coast and inland areas. Local temperatures of inland areas are also influenced by perpendicularly crossing river valleys.

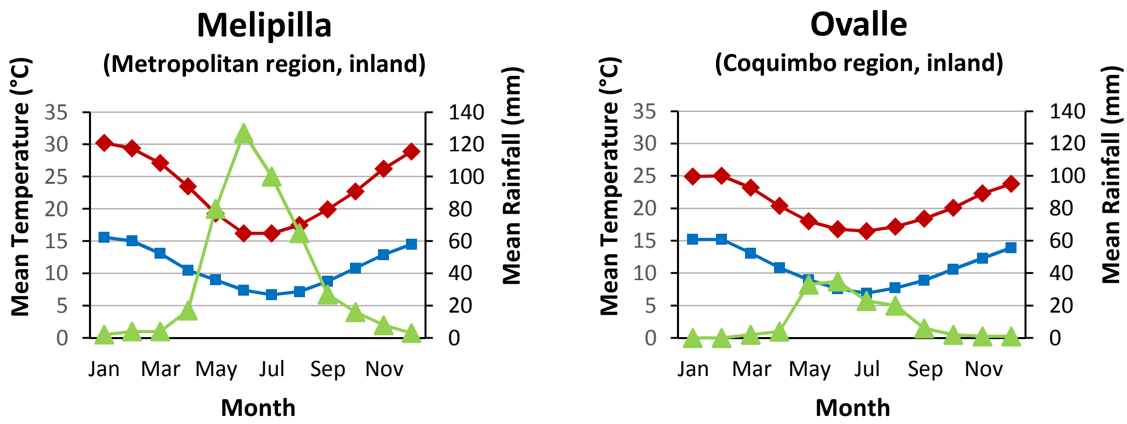
Recent avocado plantings are preferably located on the hillsides to avoid the frost in the valleys (Figure 2). Orchards that are located in valleys use wind generators to move the cold air and minimise frost damage.

Figure 2 Avocado orchard in the Metropolitan region (Melipilla province) with hillside plantings

Annual mean monthly rainfall, as well as minimum and maximum temperatures for some locations in avocado-producing areas in the three major avocado production regions are shown in Figure 3.

Figure 3 Monthly maximum and minimum temperatures and mean rainfall data in avocado production areas of Chile





Monthly mean maximum (—♦—) and minimum (—■—) temperatures (°C) and mean monthly rainfall (—▲—) (millimetres) from climate data collected between 1982 and 2012 (Climate-data.org 2017) in avocado production areas of the regions of Coquimbo, Valparaiso and Metropolitan in Chile.

3.4 Pre-harvest

3.4.1 Cultivars

The main avocado cultivar grown in Chile is Hass, which accounts for over 88 per cent of the total planted area. Other avocado cultivars grown in Chile are Bacon, Edranol, Fuerte and Negra de La Cruz (Gonzalez 2016; Lemus et al. 2010; Paull & Duarte 2011). Some cultivars such as Bacon, Edranol and Zutano are specifically planted as pollinisers alongside Hass (Crane et al. 2013; Newett 2015). The main cultivars and their respective planted areas are shown in Table 3.1.

Table 3.1 Main avocado cultivars by planted area in Chile

Cultivars	Area (ha)	Percentage (%)
Hass	26,419.99	88.26
Edranol	1,098.68	3.67
Negra de la Cruz	821.16	2.74
Fuerte	557.26	1.86
Bacon	291.86	0.97
Total	29,188.95	97.5

Hass is the main cultivar exported from Chile (Gonzalez 2016) and is expected to be the only cultivar exported to Australia. The characteristics of this cultivar are described here.

Hass

The fruit of the Hass cultivar is ovate or pyriform shaped, depending on growing conditions, and has a dark green, rough skin (Figure 4), which darkens when the fruit is mature. During ripening, the skin colour changes from green to purple/black. The fruit is small to medium in size, weighing on average 250 to 350 grams, with a medium-sized round seed. As the fruit matures, its oil content increases and its moisture content decreases. The mature fruit has a typical oil content of 18 to 20 per cent and a minimum dry matter content of 20.8 per cent (Crane et al. 2013; Paull & Duarte 2011). The flesh is creamy and yellow with a rich and nutty flavour. The fruit can be left on the tree for several months after it has reached physiological maturity and so the tree can act as a fruit storage plant. Ripening starts once the fruit has been harvested (CHAC 2015; Crane et al. 2013; Paull & Duarte 2011).

Figure 4 Hass avocado

3.4.2 Cultivation practices

Planting materials

Scions (cuttings) of commercial avocado cultivars are grafted onto seedling rootstocks. Characteristics sought in avocado rootstock are resistance to salinity, resistance to Phytophthora root rot, small stature trees and high sustainable yields of quality fruit (Crane et al. 2013; Paull & Duarte 2011). Cultivars used as rootstock in Chile include Mexicola, Nabal, Zutano and Velvick, with Mexicola being the main cultivar used (Crane et al. 2013).

Particularly for high-density plantings, seedlings of commercial avocado cultivars, without grafting, are also used as Phytophthora root rot is still at a low level in Chile and grafting onto Phytophthora resistant rootstock is not essential (Whiley, Wolstenholme & Faber 2013).

Cultivation

Avocado trees are planted on mounds to prevent waterlogging of the roots. In older avocado plantings, tree density is generally low and trees are arranged in a square pattern with spacing between trees of around 10 metres by 10 metres or 8 metres by 8 metres. Trees in these low-density plantings are generally not pruned. Other planting densities which have been used in Chile are tree spacing of 6 metres by 2 metres, 6 metres by 3 metres or 3 metres by 3 metres (Gardiazabal & Mena 2011; Paull & Duarte 2011).

In recent years, avocado production in Chile has moved to high-density plantings which come quickly into production and produce high yields. These high-density plantings, which are arranged in a square pattern, have a spacing between trees ranging from around 2.3 meters by 2.3 metres to around 1.2 metres by 1.2 metres (Newett 2015; Rolshausen, Arpaia & Faber 2016). An example of a densely planted avocado orchard is shown in Figure 5.

Figure 5 Rows of avocado trees in the San Antonio area (Valparaiso region)

As these high-density plantings get older, some trees are removed to allow sufficient sunlight penetration. Pruning, including tree topping and cutting side branches to reduce shading, is an important management tool with this high-density planting. The trees are generally kept to a height of about two metres to simplify harvesting and keep costs down. Pruning is generally done in spring right after harvest and again in autumn (Rolshausen, Arpaia & Faber 2016).

Many of the new plantings are located on steep hillsides where land costs are lower, orchard sizes are larger, frost risk is reduced, climatic conditions for fruit set are better, and fruit matures earlier compared to the orchards planted in river valleys (Gardiazabal & Mena 2011; Whiley, Wolstenholme & Faber 2013).

Application of plant growth regulators plays an increasingly important role in avocado production and is commonly used in Chile (Rolshausen, Arpaia & Faber 2016; Whiley, Wolstenholme & Faber 2013). Other management tools used to optimise production include girdling (cutting through the bark), a method used to temporarily reduce or stop the flow of sap via the bark or phloem to the lower parts of the tree.

Nutrients such as nitrogen, zinc, boron and potassium are applied at different times during the year to match the phenological stage of the tree. In addition, a number of methods are used to determine nutrient requirements. These methods include analysis of leaf samples and careful observation of leaf appearance and size.

In addition to the natural leaf litter, tree prunings are often mulched and added to the ground beneath the trees. The combination of natural leaf litter and mulched prunings beneath trees, as well as shading in densely planted orchards, prevents the growth of weeds.

Avocado trees are very sensitive to both water stress and excess moisture, especially when drainage is inadequate (Paull & Duarte 2011). With Chile's long dry summers, well-managed irrigation is an important part of avocado production. In general, drip irrigation or ground sprinklers are used. Some farms use probes or other methods to measure soil moisture and irrigate accordingly. Water is sourced from underground or from nearby rivers.

Hass avocado trees blossom once each year from the beginning to the end of spring. Bee hives, at the rate of 10 hives per hectare, are brought into the orchard at flowering time for pollination. Fruit is ready for harvest from nine months after blossom, generally in July, and harvest finishes in February/March (CHAC 2015).

3.4.3 Pest management

Chile is naturally isolated from neighbouring countries through the Atacama Desert in the north, the Andes mountain ranges in the east, the Pacific Ocean in the west and Antarctica in the south. This natural isolation helps maintain Chile's favourable phytosanitary status including freedom from fruit flies of economic importance.

Chile has a system in place, the National Fruit Fly Detection System (NFFDS), to maintain its freedom from fruit flies of economic importance and eradicate any outbreaks. The NFFDS includes strict quarantine controls at points of entry into Chile, a permanent surveillance system with fruit fly traps (for species of the genera *Ceratitis*, *Anastrepha* and *Bactrocera*) and sampling of host fruit, and a contingency plan for rapid response to the detection of any exotic fruit flies.

In addition, SAG has a permanent Agricultural Surveillance Program for pests in place for the whole country. This surveillance program consists of surveillance of orchards and domestic trees, and includes both general as well as crop-specific surveillance. The program aims to visit different orchards from year to year. Each regional SAG office develops a surveillance program for the following year, according to a number of parameters including crop types and the number of inspections the regional office is required to conduct. As part of this surveillance program, 3,367 avocado orchards accounting for around 29,000 hectares of avocado plantings have been surveyed between January 2009 and August 2017.

Regular pest monitoring is conducted by avocado producers and, if necessary, any pests are controlled. Some producers also employ external contractors to conduct monthly pest monitoring, in addition to informal monitoring carried out by farm staff.

3.5 Harvesting and handling procedures

As part of SAG's phytosanitary certification system, orchards intending to export fruit must be registered by SAG.

Harvest starts when the avocado fruit reaches 20 to 22 per cent dry matter, which is generally around September. Pickers harvest the fruit using clippers and, for picking fruit from taller trees, use clippers on extendable poles with a net attached. Fruit stems are generally clipped back to less than 5 mm (Figure 6) as this is a standard required by some exporters.

Picked fruit is put into bags worn by pickers before being emptied into field bins. Each field bin holds around 400 kilograms of fruit (Figure 7). A traceability label is affixed to each bin.

Figure 6 Harvested avocado showing short fruit stem

Figure 7 Field bins of harvested avocados at the orchard

3.6 Post-harvest

SAG is responsible for carrying out export inspections, registering of treatment facilities, certifying phytosanitary treatments (if treatment is required), and issuing of phytosanitary certificates.

3.6.1 Packing house

As part of SAG's phytosanitary certification system, packing houses intending to export fruit must be registered and approved by SAG.

Packing house facilities must meet specific requirements before they are approved by SAG for export. Requirements include that each facility has a person responsible for export activities who has completed an approved SAG training program, and that a system be in place to enable traceability of the product. SAG verifies the facility, including the inspection room, inspection equipment and dispatch area. Only approved facilities can request a phytosanitary inspection. Before inspections start on any day, a SAG supervisor will check that the inspection area meets SAG requirements.

Field bins filled with avocados are delivered to the packing house on trucks. Each bin contains around 400 kilograms of fruit. Bins are clearly labelled (Figure 8) and accompanied by documentation identifying the commodity, grower and production orchard. Bins of avocados are unloaded and either processed directly or held temporarily in a cold room (at around 6 °C to 10 °C) until processing can start. Figure 9 shows unloading of avocados from a field bin at the start of processing at the packing house.

Figure 8 Traceability label on field bin

Figure 9 Avocados being unloaded from a field bin at the packing house

During processing, fruit is first cleaned of any surface contaminants or debris. Cleaning can include brushing and agitation of fruit, or brushing and washing including high pressure washing. Fruit is then moved on conveyor belts for electronic and/or manual sorting and grading, including checking for quality (Figure 10).

Figure 10 Manual grading of avocados at the packing house

Fruit is then packed into cardboard or plastic boxes, either manually or automatically. If fruit is packed manually, another quality check is conducted before the fruit is packed. All boxes are clearly labelled (Figure 11). The label includes name of commodity, weight, destination country, grower (CSG) and packing house identification numbers (CSP), as well as other information depending on the importer's requirements, such as fruit size (Figure 12).

Figure 11 Packed avocados with label on box

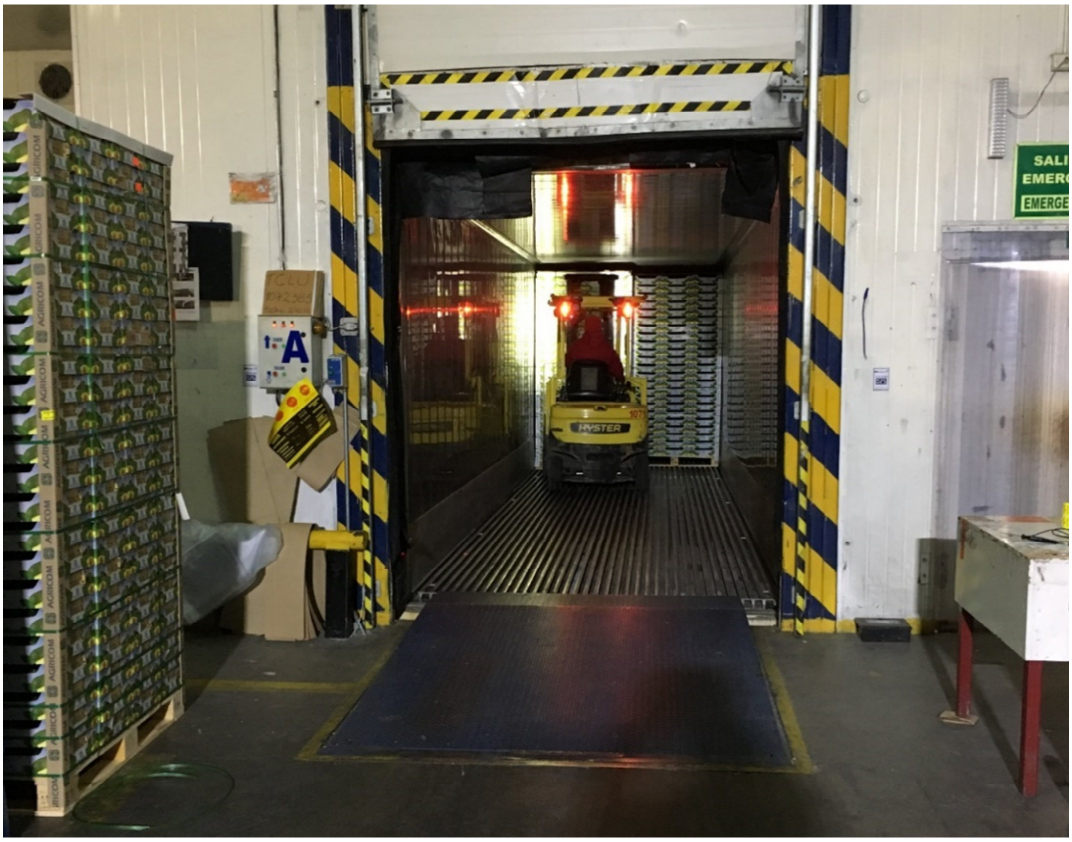
Figure 12 Label on box packed with avocados

Packed boxes are palletised and taken to a pre-cooling room to reduce the temperature of the fruit to around 4 °C to 5 °C before being stored in a cold room at around 4 °C to 5 °C (Figure 13) until they are loaded into containers. Pallets are loaded into refrigerated containers at around 4 °C (Figure 14).

In general, avocados are usually stored for extended periods at 4 °C to 7 °C (Hofman, Bower & Woolf 2013) which is consistent with Chile's practices.

Figure 13 Palletised boxes of avocados stored in a cold room at the packing house

Figure 14 Palletised boxes of avocados being loaded into a shipping container



Avocado exports are nearly all sent via sea freight. If they are exported via air freight, the pallets are sent via refrigerated truck to the airport for wrapping and loading into air containers.

Export procedures

Phytosanitary inspection, if required by the destination country, is conducted by a trained SAG inspector. The inspection process is identical in each packing house and complies with international standards (ISO 9001 Quality Management Systems certification). Packing houses have a dedicated inspection area containing a white bench, a stereo microscope and lighting to a minimum of 800 lux (Figure 15). Packing houses must ensure the inspection areas are clean.

Figure 15 Inspection area at a packing house

The phytosanitary inspection includes a document and physical inspection. The physical inspection (Figure 16) verifies that the product is free of quarantine pests of concern to the destination country. Once a consignment has passed inspection, it can be loaded into sealed, refrigerated shipping containers on trucks and dispatched to the port for export.

Figure 16 Phytosanitary inspection at the packing house

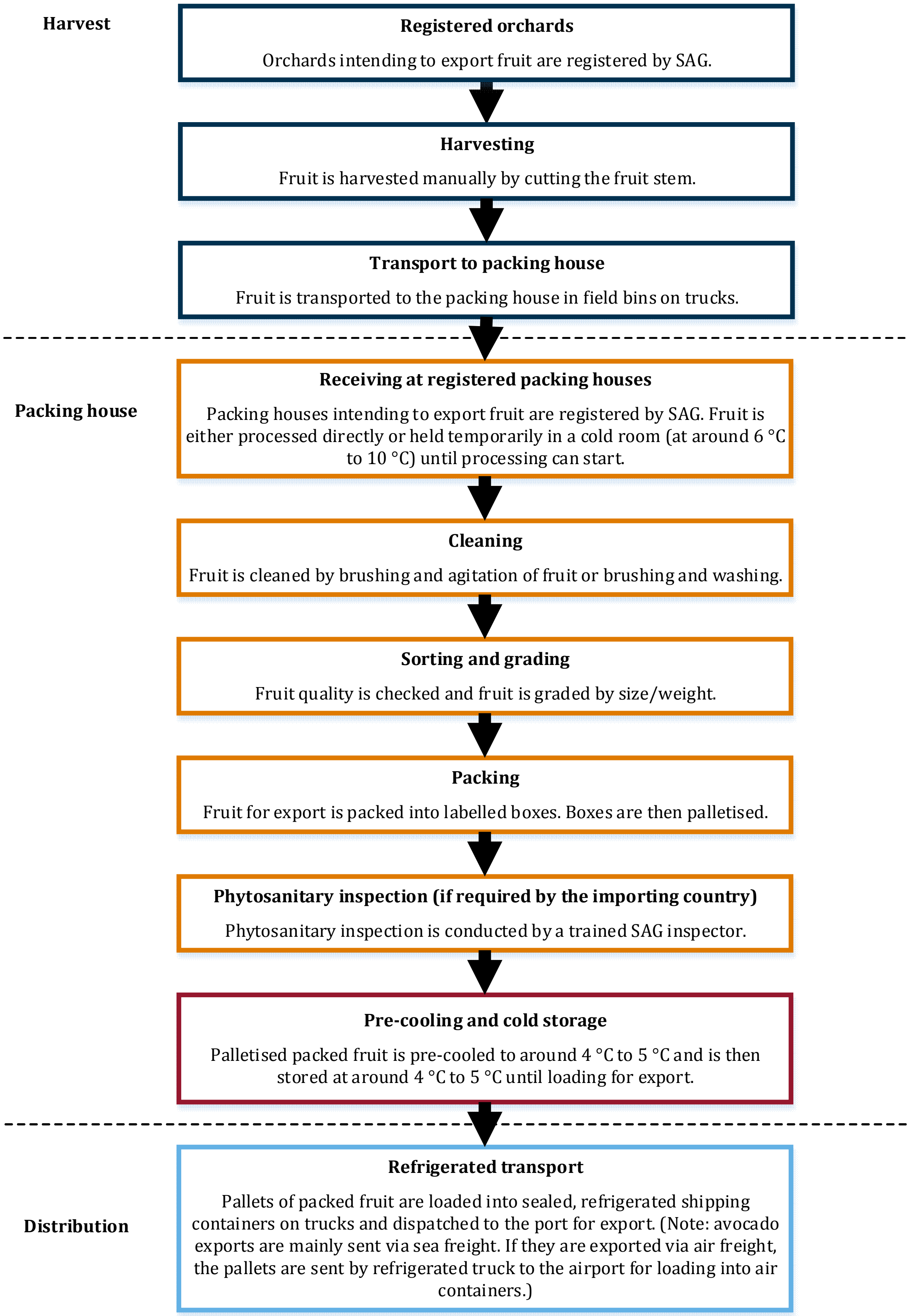
At the port, SAG conducts a physical verification of the containers/cargo and verifies documentation and compliance with phytosanitary requirements of the destination country. If everything is compliant, SAG issues a phytosanitary certificate.

3.6.2 Transport

Avocados exported from Chile are in a hard mature condition and this condition is maintained during transport to the country of destination. Avocados are mainly sent by sea freight and are kept at 4.5 °C to 6 °C during shipping. The temperature inside the shipping container is monitored during shipping to make sure the agreed temperature is maintained. Shipping time to Australia is estimated to take 30 to 40 days.

Figure 17 summarises the operational steps from harvesting to export of avocado fruit in Chile.

Figure 17 Summary of orchard and post-harvest steps for avocados grown in Chile for export



3.7 Export capability

3.7.1 Production statistics

Chile is one of the largest producers of avocados in the world. Since 2007, the total area planted with avocado in Chile has been decreasing due to a number of factors, including drought and chilling in major production regions, and high energy and labour costs (Gonzalez 2016, 2017). However in recent years, yields have been increasing, mainly due to increased rainfall compared to previous years, leading to higher production volumes (Gonzalez 2017).

Chile produced around 152,000 tonnes of avocado in 2014–15, 175,000 tonnes in 2015–16 and 215,000 tonnes in 2016–17 (Gonzalez 2016, 2017).

In 2016, Valparaiso, Coquimbo and Metropolitan, the three main avocado production regions, contained over 95 per cent of Chile's total area planted with avocado (Gonzalez 2017). A breakdown of the area planted with avocado by region in 2016 is shown in Table 3.2.

Table 3.2 Area planted with avocado by region in 2016

Region	Production area (hectares)	Share (%)
Valparaiso	19,135	65.3
Metropolitan	4,494	15.3
Coquimbo	4,416	15.1
O'Higgins	1,090	3.7
Atacama	133	0.5
Biobio	38	0.1
Arica and Parinacota	10	0
Maule	3	0
Total	29,319	100

Source: Gonzalez (2017)

3.7.2 Export statistics

Chile's avocado exports have varied over recent years, from 88,591 tonnes in 2013 to 147,246 tonnes in 2016 (International Trade Centre 2016). A breakdown of Chile's avocado exports by destination country from 2013 to 2016 is shown in Table 3.3.

Table 3.3 Export volumes of avocados from Chile to the top 10 markets from 2013 to 2016

Destination	Volume (tonnes) 2013	Volume (tonnes) 2014	Volume (tonnes) 2015	Volume (tonnes) 2016
Netherlands	37,694	42,101	42,005	57,733
United States	24,431	41,466	10,295	26,348
United Kingdom	7,650	6,840	14,555	17,910
Argentina	9,253	13,404	10,688	12,498
China	0	21	2,716	11,597
Spain	4,730	3,539	4,935	8,121
Costa Rica	0	0	1,547	3,445
France	2,168	1,389	1,487	3,379

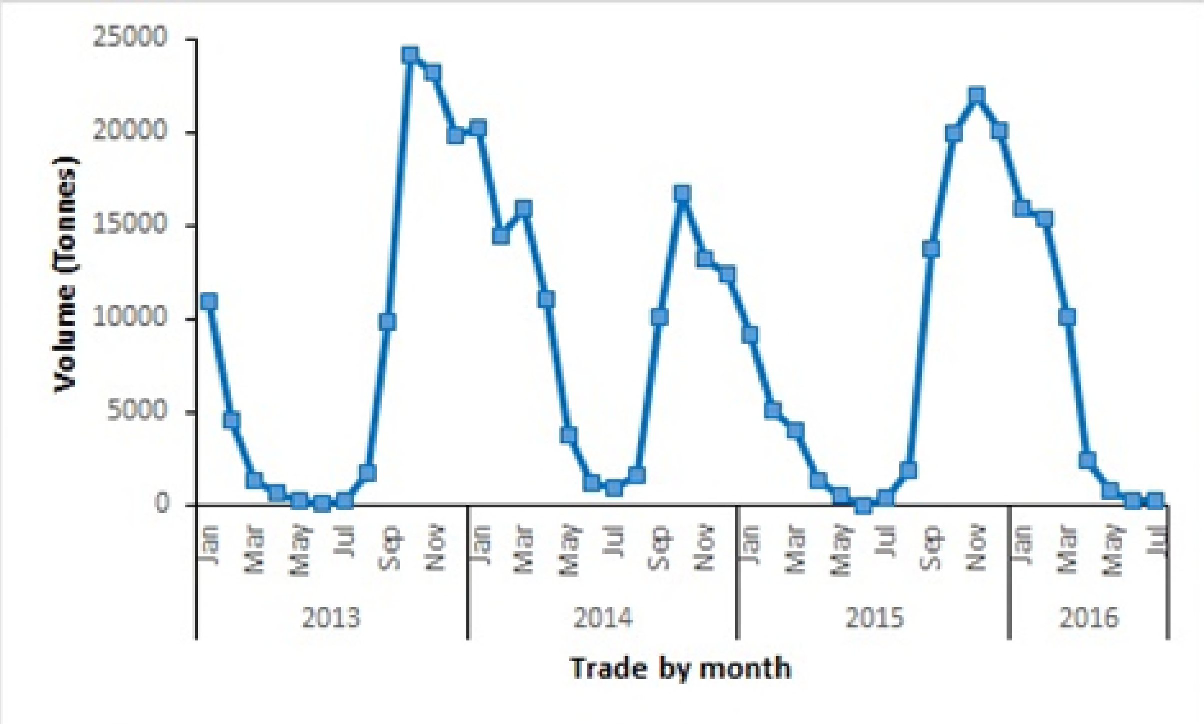
Destination	Volume (tonnes) 2013	Volume (tonnes) 2014	Volume (tonnes) 2015	Volume (tonnes) 2016
Germany	0	0	0	2,258
Switzerland	177	110	331	1,571
Total for all export markets	88,591	111,803	90,174	147,246

Source: ITC calculations based on UN COMTRADE statistics (International Trade Centre 2016)

3.7.3 Export season

Chile's avocado export season is generally from September to March (Gonzalez 2016). Chile's export volumes of avocado per month from 2013 to 2016 are shown in Figure 18.

Figure 18 Chile's avocado export volumes per month from 2013 to 2016



Source: ITC calculations based on UN COMTRADE statistics (International Trade Centre 2016)

4 Pest risk assessments for quarantine pests

A total of 14 quarantine pests which includes one regulated article (Table 4.1) associated with commercially produced, export-quality avocados produced in Chile were identified in the pest categorisation process (Appendix A). This chapter assesses the likelihoods of the entry (importation and distribution), establishment and spread of these pests, and the economic (including environmental) consequences these pests may cause if they were to enter, establish and spread in Australia.

Seven pests identified in this assessment have been recorded in some regions of Australia but, due to interstate quarantine regulations and their enforcement, are considered pests of regional concern. The acronym for the state and territory for which the regional pest status is considered, 'WA' (Western Australia) and 'NT' (Northern Territory), is used to identify these pests.

Most of the identified quarantine pests, and all pest groups considered here, have been assessed previously by the department. Where appropriate, the outcomes of the previous assessments for these pests have been adopted for this risk analysis, unless new information is available that suggests the risk would be different. The acronym 'EP' is used to identify species assessed previously and for which import policy already exists. The adoption of outcomes from previous assessments is outlined in Section 2.2.6.

The biosecurity risk posed by thrips and the orthotospoviruses they transmit, from all countries, on fresh fruit, vegetable, cut-flower and foliage imports was previously assessed in the *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetable, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017). This Group PRA has been applied to this assessment of avocados from Chile.

The acronym 'GP' is used to identify species assessed previously in a Group PRA and for which the Group PRA was applied. The application of the thrips Group PRA to this risk analysis is outlined in Section 2.2.7. A summary of pest information from the thrips Group PRA is presented in this chapter for convenience.

Assessments of risks associated with these species are presented in this chapter unless otherwise indicated.

Table 4.1 Quarantine pests associated with avocados from Chile

Pest	Common name
Fruit flies [Diptera: Tephritidae]	
Ceratitis capitata (EP)	Mediterranean fruit fly
Armoured scales [Hemiptera: Diaspididae]	
Chrysomphalus dictyospermi (EP, WA)	Spanish red scale
Fiorinia fioriniae (WA)	Fiorinia scale
Hemiberlesia cyanophylli (EP, WA)	Cyanophyllum scale
Hemiberlesia latastei	Lataste scale
Pinnaspis aspidistrae (EP, WA)	Fern scale
Unaspis citri (EP, WA)	Citrus snow scale
Mealybugs [Hemiptera: Pseudococcidae]	
Pseudococcus maritimus (EP)	Grape mealybug
Thrips [Thysanoptera: Thripidae]	
Frankliniella australis (GP)	Chilean flower thrips
Frankliniella gemina (GP)	Tamarugo thrips
Frankliniella occidentalis (GP, NT, RA)	Western flower thrips
Spider mites [Trombidiformes: Tetranychidae]	
Oligonychus punicae	Avocado brown mite
Oligonychus yothersi	Avocado red mite
Panonychus citri (EP, WA)	Citrus red mite

EP: Species has been assessed previously and import policy already exists. **GP:** Species has been assessed previously in a Group PRA (thrips Group PRA) and the Group PRA has been applied. **WA:** Pest of biosecurity concern for Western Australia. **NT:** Pest of biosecurity concern for the Northern Territory. **RA:** Regulated article, refer to Section 4.4 for definition of a regulated article.

4.1 Mediterranean fruit fly

Ceratitis capitata (EP)

Ceratitis capitata (Mediterranean fruit fly) belongs to the Tephritidae or 'fruit fly' family.

Chile is considered free of *C. capitata* and the department acknowledges that Chile has a national program in place to maintain its freedom from fruit flies of economic importance, including *C. capitata*. However, outbreaks of *C. capitata* do occur in Chile from time to time (SAG 2018), and for this reason it is considered necessary to require risk management measures to manage the risks associated with *C. capitata*. Area freedom is included as one of the measure options for this pest. In addition, other measures will be required to manage the risk in outbreak areas.

Ceratitis capitata has been assessed previously in a number of risk analyses, for example, in the risk analyses for citrus from Egypt, truss tomatoes from the Netherlands, sweet oranges from Italy, table grapes from Chile and persimmons from Japan, Korea and Israel (Biosecurity Australia 2002, 2005b, a; DAFF 2003, 2004). In those existing risk analyses, the unrestricted risk estimate for *C. capitata* was uniformly assessed as not achieving the ALOP for Australia. Therefore, specific risk management measures are required for this pest on those pathways.

The department has assessed the factors affecting the likelihood of importation of *C. capitata* on avocados from Chile as being similar to the previous assessment of Low for *C. capitata* in the risk analysis for table grapes from Chile (Biosecurity Australia 2005b). The association of *C. capitata* with avocado fruit is not considered to be greater than its association with table grapes from Chile. Additionally, the distribution and incidence of *C. capitata* in Chile has not changed since the prevalence of *C. capitata* in Chile was assessed in the risk analysis for table grapes. For these reasons, the likelihood of importation of *C. capitata* on avocados from Chile is assessed as Low.

Ceratitis capitata has a wide host range (Mau & Martin Kessing 2007a) and host material is likely to be available all year in Australia. The likelihood of distribution of *C. capitata* on avocados from Chile is considered similar to the previous assessment of Moderate for other commodity/country pathways including table grapes from Chile (Biosecurity Australia 2005b), since avocados from Chile are expected to be distributed in Australia in a similar way to the commodities assessed previously, and host material is likely to be available all year in Australia.

The likelihoods of establishment and spread of *C. capitata* in Australia are independent of the import pathway and are considered similar to those for *C. capitata* from other commodity/country pathways assessed previously, including table grapes from Chile (Biosecurity Australia 2005b). These likelihoods relate specifically to events that occur in Australia, and are principally independent of the import pathway. The ratings from previous assessments, and those assigned here for avocados from Chile for the likelihood of establishment is High, and for the likelihood of spread is Moderate. The consequences of the entry, establishment and spread of *C. capitata* in Australia are also independent of the import pathway and have been assessed as High.

In addition, the department has reviewed the latest literature on *C. capitata*—for example, Hill et al. (2016), Szyniszewska and Tatem (2014), Liquido et al. (2011), McInnis et al. (2017) and Kilic and Demirel (2018). No new information has been identified that would significantly change the assessments of risk ratings for importation, distribution, establishment, spread or consequences, as set out for *C. capitata* in existing risk analyses.

The likelihood of importation for *C. capitata* on avocados from Chile was rated as Low, while the likelihoods of distribution and spread were rated as Moderate and the likelihood of establishment as well as the consequences of entry, establishment and spread were rated as High. When these likelihood and consequences ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Moderate. All likelihood and the consequences ratings are set out in Table 4.5.

Unrestricted risk estimate

The unrestricted risk estimate for *Ceratitis capitata* from the avocados from Chile pathway is assessed as Moderate, which is identical to the outcomes of previous assessments, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for this pest.

4.2 Armoured scales

***Chrysomphalus dictyospermi* (EP, WA), *Fiorinia fioriniae* (WA), *Hemiberlesia cyanophylli* (EP, WA), *H. latastei*, *Pinnaspis aspidistrae* (EP, WA) and *Unaspis citri* (EP, WA)**

Chrysomphalus dictyospermi, *Fiorinia fioriniae*, *Hemiberlesia cyanophylli*, *H. latastei*, *Pinnaspis aspidistrae* and *Unaspis citri* belong to the Diaspididae or 'armoured scale' family. They have been grouped together because of their related biologies and taxonomies, on the bases of which they are predicted to pose similar risks and require similar risk mitigation measures. In this assessment, the term 'armoured scale' is used to refer to these six species. Scientific names are used when the information refers to an individual species.

Chrysomphalus dictyospermi, *Fiorinia fioriniae*, *Hemiberlesia cyanophylli*, *Pinnaspis aspidistrae* and *Unaspis citri* are not present in Western Australia and are pests of regional concern for that state (Government of Western Australia 2019).

Various armoured scale species, including four of the species assessed here, have been assessed previously in a number of risk analyses—for example, in the risk analyses for mangoes from India, mangoes from Taiwan, decrowned pineapples from Malaysia, sweet oranges from Italy, Tahitian limes from New Caledonia and mangoes from Indonesia, Thailand and Vietnam (Biosecurity Australia 2005a, 2006a, 2006b, 2008a; DAFF 2012a; Department of Agriculture and Water Resources 2015).

In those risk analyses, minor differences in individual risk ratings for armoured scales are present, but the final unrestricted risk estimates have all been assessed as achieving the ALOP for Australia. Therefore, specific risk management measures are not required for these pests on those pathways.

As described in Section 4.2.1, the department has assessed the factors affecting the likelihood of importation of armoured scales on avocados from Chile as being similar to those that have resulted in the previous assessments of High for the import pathways assessed previously. In the current analysis, armoured scales are considered to be associated with avocados in Chile, and able to survive the packing house procedures in Chile as well as transport from Chile to Australia.

The abilities of all species of armoured scales to disperse are effectively identical. The likelihoods of distribution of armoured scales from avocados from Chile are considered similar to those of armoured scales from other commodities assessed previously, since avocados from Chile are expected to be distributed in Australia in a similar way to those commodities, and host material is likely to be available all year in Australia. In each instance, the likelihood of distribution is assessed as Low.

The likelihoods of establishment and spread of armoured scales in Australia are considered similar to those for armoured scales from other commodities assessed previously. These likelihoods relate specifically to events that occur in Australia, and are principally independent of the import pathway. The likelihoods of establishment and of spread for armoured scales from avocados from Chile are therefore assessed as High and Moderate respectively. The consequences of the entry, establishment and spread of armoured scales in Australia are also independent of the import pathway and are assessed as Low.

In addition, the department has reviewed the latest literature on armoured scales—for example, Stocks and Evans (2017), Kondo and Muñoz (2016), Bayındır and Birgücü (2016) and Suh (2016). No new information has been identified that would significantly change the assessments of risk ratings for importation, distribution, establishment, spread or consequences, as set out for armoured scales in existing risk analyses.

All ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences are set out in Table 4.5.

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

It is considered that the likelihoods of importation of *Chrysomphalus dictyospermi*, *Hemiberlesia cyanophylli*, *Pinnaspis aspidistrae* and *Unaspis citri* on avocados from Chile are similar to the assessments made for the same species of armoured scales in the risk analyses for mangoes from India, mangoes from Taiwan, decrowned pineapples from Malaysia, sweet oranges from Italy, Tahitian limes from New Caledonia and mangoes from Indonesia, Thailand and Vietnam, where the likelihoods were rated as High (Biosecurity Australia 2005a, 2006a, 2006b, 2008a; DAFF 2012a; Department of Agriculture and Water Resources 2015). These armoured scale species are considered to be associated with avocados in Chile, and able to survive the packing house procedures in Chile as well as the transport from Chile to Australia. Therefore they are assigned an assessed likelihood of High for the pathway under consideration.

The rating of High is extended in this analysis to *Fiorinia fioriniae* and *Hemiberlesia latastei* on avocados from Chile for the following reasons:

- Both *Fiorinia fioriniae* and *Hemiberlesia latastei* have effectively identical life histories to those of other armoured scale species, including those of the other four species identified in this pest risk assessment (Beardsley & Gonzalez 1975; Buckley & Hodges 2013; Watson 2016; Zamudio & Claps 2005).
- Both *Fiorinia fioriniae* and *H. latastei* are present in Chile, known to be pests of avocado and known to infest fruit of their host plants (García Morales et al. 2019; Klein Koch & Waterhouse 2000; Kondo & Muñoz 2016; Peña et al. 2013; Vargas & Rodríguez 2008b).
- All adult female armoured scales are sessile (Beardsley & Gonzalez 1975). Therefore, adult females of *Fiorinia fioriniae* and *H. latastei* can potentially be expected to attach to the surfaces of avocados in a similar way to armoured scale species assessed previously on other commodities, and thus be capable of remaining on avocados exported from Chile.
- All feeding stages of armoured scales, as well as adult female armoured scales, produce a hard 'scale' covering (Beardsley & Gonzalez 1975) which can protect them from fruit cleaning processes. Therefore, it could be expected that, as for assessments of similar armoured scale species on import pathways assessed previously, *Fiorinia fioriniae* and *H. latastei* could survive on avocados from Chile through post-harvest processing and cleaning procedures.

For these reasons, *Fiorinia fioriniae* and *H. latastei* are considered similar to previously assessed armoured scales in all relevant biological aspects. The likelihoods of importation of *Fiorinia fioriniae* and *Hemiberlesia latastei* on avocados from Chile are therefore assessed as High.

Likelihood of distribution

Most armoured scale species, including the six species assessed here, have a wide host range (García Morales et al. 2019), and host material is likely to be available all year in Australia. Therefore, similar to previous assessments of the same and similar armoured scale species on other import pathways, the time of year when importation occurs is not considered to affect the likelihood of distribution for these armoured scales in Australia. In addition, avocados from Chile are expected to be distributed in Australia in a similar way to the commodities assessed previously.

The only means of dispersal for armoured scales is the crawler stage—other nymphal stages and adult females of armoured scales are sessile, and adult males are weak and short-lived (Beardsley & Gonzalez 1975). Crawlers may be able to reach a nearby host from infested avocado waste, however, it is considered that the dispersal range would be short.

Previous assessments for the same or similar armoured scale species on mangoes from India, decrowned pineapples from Malaysia, sweet oranges from Italy and Tahitian limes from New Caledonia rated the likelihood of distribution as Low (Biosecurity Australia 2005a, 2006a, 2008a; DAFF 2012a). The independence of the likelihood of distribution from the seasonal import window, together with the similarities in biological characteristics of the previously assessed armoured scales and those in this pest risk assessment, support the extension of the previously assessed likelihoods of distribution to this pest risk assessment. Therefore, the likelihoods of distribution of armoured scales on the avocados from Chile pathway are assessed as 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 2.2.

The likelihood that armoured scales will enter Australia as a result of trade in avocados from Chile, and be distributed in a viable state to a susceptible host, is assessed as Low.

4.2.2 Likelihood of establishment and spread

The likelihoods of establishment and of spread of armoured scales are independent of the import pathway, and are similar to those provided in all previous pest risk assessments for armoured scales, including the pest risk assessments for armoured scales in the risk analyses for mangoes from India, mangoes from Taiwan, decrowned pineapples from Malaysia, sweet oranges from Italy and Tahitian limes from New Caledonia (Biosecurity Australia 2005a, 2006a, 2006b, 2008a; DAFF 2012a). The ratings from these previous assessments are:

Likelihood of establishment: High

Likelihood of spread: Moderate

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, establishment, and spread using the matrix of rules shown in Table 2.2.

The likelihood that armoured scales will enter Australia as a result of trade in avocados from Chile, be distributed in a viable state to a susceptible host, establish in Australia, and subsequently spread within Australia is assessed as Low.

4.2.4 Consequences

It is considered that the consequences of entry, establishment and spread of armoured scales in Australia are independent of the import pathway, and are similar across pest risk assessments, including the risk analyses for mangoes from India, mangoes from Taiwan, decrowned pineapples from Malaysia, sweet oranges from Italy and Tahitian limes from New Caledonia (Biosecurity Australia 2005a, 2006a, 2006b, 2008a; DAFF 2012a). The ratings for overall consequences for armoured scales in those previous risk analyses were Low. Therefore, the overall consequences for armoured scales from the avocados from Chile pathway is also assessed as Low.

4.2.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihood of entry, establishment and spread with the estimate of consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimates for armoured scales from the avocados from Chile pathway are assessed as Very Low, which is identical to the outcomes of previous assessments, and which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for these pests.

4.3 Grape mealybug

Pseudococcus maritimus (EP)

Pseudococcus maritimus (grape mealybug) belongs to the Pseudococcidae or 'mealybug' family.

Pseudococcus maritimus has been assessed previously in the risk analyses for table grapes from Chile, table grapes from China and stone fruit from the USA (Biosecurity Australia 2005b, 2010b, 2011).

In each of those risk analyses, the unrestricted risk estimate for *P. maritimus* was assessed as not achieving the ALOP for Australia. Therefore, specific risk management measures are required for this pest on those pathways.

Literature on the presence of *P. maritimus* in Chile is contradictory. There are records and reports in the literature to suggest presence of this mealybug in Chile (García Morales et al. 2019; Gimpel & Miller 1996; Klein Koch & Waterhouse 2000; Quiros Manterola 1998). However, some authors believe that earlier records of *P. maritimus* in Chile may have been misidentifications, potentially of an undescribed *Pseudococcus* species (Correa et al. 2011; Zaviezo et al. 2015). SAG also claims that this mealybug is absent from Chile.

In recent years, two new species of *Pseudococcus*, *Pseudococcus cribata* and *Pseudococcus meridionalis*, have been found in Chile (Correa et al. 2011; Correa et al. 2012). These two species are quarantine pests for Australia, but an association with avocado plants has not been confirmed. Therefore, these species have not been assessed in this risk analysis. The department will continue to consider *P. maritimus* as on the pathway for avocados from Chile until the pest status of this species, and the host range of recently detected related species, in Chile has been clarified. Any mealybugs detected during on arrival inspection in Australia that are either quarantine pests for Australia or that cannot be identified to species level (for example immature stages) will require phytosanitary action.

The department has assessed the factors affecting the likelihood of importation of *P. maritimus* on avocados from Chile as being similar to those resulting in the previous assessments of High for *P. maritimus* in the risk analyses for table grapes from Chile, table grapes from China and stone fruit from the USA. In the current analysis, *P. maritimus* is considered to be associated with avocados from Chile and able to survive the packing house procedures in Chile, as well as transport from Chile to Australia. Therefore the assessed likelihood of importation of *P. maritimus* on the avocados from Chile pathway is High.

Pseudococcus maritimus has a wide host range including host plants from over 40 families (García Morales et al. 2019), and host material is likely to be available all year in Australia. The likelihood of distribution of *P. maritimus* from avocados from Chile is considered similar to that for *P. maritimus* from the commodity/country pathways assessed previously, since avocados from Chile are expected to be distributed in Australia in a similar way to those commodities, and host material is likely to be available all year in Australia. In each instance, the likelihood of distribution was assessed as Moderate.

The likelihoods of establishment and spread of *P. maritimus* in Australia from the avocados from Chile pathway are considered similar to those for *P. maritimus* in previous assessments. These likelihoods relate specifically to events that occur in Australia, and are principally independent of the import pathway. The likelihoods of establishment and of spread of *P. maritimus* from avocados from Chile are both assessed as High. The consequences of the entry, establishment and spread of *P. maritimus* in Australia are also independent of the import pathway and have been assessed as Low.

In addition, the department has reviewed the latest literature—for example, Fuchs et al. (2015), Wallingford et al. (2015) and Steffen et al. (2015). No new information has been identified that would significantly change the assessments of risk ratings for importation, distribution, establishment, spread or consequences, as set out for *P. maritimus* in the existing risk analyses for table grapes from Chile, table grapes from China and stone fruit from the USA (Biosecurity Australia 2005b, 2010b, 2011).

While the likelihoods of importation, establishment and spread for *P. maritimus* on avocados from Chile were rated as High, the likelihood of distribution was rated as Moderate and the consequences of entry, establishment and spread were rated as Low. When these likelihood and consequences ratings are combined using the rules presented in Table 2.2 and Table 2.5, the unrestricted risk is determined to be Low. All likelihood and consequences ratings are set out in Table 4.5.

4.3.1 Unrestricted risk estimate

The unrestricted risk estimate for *P. maritimus* from the avocados from Chile pathway is assessed as Low, which is identical to the outcomes of previous assessments of this pest, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for this pest.

4.4 Thrips

Frankliniella australis (GP), *Frankliniella gemina* (GP) and *Frankliniella occidentalis* (GP, NT, RA)

Three thrips species were identified on the avocados from Chile pathway that are either quarantine pests and/or regulated articles for Australia, these being *Frankliniella australis*, *F. gemina* and *F. occidentalis* (Table 4.2). *Frankliniella occidentalis* is not present in the Northern Territory and is a pest of regional concern for that territory.

Table 4.2 Quarantine and regulated thrips for avocados from Chile

Pest	In thrips Group PRA	Quarantine pest	Regulated thrips	On avocado pathway	Moderate likelihood of entry for thrips verified
Frankliniella australis (GP)	Yes	Yes	No	Yes	Yes
Frankliniella gemina (GP)	Yes	Yes	No	Yes	Yes
Frankliniella occidentalis (GP, NT, RA)	Yes	Yes (NT)	Yes	Yes	Yes

GP: Species has been assessed previously in a Group PRA and the Group PRA has been applied. **RA:** Regulated article, refer to Section 4.4 for definition of a regulated article. **NT:** Pest of biosecurity concern for the Northern Territory.

The indicative likelihood of entry for all thrips species is assessed in the thrips Group PRA as Moderate. *Frankliniella australis*, *F. gemina* and *F. occidentalis* are reported from Chile and are associated with avocado fruit (Agostini et al. 2005; Gonzalez 1983; Johansen & Mojica 2007; Klein Koch & Waterhouse 2000; López Laport & Bermúdez Ortiz 2011; Ripa & Larral 2008). Standard packing house procedures and transportation are not expected to eliminate these thrips on the pathway. After assessment of relevant pathway-specific factors (see Section 2.2.7) for avocados from Chile, the likelihoods of entry of Moderate were verified as appropriate for these thrips (Table 4.2).

A summary of the risk assessment for quarantine thrips is presented in Table 4.3 for convenience.

Table 4.3 Risk estimates for quarantine thrips

Risk component	Rating for quarantine thrips
Likelihood of entry (indicative) (importation x distribution)	Moderate (High x Moderate)
Likelihood of establishment	High
Likelihood of spread	High
Overall likelihood of entry, establishment and spread	Moderate
Consequences	Low
Unrestricted risk (indicative)	**Low**

The indicative unrestricted risk estimate for thrips is Low, which does not achieve the ALOP for Australia, as assessed in the thrips Group PRA (Table 4.3).

This indicative unrestricted risk estimate is considered to be applicable for the quarantine thrips species present on the avocados from Chile pathway. Therefore, specific risk management measures are required for the quarantine thrips to achieve the ALOP for Australia.

Frankliniella occidentalis is identified as regulated article, because it is capable of harbouring and spreading (vectoring) emerging orthotospoviruses that are quarantine pests for Australia, as detailed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017).

A regulated article is defined by the IPPC as '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 2019b). For simplicity, thrips identified as a regulated article are referred to as a 'regulated thrips'.

The indicative likelihood of entry for all thrips is assessed in the thrips Group PRA as Moderate. This indicative likelihood is also relevant to regulated thrips that can transmit quarantine orthotospoviruses. As indicated earlier in this section, the likelihood of entry of Moderate was verified as appropriate for the regulated thrips (Table 4.2).

A summary of the risk assessment for quarantine orthotospoviruses transmitted by thrips is presented in Table 4.4 for convenience.

Table 4.4 Risk estimates for emerging quarantine orthotospoviruses vectored by regulated thrips

Risk component	**Rating for emerging quarantine orthotospoviruses (a)**
Likelihood of entry (indicative) (importation x distribution)	Low (Moderate x Moderate)
Likelihood of establishment	Moderate
Likelihood of spread	High
Overall likelihood of entry, establishment and spread	Low
Consequences	Moderate
Unrestricted risk (indicative)	**Low**

(a) The identified regulated thrips vectors emerging quarantine orthotospoviruses, and this table presents the risk estimates for these viruses from the thrips Group PRA.

The indicative unrestricted risk estimate for emerging quarantine orthotospoviruses transmitted by regulated thrips is Low, which does not achieve the ALOP for Australia, as assessed in the thrips Group PRA (Table 4.4).

This indicative unrestricted risk estimate is considered to be applicable for the emerging orthotospoviruses known to be vectored by the thrips species present on the avocados from Chile pathway. Therefore, specific risk management measures are required for the regulated thrips to mitigate the risks posed by emerging quarantine orthotospoviruses, in order to achieve the ALOP for Australia.

The conclusion of this risk assessment, which is based on the thrips Group PRA, applies to all phytophagous quarantine thrips and regulated thrips on the avocados from Chile pathway, irrespective of their specific identification in this document.

4.5 *Oligonychus* spider mites

Oligonychus punicae and *Oligonychus yothersi*

Oligonychus punicae (avocado brown mite) and *Oligonychus yothersi* (avocado red mite) belong to the Tetranychidae or 'spider mite' family. The common name 'spider mite' refers to the habit of these mites of spinning protective silken webs (Vacante 2016). The two species of spider mites assessed here have been grouped together because of their common biological characteristics and taxonomies, on the bases of which they are predicted to pose a similar level of biosecurity risk and to require similar mitigation measures.

Like other species of spider mites, *O. punicae* and *O. yothersi* are polyphagous with a wide host range, including several economically significant horticultural crops. Mutual hosts of *O. punicae* and *O. yothersi* include avocado, banana, coffee, peach, pomegranate, grape and mango, as well as native Australian plants such as *Eucalyptus* species (Bolland, Gutierrez & Flechtmann 1998; Migeon & Dorkeld 2019; Vacante 2016; Vasquez et al. 2008).

Spider mites have five biological stages in their life cycle: egg, larva, two nymphal stages (protonymph and deutonymph) and adult (Vacante 2016). They have a short life cycle and go through many generations in a year. The time for development from egg to adult varies from species to species, but usually takes one to two weeks or more and depends on temperature, host plant, humidity and other environmental factors (Vásquez et al. 2012). The duration of the various life stages, under similar temperatures, are similar for *O. punicae* and *O. yothersi* (Ebeling 1959). In summer, they may complete two generations in one month (Ebeling 1959). At a constant temperature of 25 °C, under laboratory conditions, a generation is completed in one week (Ebeling 1959). Most species of spider mites, including *O. punicae* and *O. yothersi*, reproduce through arrhenotokous parthenogenesis, which means that fertilised eggs produce females and unfertilised eggs produce males (Vacante 2016).

All spider mites feed by piercing plant cells and consuming their contents, which commonly causes yellow spots on leaves of the host plant (Zhang 2008). High levels of attack show as yellowing or bronzing on leaves and can lead to defoliation (Vacante 2016; Zhang 2008). Necrosis can also occur in young leaves, stems and growing tips (Tomczyk & Kropczynska 1985). Physiological consequences of spider mite damage to host plants include reduction in photosynthetic activity and water stress (Tomczyk & Kropczynska 1985). Some authors report that severe damage by spider mites can kill the plant (Zhang 2008). Hot, dry weather seems to increase symptoms of damage caused by spider mite feeding (Tomczyk & Kropczynska 1985). Applications of pesticides which kill natural enemies can lead to high population densities of spider mites (Kennedy & Smitley 1985).

Oligonychus punicae and *O. yothersi* are considered major pests of economic plants (Vacante 2016). *Oligonychus punicae* is considered an important pest mite of avocado in Mexico, but in California it is only considered a minor pest of avocado that flares up occasionally when accumulation of dust on leaves is high (Estrada-Venegas, Rodriguez-Navarro & McMurty 2002; Peña et al. 2013). High population densities can cause severe defoliation on several avocado cultivars (Vasquez et al. 2008). It is also an occasional pest of grapevine in Venezuela (Vasquez et al. 2008) and has been reported as a pest of a number of other plants including banana, coffee, mango and pomegranate in tropical America. *Oligonychus punicae* is also known to occur on grape and pomegranate in Asia (Flechtmann 1996).

Oligonychus yothersi is a common pest of avocado in Chile and Florida (Peña et al. 2013; Vargas & Rodríguez 2008a). It is also known to infest apple, grapevine, peach, pomegranate and various ornamentals, as well as a number of tropical plants of economic importance such as coffee, banana, cacao, camphor, cassava, cashew, guava, loquat, lychee, mango and tea (Vacante 2016).

Two species of the genus *Oligonychus* have been assessed previously on the pathway for bananas from the Philippines (Biosecurity Australia 2008b). Various other species of spider mites of the genera *Amphitetranychus* and *Tetranychus* have been assessed previously in the risk analyses for apples from China, table grapes from China and mangosteens from Indonesia (Biosecurity Australia 2010a, 2011; DAFF 2012b).

In those risk analyses, the unrestricted risk estimate for spider mites was assessed as not achieving the ALOP for Australia. Therefore, specific risk management measures are required for these pests on those pathways.

As described in Section 4.5.1, the department has assessed the factors affecting the likelihood of importation for *O. punicae* and *O. yothersi* on avocados from Chile. For *O. yothersi*, all factors are considered similar to those resulting in the previous assessments of High for spider mites in the risk analyses for the import pathways assessed previously. For *O. punicae*, the factor relating to abundance in Chile is not considered similar to the previous assessments.

Spider mites have a wide host range, and host material is likely to be available all year in Australia. The likelihoods of distribution of *O. punicae* and *O. yothersi* from avocados from Chile are considered similar to those of spider mites from other commodities assessed previously, since avocados from Chile are expected to be distributed in Australia in a similar way to those commodities, and host material is likely to be available all year in Australia. In previous instances and in this analysis, the likelihood of distribution is assessed as Moderate.

The likelihoods of establishment and spread of *O. punicae* and *O. yothersi* in Australia are also considered similar to those of previous assessments. Those likelihoods relate specifically to events that occur in Australia, and are principally independent of the import pathway. The likelihoods of establishment and of spread for *Oligonychus* spider mites from avocados from Chile are therefore assessed as High and Moderate respectively. The consequences of the entry, establishment and spread of spider mites in Australia are also independent of the import pathway and have been assessed as Moderate.

In addition, the department has reviewed the latest literature on spider mites—for example, Vacante (2016), Peña et al. (2013), Khodayari et al. (2013) and Ramírez López (2017). No new information has been identified that would significantly change the assessments of risk ratings for importation, distribution, establishment, spread or consequences, as set out for spider mites in the risk analyses for apples from China, table grapes from China and mangosteens from Indonesia (Biosecurity Australia 2010a, 2011; DAFF 2012b).

All ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences are set out in Table 4.5.

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

It is considered that the likelihood of importation of *O. yothersi* on avocados from Chile is similar to the assessments made for similar species of spider mites in the risk analyses for apples from China, table grapes from China and mangosteens from Indonesia, where the likelihoods were rated as High (Biosecurity Australia 2010a, 2011; DAFF 2012b). The likelihood rating of importation of *O. punicae* is reduced to Low due to its apparent rarity on avocados in Chile.

The following information provides supporting evidence for this assessment:

- *Oligonychus punicae* and *O. yothersi* have effectively identical life histories to other spider mite species, including those assessed previously for apples from China, table grapes from China and mangosteens from Indonesia (Ebeling 1959; Vacante 2016).
- Both *O. punicae* and *O. yothersi* are present on avocado in Chile: *Oligonychus punicae* has been reported on avocado in Chile by reference to a record from 1988 (Flechtmann 1996) but no evidence of economic damage in Chile caused by this pest could be found. *Oligonychus yothersi* is recognised as a common pest of avocado in Chile (Vargas & Rodríguez 2008a).
- *Oligonychus punicae* and *O. yothersi* usually feed on the upper surface of leaves of avocado but in heavy infestations they also feed on the lower surface of leaves and on fruit (Bailey & Olsen 1990; Estrada-Venegas, Rodriguez-Navarro & McMurty 2002; McMurtry 1985a; Paull & Duarte 2011; Peña et al. 2013).
- Spider mites are very small, ranging from 0.35 to 1 millimetre in length (Vacante 2016). Adult females of *O. punicae* and *O. yothersi* are 0.4 millimetres and 0.3 millimetres long respectively, and adult males are even smaller (Ebeling 1959). Therefore, spider mites, including *O. punicae* and *O. yothersi*, can hide on fruit, for example near the peduncle of avocado fruit. Such factors make detection of spider mites difficult during harvest and quality control inspections for export commodities. In addition, brushing of avocados during packing house processes may not remove spider mites located near the peduncle.
- Spider mites have been intercepted on fresh fruit, including avocados, imported into Australia (Department of Agriculture unpublished data). In addition, both *O. punicae* and *O. yothersi* have been intercepted on trade in fresh fruit in the North American Plant Protection (NAPPO) region (NAPPO 2014).
- *Oligonychus punicae* and *O. yothersi* lay their eggs on leaves (Jeppson, Keifer & Baker 1975; Vacante 2016). Eggs are therefore unlikely to be present on avocado fruit.

For these reasons, *O. punicae* and *O. yothersi* are considered to be very similar to the previously assessed spider mites for apples from China, table grapes from China and mangosteens from Indonesia in all relevant biological aspects. The likelihood of importation of *O. yothersi* on avocados from Chile is therefore assessed as High. The likelihood of importation of *O. punicae* on avocados from Chile is assessed as Low due to its apparent rarity and the lack of evidence of economic damage caused by this pest in Chile.

Likelihood of distribution

Most spider mites, including *O. punicae* and *O. yothersi*, have a wide host range (Bolland, Gutierrez & Flechtmann 1998; Migeon & Dorkeld 2019; Vacante 2016; Vasquez et al. 2008) and host material is likely to be available all year in Australia. Therefore, similar to previous assessments of spider mites on other import pathways, the time of year when importation occurs does not affect the likelihood of distribution for *O. punicae* and *O. yothersi* in Australia. In addition, avocados from Chile are expected to be distributed in Australia in a similar way to the commodities assessed previously.

Spider mites disperse within and between host plants through crawling (Kennedy & Smitley 1985). In addition, aerial dispersal, mainly by adult females, has the potential for long-range transport on wind currents, but it is entirely passive once the mites are airborne and most aerially dispersing mites fall out of the air current soon after they are carried aloft (Kennedy & Smitley 1985). Spider mites may be able to reach nearby hosts from infested avocado waste but the dispersal range would be short.

Previous assessments for similar spider mites on apples from China, table grapes from China and mangosteens from Indonesia rated the likelihood of distribution as Moderate (Biosecurity Australia 2010a, 2011; DAFF 2012b). The independence of the likelihood of distribution from the import window, together with the similarities in biological characteristics of the previously assessed spider mites and the spider mites in this pest risk assessment, support the extension of the previously assessed likelihoods of distribution to this pest risk assessment. Therefore, the likelihoods of distribution of *O. punicae* and *O. yothersi* on avocados from Chile are assessed as 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 2.2.

The likelihood that *O. yothersi* will enter Australia as a result of trade in avocados from Chile, and be distributed in a viable state to a susceptible host, is assessed as Moderate.

The likelihood that *O. punicae* will enter Australia as a result of trade in avocados from Chile, and be distributed in a viable state to a susceptible host, is assessed as Low.

4.5.2 Likelihood of establishment and spread

The likelihoods of establishment and of spread for *O. punicae* and *O. yothersi* are independent of the import pathway, and are similar to those provided in previous pest risk assessments for similar spider mites, including the pest risk assessments for spider mites in the risk analyses for apples from China and table grapes from China (Biosecurity Australia 2010a, 2011). The ratings from these 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, establishment, and spread using the matrix of rules shown in Table 2.2.

The likelihood that *O. punicae* and/or *O. yothersi* will enter Australia as a result of trade in avocados from Chile, be distributed in a viable state to a susceptible host, establish in Australia, and subsequently spread within Australia is assessed as Low.

4.5.4 Consequences

It is considered that the consequences of entry, establishment and spread of *O. punicae* and *O. yothersi* are independent of the import pathway, and are similar to the outcomes of previous assessments for similar spider mites, including those assessed in the risk analyses for apples from China and table grapes from China (Biosecurity Australia 2010a, 2011). The rating for overall consequences for similar spider mites in previous risk analyses was Moderate. Therefore, the overall consequences for *O. punicae* and *O. yothersi* from the avocados from Chile pathway is also assessed as Moderate.

4.5.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the estimate of consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimates for *O. punicae* and *O. yothersi* from the avocados from Chile pathway are assessed as Low, which is identical to the outcomes of previous assessments of similar spider mites, and which does not achieve the ALOP for Australia. Therefore, specific risk management measures are required for these pests.

4.6 Citrus red mite

Panonychus citri (EP, WA)

Panonychus citri (Citrus red mite) belongs to the Tetranychidae or 'spider mite' family. It is distributed throughout the world, and is primarily a pest of citrus, but is also found on avocado (Bolland, Gutierrez & Flechtmann 1998; CABI EPPO 1964; Vacante 2016). Its host range includes horticultural crops that are widespread in Australia such as avocado, apple, citrus and stone fruit (Bolland, Gutierrez & Flechtmann 1998; NSW DPI 2017; Vacante 2016).

Panonychus citri is not present in Western Australia and is a pest of regional concern for that state (Government of Western Australia 2019).

Economic damage caused by *P. citri* is mainly reported on citrus, which is the major host (CABI 2019a; Jeppson 1989). *Panonychus citri* mainly becomes a problem when broad-spectrum insecticides, which kill natural enemies of *P. citri*, are used to control other pests (McMurtry 1985b). Damage to host plants is largely dependent on infestation levels. At low levels, slight leaf or fruit scarring may occur (NSW DPI 2017). Large populations cause premature fruit drop and leaf fall, impacting plant functions by reducing gas exchange and photosynthetic activity in damaged leaves, and causing fruit scarring, significantly reducing fruit quality (Ripa & Larral 2008; Zanardi et al. 2015).

Panonychus citri has been assessed previously in the risk analyses for sweet oranges from Italy and unshu mandarins from Japan (Biosecurity Australia 2005a, 2009).

In those risk analyses, the unrestricted risk estimate for *P. citri* was assessed as achieving the ALOP for Australia. Therefore, specific risk management measures are not required for this pest on those pathways.

As avocado is not a main host of *P. citri* (CABI 2019a; Jeppson 1989), and the previous assessments of this pest were all for citrus commodities, it is considered necessary to reassess the likelihood of importation of *P. citri* on avocados from Chile.

Panonychus citri has a wide host range and host material is likely to be available all year in Western Australia. The likelihood of distribution of *P. citri* from avocados from Chile is considered similar to that of *P. citri* from other commodities assessed previously, since avocados from Chile are expected to be distributed in Western Australia in a similar way to those commodities, and host material is likely to be available all year in Western Australia. In each previous instance the likelihood of distribution was assessed as Low, and the same assessment is adopted in this analysis.

The likelihoods of establishment and spread of *P. citri* in Western Australia from avocados from Chile are also considered to be similar to those of previous assessments. These likelihoods relate specifically to events that occur in Australia, and are principally independent of the import pathway. The likelihoods of establishment and of spread for *P. citri* from avocados from Chile are therefore both assessed as Moderate. The consequences of the entry, establishment and spread of *P. citri* in Western Australia are also independent of the import pathway, and have been assessed as Low.

In addition, the department has reviewed the latest literature on *P. citri*—for example, Zanardi et al. (2015), Rogers and Stansly (2016) and Vacante (2016). No new information has been identified that would significantly change the assessments of risk ratings for distribution, establishment, spread or consequences, as set out for *P. citri* in the risk analysis for sweet oranges from Italy (Biosecurity Australia 2005a).

All ratings for the likelihoods of entry, establishment and spread, and the rating for the overall consequences are set out in Table 4.5.

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 *Panonychus citri* will arrive in a viable condition in Western Australia with the importation of avocados from Chile is assessed as Low.

The following information provides supporting evidence for this assessment.

Panonychus citri is present in avocado growing regions in Chile, but is not considered a pest of avocado in Chile.

- *Panonychus citri* is present in avocado growing regions in Chile (Ripa & Larral 2008), and is known to affect avocado in other countries (Ehara 1969; Guanilo et al. 2012; Peña et al. 2013; Vacante 2016).
- In Chile, *P. citri* is considered a pest of citrus, not of avocado (Ripa & Larral 2008). No reports to confirm the presence of *P. citri* on avocado in Chile could be found. *Panonychus citri* is therefore unlikely to be abundant on avocado crops in Chile.

Larvae and adults of *P. citri* may be present on avocado fruit, but packing house processes are likely to reduce any infestation of fruit to be exported.

- Once hatched, larvae of *P. citri* move to the upper side of new avocado leaves where they spend the majority of their life cycle (Aponte & McMurty 1997). In higher population densities, larvae and adults are known to develop on fruit and stems of host plants (Gibson 1968; Vacante 2016). On citrus, *P. citri* can develop on both mature and immature fruit (Vacante 2009) and a similar biology is expected on avocado. It is therefore possible that larvae and adults may be present on harvested avocado fruit. However, it is likely that *P. citri* infestation would be detected in avocado orchards during field monitoring when high population densities are reached. Infestation may be managed before it reaches the avocado fruit.
- *Panonychus citri* lays its eggs on leaves (NSW DPI 2017). No record of oviposition on fruit was found. Eggs are therefore unlikely to be present on avocado fruit.
- Once harvested, avocados are cleaned by brushing, or brushing and washing, and sorted before being packed. Brushing and/or washing is likely to reduce any infestation with *P. citri* on avocado fruit. However, brushing of avocados during packing house processes may not remove *P. citri* located near the peduncle.
- Adult *P. citri* reach up to 0.5 millimetres in length (NSW DPI 2017), making detection of individuals difficult during packing house processing, especially if present near the peduncle.

During the avocado harvesting season, temperature and humidity conditions are favourable for *P. citri* infestation.

- The highest rate of breeding for *P. citri* occurs at approximately 30 °C, where lifespan is short with a high generational turnover, but mortality is still low (Kasap 2009). Keetch (1971) considered extreme temperatures for the species to be <5 °C and >35 °C. Harvesting of avocados in Chile occurs from September to March (Gonzalez 2016). In the main avocado-producing regions, the months of September to March have a mean maximum temperature of around 20 °C to 30 °C (Climate-data.org 2017). This temperature range is optimal for low mortality and rapid reproduction of *P. citri*, increasing the likelihood of higher level infestations, and therefore potential for presence on fruit during harvest.
- Dry weather conditions are favourable for the development of *P. citri* and spider mites in general (Beattie & Gellatley 2003; Rogers & Stansly 2016). Mean monthly rainfall during September to March is low in Chile's main avocado-producing regions (Climate-data.org 2017), which increases the likelihood of higher infestation levels.

Panonychus citri may survive transport from Chile to Australia.

- Avocados exported from Chile are mainly transported in refrigerated shipping containers which are maintained at around 4 °C to 6 °C. The minimum temperature required for development of *P. citri* larvae varies in different studies. Kasap (2009) and Jones and Morse (1984) both agree that the minimum temperature required for development of larvae is between 9.4 °C and 9.77 °C, while Yasuda (1982) claims it is 8.2 °C. There is no information available on the minimum temperature at which 100 per cent mortality occurs. It is therefore possible that larvae and adult *P. citri* may survive temperatures during transport.
- Shipping time by sea is estimated to take 30 to 40 days from Chile to Australia. The typical life span of *P. citri* is 9 to 37 days (Kasap 2009). However, Keetch (1971) found that the species is able to survive up to 70 days in cool temperatures. It is important to note that these studies were conducted at a significantly higher temperature of 14 °C in the day and 10 °C at night, as compared to the temperatures maintained during transport of avocados. No studies could be found that described the response of *P. citri* to prolonged cold temperatures. However, the studies by Keetch (1971) highlight the possibility that slowed development may assist *P. citri* to survive transport temperatures on the 30 to 40 day journey.

Panonychus citri is present in Chile's main avocado production regions and may be present on harvested avocados. Due to its small size, the pest is unlikely to be detected during sorting and packing for export. The harvest season for avocados in Chile coincides with favourable temperature and humidity conditions for *P. citri*. However, the abundance of *P. citri* on avocado in Chile is low, infestations are likely to be managed before the pest spreads to the fruit, and packing house processes are likely to reduce infestation. These factors support a likelihood estimate for importation of Low.

Likelihood of distribution

Panonychus citri has a wide host range including citrus, apple, pear, peach, plum, carambola, papaya and grapevine (Bolland, Gutierrez & Flechtmann 1998), and host material is likely to be available all year in Western Australia. Therefore, similar to previous assessments of *P. citri* on other import pathways, the time of year when importation occurs will not affect the likelihood of distribution for this pest in Western Australia. In addition, avocados from Chile are expected to be distributed in Western Australia in a similar way to the commodities assessed previously.

The previous assessment for *P. citri* on sweet oranges from Italy rated the likelihood of distribution as Low (Biosecurity Australia 2005a), which was adopted for unshu mandarins from Japan (Biosecurity Australia 2009). The independence of the likelihood of distribution from the seasonal import window, together with the similarities in the way previously and currently assessed commodities are distributed in Western Australia, support the extension of the previously assessed likelihood of distribution for *P. citri* to this pest risk assessment. Therefore, the likelihood of distribution of *P. citri* on avocados from Chile is assessed as 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 2.2.

The likelihood that *P. citri* will enter Western Australia as a result of trade in avocados from Chile, and be distributed in a viable state to a susceptible host, is assessed as Very Low.

4.6.2 Likelihood of establishment and spread

The likelihoods of establishment and of spread for *P. citri* are independent of the import pathway, and are similar to those provided in previous pest risk assessments for *P. citri*, including in the risk analysis for sweet oranges from Italy (Biosecurity Australia 2005a), which was adopted for unshu mandarins from Japan (Biosecurity Australia 2009). The ratings from these 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, establishment and spread using the matrix of rules shown in Table 2.2.

The likelihood that *P. citri* will enter Western Australia as a result of trade in avocados from Chile, be distributed in a viable state to a susceptible host, establish in Western Australia, and subsequently spread within Western Australia is assessed as Very Low.

4.6.4 Consequences

It is considered that the consequences of entry, establishment and spread of *P. citri* in Western Australia are independent of the import pathway and are similar across pest risk assessments, including the risk analysis for sweet oranges from Italy (Biosecurity Australia 2005a). The rating for overall consequences for *P. citri* in previous risk analyses was Low. Therefore, the overall consequences for *P. citri* from the avocados from Chile pathway is also assessed as Low.

4.6.5 Unrestricted risk estimate

Unrestricted risk is the result of combining the likelihoods of entry, establishment and spread with the estimate of consequences. Likelihoods and consequences are combined using the risk estimation matrix shown in Table 2.5.

The unrestricted risk estimate for *Panonychus citri* from the avocados from Chile pathway is assessed as Negligible, which achieves the ALOP for Australia. Therefore, no specific risk management measures are required for this pest.

4.7 Pest risk assessment conclusions

Table 4.5 Summary of unrestricted risk estimates for quarantine pests associated with avocados from Chile

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	**Overall**					
Fruit flies [Diptera: Tephritidae]								
Ceratitis capitata (EP)	Low	Moderate	**Low**	High	Moderate	Low	High	**Moderate**
Armoured scales [Hemiptera: Diaspididae]								
Chrysomphalus dictyospermi (EP, WA)	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Fiorinia fioriniae (WA)	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Hemiberlesia cyanophylli (EP, WA)	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Hemiberlesia latastei	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Pinnaspis aspidistrae (EP, WA)	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Unaspis citri (EP, WA)	High	Low	**Low**	High	Moderate	Low	Low	**Very Low**
Mealybugs [Hemiptera: Pseudococcidae]								
Pseudococcus maritimus (EP)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**
Thrips [Thysanoptera: Thripidae]								
Frankliniella australis (GP)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**
Frankliniella gemina (GP)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**
Frankliniella occidentalis (GP, NT, RA)	High	Moderate	**Moderate**	High	High	Moderate	Low	**Low**
Spider mites [Trombidiformes: Tetranychidae]								
Oligonychus punicae	Low	Moderate	**Low**	High	Moderate	Low	Moderate	**Low**
Oligonychus yothersi	High	Moderate	**Moderate**	High	Moderate	Low	Moderate	**Low**
Panonychus citri (EP, WA)	Low	Low	**Very Low**	Moderate	Moderate	Very Low	Low	**Negligible**

Pest name	Likelihood of						Consequences	URE
	Entry			Establishment	Spread	EES		
	Importation	Distribution	**Overall**					
Orthotospoviruses [Bunyavirales: Tospoviridae] vectored by regulated thrips (*Frankliniella occidentalis*) (a)								
Listed in the thrips Group PRA	Moderate	Moderate	**Low**	Moderate	High	Low	Moderate	**Low**

EP: Species has been assessed previously and import policy already exists. **GP:** Species has been assessed previously in a Group PRA and the Group PRA has been applied. **RA:** Regulated article, refer to Section 4.4 for definition of a regulated article. **WA:** Pest of biosecurity concern for Western Australia. **NT:** Pest of biosecurity concern for the Northern Territory. **EES**: Overall likelihood of entry, establishment and spread. **URE**: Unrestricted risk estimate. This is expressed in an ascending scale from negligible to extreme.
a: The identified regulated thrips vectors emerging quarantine orthotospoviruses, and this table presents the risk estimates for these viruses from the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017).

4.8 Summary of assessment of quarantine pests of concern

This section provides a summary of the process of assessment of potential and confirmed quarantine pests of concern (shown in Figure 19).

The pest categorisation process (Appendix A) identified 158 pests. Of these 158 pests:

- 3 pests are considered to be absent from Chile (due to unreliable/invalid records or due to eradication), and therefore were not further considered;
- 5 pests are only present on Easter Island, with quarantine procedures in place to prevent the entry of pests from Easter Island to mainland Chile, and therefore were not further considered.

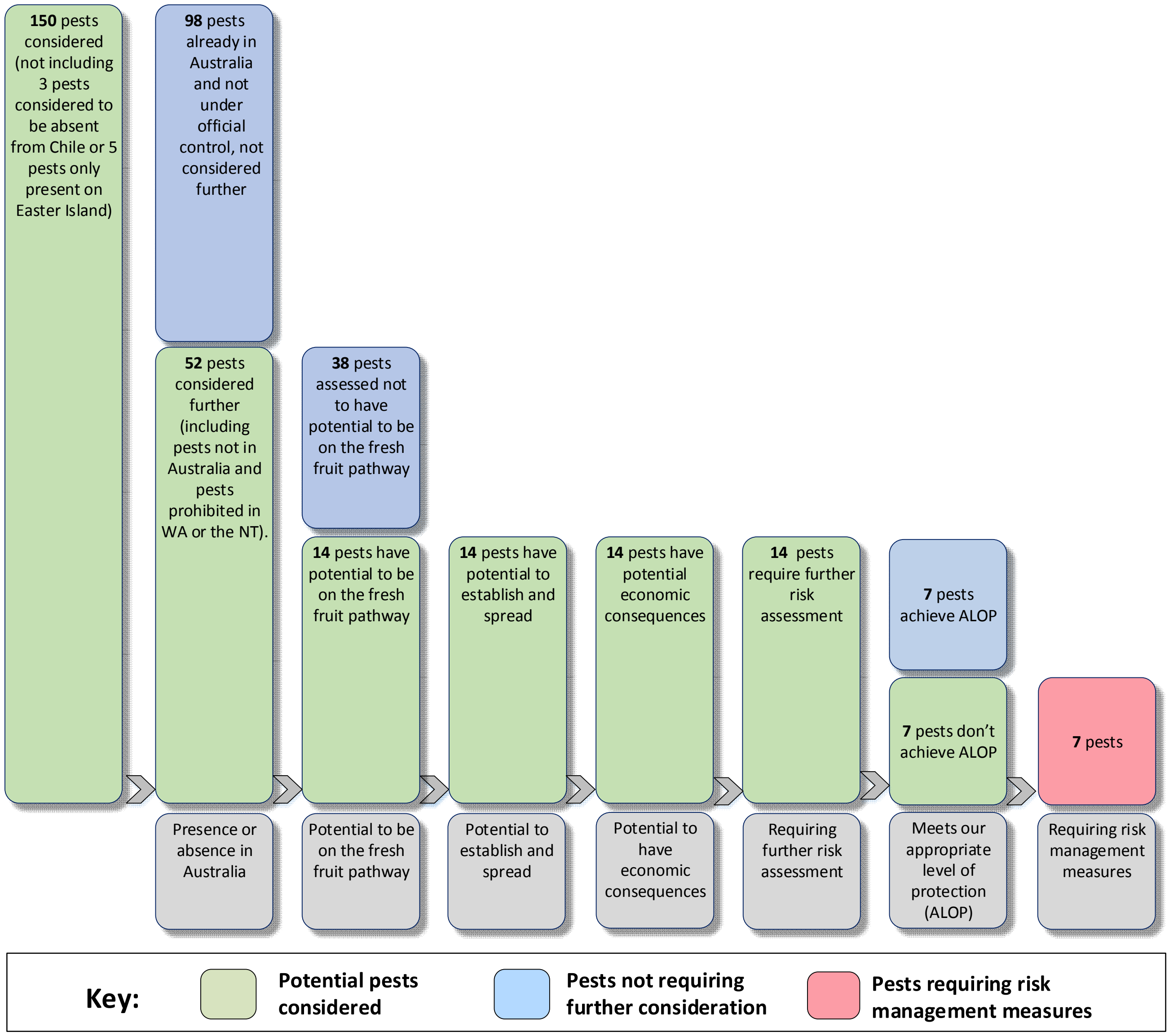
Of the remaining 150 pests:

- 98 pests are already present in Australia, and not under official control, and therefore were not further considered;
- 38 pests were assessed as not having potential to be on the fresh avocado fruit pathway, and therefore were not further considered.

The outcome of the above process left 14 pests that required further consideration, that is pest risk assessment. Pest risk assessments for these 14 pests were completed:

- The estimated unrestricted risks for seven pests (six armoured scale species and one spider mite species) were assessed as achieving the ALOP for Australia, and therefore no specific risk management measures are required for these pests on this pathway. These pests are:
  - Spanish red scale (*Chrysomphalus dictyospermi*)
  - Fiorinia scale (*Fiorinia fioriniae*)
  - Cyanophyllum scale (*Hemiberlesia cyanophylli*)
  - Lataste scale (*Hemiberlesia latastei*)
  - Fern scale (*Pinnaspis aspidistrae*)
  - Citrus snow scale (*Unaspis citri*)
  - Citrus red mite (*Panonychus citri*)
- The estimated unrestricted risks for seven pests (one fruit fly species, one mealybug species, two spider mite species and three thrips species) were assessed as not achieving the ALOP for Australia, and therefore these seven pests require specific risk management measures for this pathway. These pests are:
  - Mediterranean fruit fly (*Ceratitis capitata*)
  - Grape mealybug (*Pseudococcus maritimus*)
  - Avocado brown mite (*Oligonychus punicae*)
  - Avocado red mite (*Oligonychus yothersi*)
  - Chilean flower thrips (*Frankliniella australis*)
  - Tamarugo thrips (*Frankliniella gemina*)
  - Western flower thrips (*Frankliniella occidentalis*) (also assessed as a regulated article)

Figure 19 Summary of assessment of quarantine pests of concern



5 Pest risk management

This chapter provides information on the management of quarantine pests and regulated thrips identified as having an unrestricted risk that does not achieve the appropriate level of protection (ALOP) for Australia. The recommended risk management measures for these pests are described in this chapter. This chapter also describes the operational system that is required for the maintenance and verification of the phytosanitary status of fresh avocado fruit from Chile for export to Australia.

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 and regulated thrips for Australia, where they have been assessed to have an unrestricted risk that does not achieve the ALOP for Australia. In calculating the unrestricted risk estimates, the standard commercial production practices in Chile have been considered, including the post-harvest procedures and the packing of fruit (as described in Chapter 3: Chile's commercial production practices for avocados).

Pest risk management measures identified for quarantine thrips are considered appropriate for the regulated thrips.

In addition to Chile's standard commercial production systems and packing house operations for avocados (as described in Chapter 3: Chile's commercial production practices for avocados), specific pest risk management measures are recommended in order to achieve the ALOP for Australia.

In this chapter, the Department of Agriculture has recommended risk management measures that may be applied to consignments of avocados sourced from Chile. Finalisation of the import conditions may be undertaken with input from the Australian states and territories as appropriate.

5.1.1 Analysis of pest interception data to date

Australia currently only allows imports of avocados from New Zealand, with over 160,000 tonnes imported since 2006. Data for imports show that the organisms intercepted on avocado consignments include species of mites (Trombidiformes), armoured scales (Diaspididae), mealybugs (Pseudococcidae) and thrips (Thripidae). All of the organisms intercepted are actioned appropriately according to their quarantine status.

5.1.2 Pest risk management for quarantine pests and regulated thrips associated with avocados from Chile

The pest risk assessment process identified the quarantine pests and regulated thrips listed in Table 5.1 as having unrestricted risks that do not achieve the ALOP for Australia. Therefore, risk management measures are required to manage the risks posed by these pests. The recommended measures are listed in Table 5.1.

Table 5.1 Risk management measures recommended for quarantine pests and regulated thrips associated with avocados from Chile

Pest	Common name	Measures
Fruit fly		
Ceratitis capitata (EP)	Mediterranean fruit fly	Area freedom **a** OR Fruit treatment considered to be effective against all life stages of *C. capitata* (for example, cold disinfestation treatment) for all cultivars OR Hard condition of fruit for Hass cultivar only
Mealybug		
Pseudococcus maritimus (EP)	Grape mealybug	Pre-export visual inspection and, if found, remedial action **b**
Thrips		
Frankliniella australis (GP)	Chilean flower thrips	Pre-export visual inspection and, if found, remedial action **b**
Frankliniella gemina (GP)	Tamarugo thrips	Pre-export visual inspection and, if found, remedial action **b**
Frankliniella occidentalis (GP, NT, RA)	Western flower thrips	Pre-export visual inspection and, if found, remedial action **b**
Oligonychus **spider mites**		
Oligonychus punicae	Avocado brown mite	Pre-export visual inspection and, if found, remedial action **b**
Oligonychus yothersi	Avocado red mite	Pre-export visual inspection and, if found, remedial action **b**

a Area freedom may include pest free areas, pest free places of production and/or pest free production sites. **b** 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 withdrawal of the consignment from export to Australia.
EP: Species has been assessed previously and import policy already exists. **GP**: Species has been assessed previously in a Group PRA (thrips Group PRA) and the Group PRA has been applied. **NT:** Pest of biosecurity concern for the Northern Territory. **RA:** Regulated article, refer to Section 4.4 for definition of a regulated article.

5.1.3 Risk management measures for quarantine pests and regulated thrips

The thrips Group PRA has identified thrips and emerging orthotospoviruses of biosecurity importance to Australia (Australian Government Department of Agriculture and Water Resources 2017). *Frankliniella australis*, *F. gemina* and *F. occidentalis* are associated with avocados from Chile. Risk management measures are required to reduce the risk posed by these quarantine thrips, and the emerging quarantine orthotospoviruses that *F. occidentalis* vectors, to achieve the ALOP for Australia. The recommended measures are listed in Table 5.1.

Risk management measures recommended here for quarantine pests and regulated thrips are consistent with the risk management measures recommended for the same pests and/or pest groups in existing policies. These policies are for the import of apples from China (Biosecurity Australia 2010a), citrus from Egypt (Biosecurity Australia 2002), mangoes from Indonesia, Thailand and Vietnam (Department of Agriculture and Water Resources 2015), mangoes from India (Biosecurity Australia 2008a), mangoes from Taiwan (Biosecurity Australia 2006b), mangosteens from Indonesia (DAFF 2012b), persimmons from Japan, Korea and Israel (DAFF

2004), decrowned pineapples from Malaysia (DAFF 2012a), stone fruit from the USA (Biosecurity Australia 2010b), sweet oranges from Italy (Biosecurity Australia 2005a), table grapes from Chile (Biosecurity Australia 2005b) and table grapes from China (Biosecurity Australia 2011), as well as the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017). These policies include most of the pests and all of the pest groups identified in Table 5.1 of this report.

There has been trade in apples from China (over 2,600 tonnes), table grapes from China (over 14 tonnes), persimmons from Korea and Israel (over 1,000 tonnes), citrus from Egypt (over 10,000 tonnes), mangoes from India and Vietnam (over 26 tonnes) and stone fruit from the USA (over 33,000 tonnes). The risk management measures implemented for these commodities have successfully managed the pests associated with these pathways.

This final report recommends that when the following risk management measures are followed, the restricted risk for all identified quarantine pests and regulated thrips, and hence the orthotospoviruses the thrips may vector, will achieve the appropriate level of protection (ALOP) for Australia. These measures are:

- area freedom, fruit treatment (such as cold disinfestation treatment) for all cultivars or hard condition of fruit for the Hass cultivar only for Mediterranean fruit fly.
- pre-export visual inspection and, remedial action for grape mealybug, *Oligonychus* spider mites and thrips if live pests are found.

Management for *Ceratitis capitata*

The Department of Agriculture recommends the options of area freedom or cold disinfestation treatment for all cultivars, or hard condition of fruit for Hass variety only, as measures for *Ceratitis capitata*. The objective of each of the recommended measures is to reduce the risk associated with this pest to achieve the ALOP for Australia.

Recommended measure 1: Area freedom

Area freedom (including pest free areas, pest free places of production or pest free production sites) is a measure that can be applied to manage the risk posed by *Ceratitis capitata*. The requirements for establishing pest free areas, pest free places of production, or pest free production sites are set out in ISPM 4: *Requirements for the establishment of pest free areas* (FAO 2017a), ISPM 10: *Requirements for the establishment of pest free places of production and pest free production sites* (FAO 2016b) and, more specifically, ISPM 26: *Establishment of pest free areas for fruit flies* (Tephritidae) (FAO 2019e).

The Department of Agriculture recognises Chile as free from *Ceratitis capitata*. Under the area freedom option, SAG is to be responsible for maintaining area freedom, which includes monitoring and trapping for *C. capitata* and regulating the movement of risk material on an ongoing basis. SAG would be required to notify the Department of Agriculture of an outbreak of *C. capitata* in Chile within 48 hours.

In the case of an outbreak of *C. capitata* in Chile, avocados sourced from the area within a certain distance of the outbreak area, as specified in Chile's national fruit fly program, will require a mandatory treatment (recommended measure 2) or an alternative risk management measure (recommended measure 3) for *C. capitata*. SAG must notify the Department of Agriculture if there are any significant changes to Chile's national fruit fly program, particularly the management of *C. capitata* outbreaks.

SAG is required to report to the Department of Agriculture any actions undertaken, including eradication activities. Reinstatement of the area freedom status will be subject to joint investigation between SAG and the Department of Agriculture on the eradication outcomes.

If any fruit flies of economic importance are detected at on arrival inspection, trade will be suspended immediately, pending the outcome of an investigation.

Recommended measure 2: Cold disinfestation treatment

In the case of an outbreak of *C. capitata*, cold disinfestation treatment can be used as a measure to manage the risk posed by this pest. Cold disinfestation treatments can be conducted pre-export in Chile or in-transit to Australia.

Cold disinfestation treatment has been used since the early 20th century as an effective treatment method to provide phytosanitary control of fruit flies for a variety of fruits grown around the world (Heather & Hallman 2008).

A treatment regime consistent with the USDA treatment schedule (USDA 2019) for *C. capitata* on a range of commodities, including avocado, is recommended by Australia.

Thus, the Department of Agriculture recommends the following specifications for temperatures and exposure times where cold disinfestation treatment is utilised:

- fruit held at 1.11 °C or below for 14 days, or
- fruit held at 1.67 °C or below for 16 days, or
- fruit held at 2.22 °C or below for 18 days.

Should Chile wish to use pre-export cold disinfestation treatment as a phytosanitary measure, SAG would need to provide a submission to the Australian Government Department of Agriculture that demonstrates it has processes and procedures for the registration, approval and audit of treatment facilities. The Australian Government Department of Agriculture may request on-site verification of the treatment facilities.

Both pre-export and in-transit cold disinfestation treatment must fulfil the requirements as set out in the Australian phytosanitary treatment application standard for cold disinfestation treatment available at http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/plants-plant-products/plant-exports-manual/resources/australian-phytosanitary-treatment-cold.pdf.

Recommended measure 3: Hard condition of fruit for the Hass cultivar only

Hard condition of fruit is a measure that can be applied to manage the risk posed by *C. capitata* on the Hass avocado cultivar. A number of studies have shown that *C. capitata* is not able to infest hard mature Hass avocado fruit (De Lima 1995; Liquido et al. 2011). Hard mature Hass avocado fruit are thus not considered a host of *C. capitata*.

The Department of Agriculture recommends the following specifications for the hard condition

- Fruit must be harvested from trees while in a hard condition and stored in secure conditions within a defined period after harvest.
- Hard condition means avocados showing no signs of softening, or having any isolated soft areas or broken skin on any part of the fruit that have been deliberately detached from healthy branches of living trees.

Should Chile wish to use the hard condition of fruit as a measure to manage the risk posed by *C. capitata* on the Hass cultivar, SAG would have to submit a proposal outlining components and procedures of the system to certify Hass avocado fruit for hard condition. The Department of Agriculture will consider the effectiveness of the system proposed by SAG.

Management for *Pseudococcus maritimus, Oligonychus punicae* and *Oligonychus yothersi*

The Department of Agriculture recommends pre-export visual inspection, and, if found, remedial action to manage the risk of *Pseudococcus maritimus*, *Oligonychus punicae* and *Oligonychus yothersi*. The objective of the recommended measure is to reduce the risk associated with these pests to achieve the ALOP for Australia.

Recommended measure: Pre-export visual inspection and, if found, remedial action

All consignments of avocados exported to Australia must be inspected by SAG, Chile's NPPO, and found free of *P. maritimus, O. punicae* and *O. yothersi*. Pre-export visual inspection must be undertaken by SAG in accordance with ISPM 23: *Guidelines for inspection* (FAO 2019d) and consistent with the principles of ISPM 31: *Methodologies for sampling of consignments* (FAO 2016c) ensuring that the inspection method is designed to detect *P. maritimus, O. punicae* and *O. yothersi*. Export consignments found to contain these pests must be subjected to remedial action. Remedial action may include withdrawing the consignment from export to Australia or, if available, applying approved treatment to the export consignment to ensure that the pest is no longer viable.

Management for quarantine thrips and regulated thrips

The Department of Agriculture recommends pre-export visual inspection and, if found, remedial action to manage the risk of quarantine thrips and regulated thrips. This measure is consistent with the options provided in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017). The objective of the recommended measure is to reduce the risk associated with these pests to achieve the ALOP for Australia.

The recommended measure applies to all phytophagous quarantine thrips and regulated thrips on the avocados from Chile pathway, irrespective of their specific identification in this document, consistent with the thrips Group PRA.

Recommended measure: Pre-export visual inspection and, if found, remedial action

All consignments of avocados exported to Australia must be inspected by SAG, Chile's NPPO, and found free of quarantine thrips and regulated thrips. Pre-export visual inspection must be undertaken by SAG in accordance with ISPM 23: *Guidelines for inspection* (FAO 2019d) and consistent with the principles of ISPM 31: *Methodologies for sampling of consignments* (FAO 2016c) ensuring that the inspection method is designed to detect thrips. Export consignments found to contain any quarantine thrips or regulated thrips must be subjected to remedial action. Remedial action may include withdrawing the consignment from export to Australia or, if available, applying an approved treatment to the export consignment to ensure that the pest is no longer viable.

5.1.4 Consideration of alternative measures

Consistent with the principle of equivalence detailed in ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c), the Department of Agriculture will consider any alternative measure proposed by SAG, providing that it demonstrably manages the target pests to achieve the ALOP for Australia. Evaluation of any such measure will require a technical submission from SAG that details the proposed measures, including suitable information to support the claimed efficacy, for consideration by the Department of Agriculture.

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 avocados from Chile. This is to ensure that the recommended risk management measures have been met and are maintained.

5.2.1 A system of traceability to source orchards

The objectives of this recommended requirement are to ensure that:

- avocados are sourced only from orchards producing commercial export-quality fruit
- orchards from which avocados are sourced can be identified, so that any investigation and corrective action can be targeted rather than applied to all contributing export orchards, in the event that live/viable pests are intercepted.

SAG must ensure that avocados for export to Australia can be traced back to orchard level. SAG would be responsible for ensuring that export avocado growers are aware of pests of biosecurity concern to Australia and the required risk management measures.

5.2.2 Registration of packing houses and auditing of procedures

The objective of this recommended procedure is to ensure that:

- avocados are sourced only from packing houses approved by SAG for processing of commercial-quality fresh avocados.

Export packing houses must be registered with SAG before the commencement of harvest each season. The list of registered packing houses must be kept by SAG. SAG is required to ensure that the registered packing houses are suitably equipped and have a system in place to carry out the specified phytosanitary activities. The list of registered packing houses and records of SAG audits must be made available to the Department of Agriculture upon request.

5.2.3 Registration of treatment providers and auditing of procedures

The objectives of this recommended procedure are to ensure that:

- avocados are treated by treatment providers that have been approved by SAG.

In circumstances where avocados undergo treatment prior to export, this process must be undertaken by treatment providers that have been registered with and audited by SAG for that purpose. The list of registered treatment providers, and records of SAG registration requirements and audits must be made available to the Department of Agriculture upon request.

Approval of treatment providers by SAG must include verification that suitable systems are in place to ensure compliance with the treatment requirements. This may include:

- documented procedures to ensure avocados are appropriately treated and safeguarded post treatment
- staff training to ensure compliance with procedures
- record keeping procedures
- suitability of facilities and equipment
- compliance with SAG's system of oversight of treatment application or system of authorisation of treatment oversight.

The Australian NPPO provides final approval of facilities, following review of the regulatory oversight provided by the exporting NPPO and the capability demonstrated by the facility. Site visits may be required for the Australian NPPO to have assurance that the treatment can be applied accurately and consistently.

5.2.4 Packaging, labelling and containers

The objectives of this recommended procedure are to ensure that:

- avocados intended for export to Australia, and associated packaging, are not contaminated by quarantine pests or regulated articles (as defined in ISPM 5: *Glossary of phytosanitary terms* (FAO 2019b))
- unprocessed packing material, which is not permitted, as it may vector other pests not associated with avocados, is not imported with Chilean avocados
- all wood material associated with the consignment used in packaging and transport of avocados must comply with the Department of Agriculture's import conditions, as published on BICON
- secure packaging is used for export of avocados to Australia to prevent re-infestation during storage and transport and prevent escape of pests during clearance procedures on arrival in Australia. To make consignments insect-proof and secure, at least one of the following packaging options must be used:
  - **Integral cartons**: produce may be packed in integral (fully enclosed) cartons (packages) with boxes having no ventilation holes and lids tightly fixed to the bases.
  - **Ventilation holes of cartons covered:** cartons (packages) with ventilation holes must have the holes covered/sealed with a mesh/screen of no more than 1.6 mm pore size and not less than 0.16 mm strand thickness. Alternatively, the vent holes could be taped over.
  - **Polythene liners -** vented cartons (packages) with sealed polythene liners/bags within are acceptable (folded polythene bags are acceptable).
  - **Meshed or shrink wrapped pallets or Unit Loading Devices (ULDs)**:ULDs transporting cartons with open ventilation holes/gaps, or palletised cartons with ventilation holes/gaps must be fully covered or wrapped with polythene/plastic/foil sheet or mesh/screen of no more than 1.6 mm diameter pore size. The wrapped pallet or ULD must be loaded and sealed at packing house or treatment facility.
  - **Produce transported in fully enclosed containers:** cartons (packages) with holes as loose boxes or on pallets may be transported in fully enclosed containers. Enclosed

containers include 6-sided container with solid sides, or ULDs with tarpaulin sides that have no holes or gaps. The container must be loaded and sealed at the packing house or treatment facility.

- the packaged avocados are labelled with sufficient identification for the purposes of traceability of goods to orchard, packing house and treatment provider (if required).

Export packing houses and treatment providers (where applicable) must ensure packaging and labelling are appropriate to maintain phytosanitary status of the export consignments.

5.2.5 Specific conditions for storage and movement

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

Treated and/or inspected avocados for export to Australia must be kept secure and segregated at all times from any fruit for domestic or other markets, and from untreated/non pre-inspected product to prevent mixing or cross-contamination.

5.2.6 Freedom from trash

The objective of this recommended procedure is to ensure that avocados for export are free from trash (for example, loose stem and leaf material, seeds, soil, animal matter/parts or other extraneous material) and foreign matter.

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

5.2.7 Pre-export phytosanitary inspection and certification by SAG

The objectives of this recommended procedure are to ensure that Australia's import conditions have been met.

- All consignments must be inspected in accordance with official procedures for all visually detectable quarantine pests and other regulated articles (including soil, animal and plant debris) at a random 600 unit sampling rate per phytosanitary certificate, or equivalent (as defined in ISPM 31: Methodologies for sampling consignments (FAO 2016c). One unit is considered to be a single avocado fruit.
- The department may request information from SAG on the inspection method used to identify quarantine pests.
- A phytosanitary certificate must be issued for each consignment upon completion of pre-export inspection to verify that the required risk management measures have been undertaken prior to export and the consignment meets Australia's import requirements.
- Each phytosanitary certificate must include:

– a description of the consignment (including traceability information)

– details of disinfestation treatments (for example, cold disinfestation treatment)

– any other statements that may be required such as identification of the consignment as being sourced from a recognised pest free area.

5.2.8 Phytosanitary inspection by the Department of Agriculture

The objectives of this recommended procedure are to ensure that:

- 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 Department of Agriculture will:

- assess documentation 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
- verify that the biosecurity status of consignments of avocados from Chile meet Australia's import conditions. When inspecting consignments, the department will use random samples of 600 units, or equivalent, per phytosanitary certificate (or as goods are lodged) and inspection methods suitable for the commodity.

5.2.9 Remedial action(s) for non-compliance

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

- any quarantine pest or regulated article, including trash, 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 will be subject to suitable remedial treatment where an effective treatment is available and biosecurity risks associated with applying the treatment can be effectively managed, or the imported consignment will be exported or destroyed.

Other actions including partial or complete suspension of the import pathway may be taken depending on the identity and/or importance of the pest intercepted, for example, fruit flies of economic importance.

In the event that avocado consignments are repeatedly non-compliant, the Department of Agriculture reserves the right to suspend imports (either all imports, or imports from specific pathways) and conduct an audit of the risk management systems. Imports will be allowed to recommence only when the Department of Agriculture is satisfied that appropriate corrective action has been undertaken.

5.3 Uncategorised pests

If an organism that has not been categorised, including a contaminant pest, is reported on avocados in Chile or detected on avocados on arrival in Australia, 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 the ALOP for Australia, then it may require reassessment. The detection of any pests of biosecurity concern not already identified in this 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 Department of Agriculture will verify the implementation of the required import conditions and phytosanitary measures including registration, operational procedures and treatment providers, where applicable. For example, for measures conducted off shore, the department may require information about standard operating procedures (SOPs). This may involve representatives from the Department of Agriculture visiting areas in Chile that produce avocados for export to Australia.

5.4.2 Review of policy

The Department of Agriculture will review the import policy after a suitable volume of trade has been achieved. In addition, the department reserves the right to review the import policy as deemed necessary, including if there is reason to believe that the pest or phytosanitary status in Chile has changed.

SAG must inform the Department of Agriculture immediately on detection of any newly identified pests of avocado that might be of potential biosecurity concern to Australia, or when the phytosanitary status of a pest has changed, in accordance with ISPM 8: *Determination of pest status in an area* (FAO 2017b).

5.5 Meeting Australia's food laws

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

The Department of Agriculture administers the *Imported Food Control Act 1992*. This legislation provides for the inspection and control of imported food using a risk-based border inspection program, the Imported Food Inspection Scheme. More information on this inspection scheme, including the testing of imported food, is available from the department's website at http://agriculture.gov.au/import/goods/food/inspection-compliance/inspection-scheme.

Food Standards Australia New Zealand (FSANZ) is responsible for developing and maintaining the Code, including Standard 1.4.2 - Agvet chemicals. This standard is available on the Federal Register of Legislation at http://www.legislation.gov.au/ or through the FSANZ website at http://www.foodstandards.gov.au/code/Pages/default.aspx.

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

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

6 Conclusion

The findings of this final risk analysis for fresh avocados from Chile are based on a comprehensive scientific analysis of relevant literature, and other avenues of enquiry.

The Department of Agriculture considers that the risk management measures recommended in this report will provide an appropriate level of protection against the quarantine pests and regulated thrips identified as associated with the trade of fresh avocados from Chile.

Appendix A: Initiation and categorisation for pests of fresh avocado fruit from Chile

The following table identifies pests that have the potential to be present on avocados grown in Chile using standard commercial production and packing procedures, and to be imported into Australia.

The purpose of pest categorisation is to ascertain which of these pests require detailed assessment in order to determine whether phytosanitary measures are required. The steps in the pest categorisation process are considered sequentially. The assessment terminates at 'Yes' for the third column (presence within Australia), except for pests that are present but under official control, and/or are pests of regional concern. In cases where this does not apply, assessment terminates at the first 'No' in any of the following columns.

In the final column of the table (column 7) the acronyms 'EP' and 'WA' are used. The acronym 'EP' (existing policy) is used for pests that have previously been assessed by Australia and for which import policy exists. The acronym 'WA' (Western Australia) is used to identify organisms that have been recorded in some regions of Australia but, due to interstate quarantine regulations, are considered pests of regional concern to Western Australia.

The *Final group pest risk analysis for thrips and orthotospoviruses on fresh fruit, vegetables, cut-flower and foliage imports* (Australian Government Department of Agriculture and Water Resources 2017) has been applied in this risk analysis. Application of group policy involves identification of up to three species of each relevant group associated with the commodity pathway. However, if any other quarantine pests or regulated articles not included in this risk analysis and/or in the relevant group policies is detected at pre-export or on arrival in Australia, the relevant group policy will also apply.

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

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

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

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
ARTHROPODS						
Coleoptera						
Araecerus fasciculatus (DeGeer, 1775) [Anthribidae] Coffee bean weevil	No. Only present on Easter Island (CABI 2019a), which is a special territory of Chile located in the South Pacific Ocean more than 3,500 km west of mainland Chile. Quarantine procedures are in place to prevent the entry of pests from Easter Island to mainland Chile (SAG 2005a). In addition, avocados will not be exported from Easter Island.	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No
Naupactus cervinus Boheman, 1840 Synonyms: *Pantomorus cervinus* (Boheman, 1840), *Asynonychus cervinus* (Boheman, 1840) [Curculionidae] Fuller's rose weevil	Yes (Ripa & Larral 2008)	Yes. NSW, Qld, Tas., SA, Vic., WA (CSIRO 2004; Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Naupactus xanthographus (Germar, 1824) [Curculionidae] Fruit tree weevil	Yes (EPPO 2019)	No records found	No. *Naupactus xanthographus* feeds on roots and leaves of its hosts (Ripa & Larral 2008; Ripa 1986). Adults are 2 to 2.5 cm long and feed on leaves of avocado (EPPO 2018; Ripa & Larral 2008). The female lays its eggs on leaves, in cracks in broken branches and under material used to support grafts, with larvae dropping to the ground to feed on the roots (Peña et al. 2013; Ripa & Larral 2008). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Pagiocerus frontalis (Fabricius, 1801) [Curculionidae]	Yes (Elgueta & Marvaldi 2006)	No records found	No. Although *P. frontalis* has been reported on fruit and seed of avocado, it is only known to infest fruit and seed of avocado fruit that has fallen to the ground (Atkinson et al. 1986; CDFA 2015; Wood 1982). Fallen fruit would not be export quality fruit. No evidence of an association with avocado fruit on the tree was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rhyephenes humeralis (Guérin Méneville, 1830) [Curculionidae] South American weevil	Yes (Alonso-Zarazaga & Goldarazena 2005; Ebeling 1959)	No records found	No. *Rhyephenes humeralis* has been reported as a pest of avocado (Ebeling 1959). However, the female lays its eggs in and underneath the bark of host trees with the larvae living underneath the bark of the tree and adult *R. humeralis* feed on the bark, tender shoots and foliage of host trees (Aguayo Silva et al. 2008; Alonso-Zarazaga & Goldarazena 2005). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Diptera						
Anastrepha fraterculus (Wiedemann, 1830) [Tephritidae] South American fruit fly	No. While there are records of this species in Chile in the past, they do not reflect the current distribution (White & Elson-Harris 1994) as *A. fraterculus* was eradicated from Chile in 1964 (CABI 2019a; EPPO 2019).	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Atherigona orientalis Schiner, 1868 [Muscidae] Pepper fruit fly	No. Only present on Easter Island (CABI 2019a; Pont 1992), which is a special territory of Chile located in the South Pacific Ocean more than 3,500 km west of mainland Chile. Quarantine procedures are in place to prevent the entry of pests from Easter Island to mainland Chile (SAG 2005a). In addition, avocados will not be exported from Easter Island.	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Ceratitis capitata (Wiedemann, 1824) [Tephritidae] Mediterranean fruit fly	Yes, but under eradication (EPPO 2019).	Yes. Present in WA, but under official control.	Yes. Eskafi and Cunningham (1987) found *C. capitata* in avocado fruit collected in Guatemala. Eggs of *C. capitata* are laid below the skin of host fruit and larvae feed and develop within the fruit. The transport of infested fruits is the main means of movement of this pest (CABI 2019a). Unripe Sharwil variety avocados still on the tree have also been shown to be infested in Hawaii (Liquido, Chan & McQuate 1995).	Yes. This pest is polyphagous; larvae feed on the fruit of many plants such as citrus, peach, pear, apple, apricot, fig, plum, kiwifruit, quince, grape, sweet cherry, pomegranate and strawberry (CABI 2019a). Mediterranean type climates that favour the establishment of this species occur in various parts of Australia.	Yes. *Ceratitis capitata* is a highly damaging pest, particularly in citrus and peach. It can also transmit fruit-rotting fungi. Damage to fruit crops can sometimes reach 100 per cent (CABI 2019a).	Yes (EP)
Neosilba pendula (Bezzi, 1919) [Lonchaeidae] Cassava shoot fly	Yes (Klein Koch & Waterhouse 2000)	No records found	No. Although *N. pendula* can be associated with avocado fruit (Bush 1957), flies of the genus *Neosilba* are secondary pests of fruit that is already injured or previously infested by other species (Ahlmark & Steck 1997; White & Elson-Harris 1994). Such obviously damaged fruit will be culled during standard commercial production practices.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hemiptera						
Aleurothrixus floccosus (Maskell, 1896) [Aleyrodidae] Woolly whitefly	Yes (Klein Koch & Waterhouse 2000)	No records found	No. *Aleurothrixus floccosus* is an important pest of avocado in Peru (Ayquipa Aycho, Mendocilla Bacilio & Neyra 2009). However, eggs are laid on leaves and both larval stages and adults attack young leaves (CABI 2019b). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Aleurothrixus porteri Quaintance & Baker, 1916 [Aleyrodidae]	Yes (Evans 2007; Klein Koch & Waterhouse 2000)	No records found	No. Although avocado is known to be a host of *A. porteri* (Evans 2007), whitefly eggs are laid on leaves, and all life stages feed on sap from leaves (Byrne & Bellows 1991). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Antecerococcus badius (Leonardi, 1911) Synonym: *Cerococcus badius* Leonardi, 1911 [Cerococcidae]	Yes (García Morales et al. 2019)	No records found	No. There is extremely little information on the biology of the *Antecerococcus* genus. However, other species in this genus are known to attack only branches and twigs of their hosts, causing foliage dieback (Hodges 2017; Miller et al. 2014). Avocado is listed as a host plant of this pest (García Morales et al. 2019), but no evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Aonidiella aurantii (Maskell, 1879) [Diaspididae] California red scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Aonidiella citrina (Coquillett, 1891) [Diaspididae] Yellow scale	Yes (García Morales et al. 2019)	Yes. NSW, SA, Vic., WA (Government of Western Australia 2019; Plant Health Australia 2019; Watson 2019)	Assessment not required	Assessment not required	Assessment not required	No
Aphis fabae Scopoli, 1763 [Aphididae] Black bean aphid	Yes (CABI 2019a)	No records found	No. On avocado, it is only found on branches (Ebeling & Pence 1952). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aphis gossypii Glover, 1877 [Aphididae] Cotton aphid, Melon aphid	Yes (CABI 2019a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Aphis spiraecola Patch, 1914 [Aphididae] Spirea aphid, green citrus aphid	Yes (CABI 2019a)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Aspidiotus destructor Signoret, 1869 [Diaspididae] Coconut scale	No. Only present on Easter Island (CABI 2019a; Claps, Wolff & Gonzalez 2001), which is a special territory of Chile located in the South Pacific Ocean more than 3,500 km west of mainland Chile. Quarantine procedures are in place to prevent the entry of pests from Easter Island to mainland Chile (SAG 2005a). In addition, avocados will not be exported from Easter Island.	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No
Aspidiotus nerii Bouché, 1833 [Diaspididae] Oleander scale	Yes (García Morales et al. 2019)	Yes. NT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Bemisia tabaci (Gennadius, 1889) [Aleyrodidae] Silverleaf whitefly	Yes (Evans 2008)	Yes. ACT, NT, NSW, Qld, SA, WA (Plant Health Australia 2019) However, *B. tabaci* biotypes Nauru and Q are regulated as Declared Organisms (Prohibited (s. 12)) and biotype B is regulated as a Declared Organism (s. 22 (2)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	No. Although avocado has been reported as a host (Manani et al. 2017), eggs and larval stages of *B. tabaci* are found on the underside of leaves (CABI 2019a) and adults are likely to fly away during harvest and processing. No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Ceroplastes ceriferus (Fabricius, 1798) [Coccidae] Indian white wax scale	Yes (García Morales et al. 2019)	Yes. NSW, Qld, WA (Plant Health Australia 2019; Qin & Gullan 1994).	Assessment not required	Assessment not required	Assessment not required	No
Ceroplastes cirripediformis Comstock, 1881 [Coccidae] Barnacle scale	Yes (García Morales et al. 2019)	No records found	No. This species primarily occurs on the stems of its hosts (Miller et al. 2014). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Ceroplastes sinensis Del Guercio, 1900 [Coccidae] Chinese wax scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Chrysomphalus aonidum (Linnaeus, 1758) [Diaspididae] Circular black scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Chrysomphalus dictyospermi (Morgan, 1889) [Diaspididae] Spanish red scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA (Plant Health Australia 2019) Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	Yes. *Chrysomphalus dictyospermi* can be found on the branches, leaves and fruit of avocado (de Villiers & Van den Berg 1987; Peña et al. 2013).	Yes. *Chrysomphalus dictyospermi* is polyphagous and known hosts include avocado, citrus and other crops grown commercially in Australia (García Morales et al. 2019). This species is distributed throughout the world including Asia, Europe, Africa, North and South America, and parts of Australia (García Morales et al. 2019), and it is likely that similar climatic conditions exist in parts of Western Australia. The availability of host plants and suitable climatic conditions in Western Australia suggest that this pest could establish and spread in Western Australia.	Yes. This species is known to attack avocado, citrus and other crops grown commercially in Australia (García Morales et al. 2019). It secretes honeydew, which causes sooty mould. Heavy infestations can also cause leaf and fruit tissue discolouration, branch wilt, leaf drop and fruit deformation (Alford 2007).	Yes (EP, WA)
Coccus hesperidum Linnaeus, 1758 [Coccidae] Brown soft scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Comstockaspis perniciosa (Comstock, 1881) Synonym: *Diaspidiotus perniciosus* (Comstock, 1881) [Diaspididae] San José scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Dialeurodes citri (Ashmead, 1885) Synonym: *Aleyrodes citri* Ashmead, 1885 [Aleyrodidae] Citrus whitefly	Yes (CABI 2019a)	No records found	No. Although *Persea sp.* has been reported as a host (Evans 2008), eggs and larval stages of *D. citri* are found on the underside of leaves (CABI 2019a) and adults are likely to fly away during harvest and processing. No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Diaspidiotus ancylus (Putnam, 1878) [Diaspididae] Putnam scale	Yes (García Morales et al. 2019)	Yes. NSW, Qld (Plant Health Australia 2019) Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	No. *Diaspidiotus ancylus* is mainly found on the underside of leaves, branches and stems. It has been found on blueberry fruit and occasionally plums; however, no evidence of an association with avocado fruit was found (García Morales et al. 2019; Miller & Davidson 2005).	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Dysmicoccus brevipes (Cockerell, 1893) [Pseudococcidae] Pineapple mealybug	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	
Epidiaspis leperii (Signoret, 1869) [Diaspididae] European pear scale	Yes (García Morales et al. 2019)	No records found	No. Avocado is considered a host of *E. leperii*, but this pest only occurs on twigs, branches and trunks of its hosts (Cean, Cean & Stănică 2012; Gill 1997; Kozar 1976; Miller & Davidson 2005). This pest is often found sheltering under lichens on the bark (CABI 2019a; Gill 1997). The risk of movement of this pest in international trade is associated with transport of infested planting material (CABI 2019a). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fiorinia fioriniae (Targioni Tozzetti, 1867) [Diaspididae] Fiorinia scale	Yes (Claps, Wolff & Gonzalez 2001; Klein Koch & Waterhouse 2000)	Yes. NSW, NT, Qld, SA, Tas., Vic. (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	Yes. *Fiorinia fioriniae* attacks leaves and fruit of avocado (Peña et al. 2013).	Yes. *Fiorinia fioriniae* is polyphagous and known hosts include avocado, citrus and other crops grown commercially in Australia (García Morales et al. 2019). This species is distributed throughout the world including Asia, Europe, Africa, North and South America, and parts of Australia (García Morales et al. 2019), and it is likely that similar climatic conditions exist in parts of Western Australia. The availability of host plants and suitable climatic conditions in Western Australia suggest that this pest could establish and spread in Western Australia.	Yes. This species is considered to be a pest of concern on multiple hosts causing leaf chlorosis and defoliation (Miller & Davidson 2005; Watson 2016). *Fiorinia fioriniae* is known to attack avocado, citrus and other crops grown commercially in Australia (García Morales et al. 2019).	Yes (WA)

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hemiberlesia cyanophylli (Signoret, 1869) Synonym: *Abgrallaspis cyanophylli* (Signoret, 1869) [Diaspididae] Cyanophyllum scale	Yes (Klein Koch & Waterhouse 2000; Watson 2016)	Yes. Qld, NSW, SA, Tas., NT (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	Yes. *Hemiberlesia cyanophylli* has been found feeding on the underside of leaves and on fruit of avocado (Gerson & Zor 1973; Kondo & Muñoz 2016).	Yes. *Hemiberlesia cyanophylli* is polyphagous and known hosts include avocado, mango and other crops grown commercially in Australia (García Morales et al. 2019). This species is distributed throughout the world including Asia, Europe, Africa, North and South America, and parts of Australia (García Morales et al. 2019), and it is likely that similar climatic conditions exist in parts of Western Australia. The availability of host plants and suitable climatic conditions in Western Australia suggest that this pest could establish and spread in Western Australia.	Yes. This species is known to attack avocado, mango and other crops grown commercially in Australia (García Morales et al. 2019).	Yes (EP, WA)
Hemiberlesia lataniae (Signoret, 1869) [Diaspididae] Latania scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hemiberlesia latastei (Cockerell, 1894) Synonym: *Abgrallaspis latastei* (Cockerell, 1894) [Diaspididae] Lataste scale	Yes (Evans, Watson & Miller 2009; García Morales et al. 2019; González & Charlín 1968; Klein Koch & Waterhouse 2000)	No records found.	Yes. *Hemiberlesia latastei* is a pest of avocado in Chile (Evans, Watson & Miller 2009; Vargas & Rodríguez 2008b). No information on the biology of this species was found. However, other species in this genus are known to be found on leaves, bark and fruit of their hosts (Martin Kessing & Mau 2007).	Yes. This species is polyphagous, with known hosts including avocado, plum and other crops grown commercially in Australia (García Morales et al. 2019). This species is likely to be easily spread through the distribution of planting material since females of species in the family Diaspididae remain on the host for their entire lives (Martin Kessing & Mau 2007) and are not easily dislodged. This species is found in Argentina and Chile (García Morales et al. 2019), and it is likely that similar climatic conditions exist in parts of Australia. The availability of host plants and suitable climatic conditions in Australia suggest that this pest could establish and spread in Australia.	Yes. This species is known to attack avocado, plum and other crops grown commercially in Australia (García Morales et al. 2019).	Yes

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Hemiberlesia palmae (Cockerell, 1893) [Diaspididae] Tropical palm scale	Yes (García Morales et al. 2019)	Yes. NSW, Qld (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	No. *Hemiberlesia palmae* is found on leaves and branches of avocado (Kondo & Muñoz 2016; USDA-APHIS 2006). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Hemiberlesia rapax (Comstock, 1881) [Diaspididae] Greedy scale	Yes (García Morales et al. 2019)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Homalodisca vitripennis (Germar, 1821) [Cicadellidae] Glassy-winged sharpshooter	No. Only present on Easter Island (EPPO 2019), which is a special territory of Chile located in the South Pacific Ocean more than 3,500 km west of mainland Chile. Quarantine procedures are in place to prevent the entry of pests from Easter Island to mainland Chile (SAG 2005a). In addition, avocados will not be exported from Easter Island.	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Icerya purchasi (Maskell, 1879) [Monophlebidae] Cottony cushion scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Lepidosaphes beckii (Newman, 1869) [Diaspididae] Purple scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Lindingaspis rossi (Maskell, 1892) [Diaspididae] Ross scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (García Morales et al. 2019; Plant Health Australia 2019; Poole 2010).	Assessment not required	Assessment not required	Assessment not required	No
Morganella longispina (Morgan, 1889) [Diaspididae] Plumose scale	No. Only present on Easter Island (Claps, Wolff & Gonzalez 2001), which is a special territory of Chile located in the South Pacific Ocean more than 3,500 km west of mainland Chile. Quarantine procedures are in place to prevent the entry of pests from Easter Island to mainland Chile (SAG 2005a). In addition, avocados will not be exported from Easter Island.	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Myzus persicae (Sulzer, 1776) [Aphididae] Green peach aphid	Yes (CABI 2019a)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Nezara viridula (Linnaeus, 1758) [Pentatomidae] Green vegetable bug	Yes (CABI 2019a)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Paraleyrodes urichii Quaintance and Baker, 1913 [Aleyrodidae] White fly	Yes (Dooley 2017)	No records found	No. This species has been intercepted on avocado, but avocado is not considered a host (Evans 2008), suggesting *P. urichii* was a contaminant pest in these cases. In addition, whitefly eggs are laid on leaves and all life stages feed on sap from leaves (Byrne & Bellows 1991). Adults are likely to fly away during harvest and processing.	Assessment not required	Assessment not required	No
Parlatoria camelliae (Comstock, 1883) [Diaspididae] Camellia parlatoria scale	Yes (García Morales et al. 2019)	No records found	No. Very little information is available on this species. However, on camellia, its primary host, infestations are limited to leaves (García Morales et al. 2019). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Parthenolecanium corni (Bouché, 1844) [Coccidae] Brown scale	Yes (García Morales et al. 2019)	Yes. Tas., Vic. (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	No. *Parthenolecanium corni* overwinters on branches, with instars infesting the underside of leaves. Later stages may be found on leaves, stems and branches (CABI 2019a; Landcare Research 2019). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Parthenolecanium persicae (Fabricius, 1776) [Coccidae] Grapevine scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No

Pellaea stictica (Dallas, 1851) [Pentatomidae]	Yes (Da Silva, Santos & Fernandes 2018; Faúndez & Rider 2014)	No records found	No. *Pellaea stictica* belongs to the Pentatomidae or 'pentatomid bug' family. Some species of pentatomid bugs have been observed feeding on avocado fruit (Joubert & Claasens 1994). Although *P. stictica* has been collected from avocado crops in South America, it is uncertain whether avocado is a host of this pest (Maes 2004). Very little information is available on this species. However, pentamonid bugs generally lay their eggs in clusters on the underside of leaves of their hosts (Esselbaugh 1946; Javahery 1994; McPherson 2018). Pentatomid nymphs and adults are unlikely to remain on fruit during harvest as they have been observed to drop or disperse from hosts when disturbed (Alcock 1971; Gyeltshen, Bernon & Hodges 2010; Hodgson & Leskey 2014; Kamminga et al. 2012; Li et al. 2007; Schoeman 2013). In addition, eggs, nymphs or adults of *P. stictica* that may still be associated with the	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			avocado fruit after harvest are likely to be removed during standard packing house procedures.			
Pinnaspis aspidistrae (Signoret, 1869) [Diaspididae] Fern scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, NT, Qld, SA (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	Yes. This species is a known pest of avocado (García Morales et al. 2019; Tenbrink, Hara & Diez 2007). It can be found on fruit, stems and leaves causing deformation and chlorotic spots (García Morales et al. 2019; Tenbrink, Hara & Diez 2007).	Yes. *Pinnaspis aspidistrae* is polyphagous, with known hosts including avocado, citrus and other crops grown commercially in Australia (García Morales et al. 2019). This species is distributed throughout the world including Asia, Europe, North and South America, and parts of Australia (García Morales et al. 2019), and it is likely that similar climatic conditions exist in parts of Western Australia. The availability of host plants and suitable climatic conditions in Western Australia suggest that this pest could establish and spread in Western Australia.	Yes. This species is known to attack avocado, citrus and other crops grown commercially in Australia (García Morales et al. 2019).	Yes (EP, WA)

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pinnaspis strachani (Cooley, 1899) [Diaspididae] Lesser snow scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Planococcus citri (Risso, 1813) [Pseudococcidae] Citrus mealybug	Yes (García Morales et al. 2019; Ripa & Larral 2008)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Protopulvinaria pyriformis Cockerell, 1894 [Coccidae] Pyriform scale	Yes (García Morales et al. 2019)	Yes. Only in some areas in WA (IPPC 2017) and is permitted (s. 11) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019). Domestic restrictions for the movement of host material of this pest into NSW, Qld, SA and Vic. from other Australian states/territories where this pest is present only include planting material, not fruit (DJPR 2019; New South Wales Government 2017; PIRSA 2019; QDAF 2019; Queensland Government 2018).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudischnaspis bowreyi (Cockerell, 1893) [Diaspididae] Bowrey scale	Yes (Watson 2016)	No records found	No. *Pseudischnaspis bowreyi* primarily occurs on bark and leaves of its hosts, including avocado (Miller & Davidson 2005). It has also been reported on fruit of other hosts, for example guava (Gould & Raga 2002), but no evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Pseudococcus calceolariae (Maskell, 1879) [Pseudococcidae] Citrophilus mealybug	Yes (García Morales et al. 2019)	Yes. NSW, Qld, SA, Tas., Vic. (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019). However, WA has assessed the risks associated with this pest and does not require risk management measures for this pest for other hosts (such as stone fruit and table grapes) from Australian states where this pest is present (DAFWA 2015; Poole et al. 2011).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudococcus longispinus (Targioni Tozzetti, 1867) [Pseudococcidae] Long-tailed mealybug	Yes (García Morales et al. 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Pseudococcus maritimus (Ehrhorn, 1900) [Pseudococcidae] Grape mealybug	Yes (García Morales et al. 2019; Gimpel & Miller 1996; Klein Koch & Waterhouse 2000; Quiros Manterola 1998)	No records found	Yes. *Pseudococcus maritimus* occurs on most plant parts, including fruit, leaves, bark and roots of its hosts (Miller et al. 2007), and is known to feed on *Persea* sp. (García Morales et al. 2019).	Yes. *Pseudococcus maritimus* is currently distributed through North, Central and South America, Eastern Europe and South East Asia. It is polyphagous with hosts in at least 44 families, including *Acer*, *Annona*, *Acacia*, *Trifolium*, *Grevillea*, *Malus*, *Prunus*, *Pyrus*, *Rubus*, *Citrus*, *Solanum* and *Vitis* (García Morales et al. 2019). The wide host range and distribution of this pest suggest that it could establish and spread in Australia.	Yes. In California this species is reported as a pest of grape, pear and apricot (García Morales et al. 2019). This species causes indirect damage in vineyards from feeding, accumulation of honeydew and, subsequently, growth of sooty mould (Bahder et al. 2013).	Yes (EP)
Pseudococcus viburni (Signoret, 1875) [Pseudococcidae] Obscure mealybug	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudoparlatoria ostreata Cockerell, 1892 [Diaspididae] Acalypha scale	Yes (García Morales et al. 2019)	No records found	No. *Pseudoparlatoria ostreata* occurs on bark and leaves of its hosts, including avocado (Miller & Davidson 2005). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Saissetia coffeae (Walker, 1852) [Coccidae] Hemispherical scale	Yes (García Morales et al. 2019)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Saissetia oleae (Olivier, 1791) [Coccidae] Black scale	Yes (García Morales et al. 2019)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Toxoptera aurantii (Boyer de Fonscolombe, 1841) [Aphididae] Black citrus aphid	Yes (SAG 2005b)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Trialeurodes vaporariorum (Westwood, 1856) [Aleyrodidae] Greenhouse whitefly	Yes (Evans 2007)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Unaspis citri (Comstock, 1883) [Diaspididae] Citrus snow scale	Yes (García Morales et al. 2019; Ripa & Larral 2008)	Yes. NSW, NT, Qld (Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019).	Yes. This species is a known pest of avocado (García Morales et al. 2019). In heavy infestations, *U. citri* may spread onto all parts of a host plant, including the fruit (García Morales et al. 2019). *Unaspis citri* is extremely small and may well stay unnoticed during harvest and packing.	Yes. This species is already present in parts of Australia and is polyphagous (CABI 2019a). Introduction into WA may lead to establishment since it is likely to find a suitable host plant on which to grow and reproduce.	Yes. Heavy infestations lead to drying and splitting of branches of citrus trees and other crops (García Morales et al. 2019).	Yes (EP, WA)
Lepidoptera						
Arctopoda maculosa Butler, 1883 [Oecophoridae] Chilean horn worm	Yes (Klein Koch & Waterhouse 2000; Ripa & Larral 2008)	No records found	No. Although this species attacks avocado plants (Klein Koch & Waterhouse 2000), it is a leaf feeder and is not associated with fruit (Peña et al. 2013; Ripa 2008a). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Cercophana frauenfeldi Felder, 1862 [Cercophanidae] Andean moon moth	Yes (Klein Koch & Waterhouse 2000)	No records found	No. This is a phytophagous insect associated with avocado trees (López Laport & Bermúdez Ortiz 2011; Ripa & Larral 2008). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Chilecomadia moorei Silva Figuero, 1915 [Cossidae] Avocado tree worm	Yes (Klein Koch & Waterhouse 2000; Ripa & Larral 2008)	No records found	No. Feeds on branches of avocado, not fruit (Ripa & Larral 2008). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Chilecomadia valdiviana Philippi, 1860 [Cossidae] Quince trunk borer	Yes (Klein Koch & Waterhouse 2000; Ripa & Larral 2008)	No records found	No. Feeds on branches of avocado, not fruit (Ripa & Larral 2008). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Chrysodeixis includens (Walker, 1858) Synonym: *Pseudoplusia includens* (Walker, 1857) [Noctuidae] Soybean looper	Yes. Few occurrences (EPPO 2015).	No records found	No. *Chrysodeixis includens* is highly polyphagous but is considered to be mostly a pest of soybean and tomato (EPPO 2015). On avocado, it feeds on leaves, not fruit (Nunez 2008; Rodriguez-Saona & Trumble 2000). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Helicoverpa zea (Boddie, 1850) [Noctuidae] Corn earworm	Yes (Angulo et al. 1990; Ripa & Larral 2008)	No records found	No. Avocado is not considered a main host of *H. zea* (CABI 2019a; EPPO 2019). Eggs are laid on leaves and corn silks (Capinera 2017; Sparks & Riley 2008). Although some review articles, such as Capinera (2017), include avocado fruit in a list of	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			fruit and ornamental plants that can be attacked by *H. zea*, no specific/primary reports or records of this pest on avocado fruit could be found. Larvae of *H. zea* prefer to feed on young plant material, particularly flowers and fruit (Cook & Weinzierl 2004; Plant Health Australia 2009). Feeding of *H. zea* larvae on avocado fruit, and in particular on young fruit, is likely to result in obvious damage and such fruit is unlikely to be picked and packed for export.			

Oiketicus kirbyi Guilding, 1827 [Psychidae]	Yes (Klein Koch & Waterhouse 2000)	No records found	No. *Oiketicus kirbyi* belongs to the bagworm family (Psychidae). All life stages of bagworms occur on the outside of the host plant. The life history of bagworms is unusual, for example the entire larval development occurs inside an enclosed bag made of silk and plant material. Mated females of *O. kirbyi* lay their eggs inside the pupal case inside the enclosed bag (Rhainds & Cabrera-La Rosa 2010; Stephens 1962). *Oiketicus kirbyi* larvae feed on the leaves and the surface of fruit of avocado (Coria-Avalos et al. 2011; Rhainds & Cabrera-La Rosa 2010; Ripa & Larral 2008). Damage to the fruit surface can expose the pulp, causing blemishes (Coria-Avalos et al. 2011; Rhainds & Cabrera-La Rosa 2010). Therefore, it is unlikely that infested fruit will be picked and packed for export. All life stages of *O. kirbyi* that may still be associated with the avocado fruit after harvest are likely to be removed during	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
			standard packing house procedures.			
Peridroma saucia (Hübner, 1808) [Noctuidae] Pearly underwing, variegated cutworm	Yes (Ripa & Larral 2008)	No records found	No. *Peridroma saucia* larvae feed on buds, flowers, leaves and fruit of its hosts; however, larvae only feed at night and shelter in the soil during the day (CABI 2019a; Mau & Martin Kessing 2007b). Larvae of this species will therefore not be present on the fruit when they are picked during daylight hours.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Spodoptera eridania (Stoll, 1782) [Noctuidae] Southern armyworm	Yes. Limited distribution (EPPO 2019)	No records found	No. Avocado is not considered a main host (CABI 2019a). First and second instar larvae only feed on leaves. Later instar larvae may also feed on fruit of its hosts, but they only feed at night and shelter in leaf litter or plant foliage during the day (CABI & EPPO 2016). Larval damage to fruit, for example tomato, causes holes (CABI 2019a; CABI & EPPO 2016). Such obviously damaged fruit will be culled during standard commercial production practices. In addition, larvae of this species will not be present on the fruit when they are picked during daylight hours. Furthermore, no evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Thanatopsyche chilensis Philippi, 1860 [Psychidae] Bag worm	Yes (Ripa & Larral 2008)	No records found	No. *Thanatopsyche chilensis* larvae feed on leaves (Ripa & Larral 2008). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Orthoptera						
Gryllus fulvipennis Blanchard, 1854 [Gryllidae] Field brown cricket	Yes (Ripa & Larral 2008).	No records found	No. Feeds on bark of avocado seedlings (Ripa & Larral 2008). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Thysanoptera						
Frankliniella australis Morgan, 1925 [Thripidae] Chilean flower thrips	Yes (Klein Koch & Waterhouse 2000; López Laport & Bermúdez Ortiz 2011; Ripa & Larral 2008)	No records found (Australian Government Department of Agriculture and Water Resources 2017)	Yes. *Frankliniella australis* has been reported present in northern Chile with avocado as a known host, but is not considered an important pest (Klein Koch & Waterhouse 2000). This pest is mainly found on flowers of avocado (Agostini et al. 2005) but it is also likely to be on avocado fruit because it can be found on fruit of its hosts and may cause fruit scarring (de Borbón et al. 2008; Gonzalez 1983). *Frankliniella australis* has been detected on fresh fruit exported from Chile, mainly on raspberries, kiwifruit and nectarines (Araya, Curkovic & Zárate 2007).	Yes. Assessed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017)	Yes. Assessed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017)	Thrips Group PRA applied (Australian Government Department of Agriculture and Water Resources 2017)

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Frankliniella gemina Bagnall, 1919 [Thripidae] Tamarugo thrips	Yes (CONAF 2008; Klein Koch & Waterhouse 2000)	No records found (Australian Government Department of Agriculture and Water Resources 2017)	Yes. *Frankliniella gemina* has been reported to cause damage to avocado fruit (Agostini et al. 2005). It is usually associated with flowers and floral structures of its hosts which include fruit trees and *Nothofagus macrocarpa*, a deciduous tree endemic to central Chile (CONAF 2008). *Frankliniella gemina* was found associated with young foliage and flowers of avocado in Brazil (Hoddle, Nakahara & Phillips 2002). Species of the family Thripidae lay their eggs into living plant tissue (Morse & Hoddle 2006). On citrus, *F. gemina* can oviposit in, and feed on, small fruit (Anderson 1996). A similar biology is expected on avocado.	Yes. Assessed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017)	Yes. Assessed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017)	Thrips Group PRA applied (Australian Government Department of Agriculture and Water Resources 2017)

Pest	Present in Chile	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 (CABI 2019a; Ripa & Larral 2008; Wang et al. 2010)	Yes. All states except the NT (Australian Government Department of Agriculture and Water Resources 2017).	Yes. *Frankliniella occidentalis* has been reported on young fruit of avocado (Castaneda-Gonzalez et al. 2003; Johansen & Mojica 2007; Ripa 2008b). It prefers to feed on flowers of its hosts, but will also feed on leaves, fruit or stems (Hodges et al. 2009). Both larvae and adults are mainly found on flowers of avocado and disperse after flowering is complete (Hoddle 2013).	Yes. Assessed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017).	Yes. Assessed in the thrips Group PRA (Australian Government Department of Agriculture and Water Resources 2017).	Thrips Group PRA applied (Australian Government Department of Agriculture and Water Resources 2017)
Trombidiformes						
Brevipalpus californicus (Banks, 1904) Synonym: Brevipalpus australis Baker, 1949 [Tenuipalpidae] Citrus flat mite	Yes (Klein Koch & Waterhouse 2000)	Yes. NSW, NT, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Brevipalpus obovatus Donnadieu, 1875 [Tenuipalpidae] Privet mite, scarlet tea mite	Yes (Klein Koch & Waterhouse 2000; Vacante 2016)	Yes. NSW, NT, Qld, SA, WA (CABI 2019a; CSIRO 2004; Government of Western Australia 2019; Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Brevipalpus phoenicis (Geijskes, 1939) [Tenuipalpidae] Red and black flat mite	Yes (CABI 2019a)	Yes. NSW, NT, Qld, SA, WA (Government of Western Australia 2019; Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Eotetranychus sexmaculatus (Riley, 1890) [Tetranychidae] Six-spotted mite	Yes (Steven, Valenzuela & Gonzalez 1997)	No. A recent study re-examined the Australian specimens previously identified as *E. sexmaculatus* concluding that all Australian specimens are a different species, *E. queenslandicus*, and that *E. sexmaculatus* is no longer considered present in Australia (Seeman, Beard & Zhang 2017).	No. Although this mite is a pest of avocado, it feeds and lays its eggs on the underside of avocado leaves (Faber, Morse & Hoddle 2016; Jeppson, Keifer & Baker 1975; Vacante 2016). *Eotetranychus sexmaculatus* is generally not considered associated with avocado fruit (Faber, Morse & Hoddle 2016; New Zealand Avocado 2018; Stevens 2001).	Assessment not required	Assessment not required	No
Oligonychus mangiferus (Rahman & Sapra, 1940) [Tetranychidae] Mango red mite	Yes (GBIF Secretariat 2019; Migeon & Dorkeld 2019)	Yes. NT, Qld, WA (Government of Western Australia 2019; Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oligonychus punicae (Hirst, 1926) [Tetranychidae] Avocado brown mite	Yes (Flechtmann 1996)	No. Only unconfirmed or doubtful records (Halliday 2000; Plant Health Australia 2019). Records of *O. punicae* in Australia are based only on a provisional identification by Davis in 1968 and this species has not been recorded since (ABRS 2019; Halliday 2000).	Yes. *Oligonychus punicae* feeds on the upper surface of leaves, and, in high infestations, may feed on the lower surface of leaves as well as on avocado fruit (Bailey & Olsen 1990; Cerna et al. 2009).	Yes. *Oligonychus punicae* is polyphagous and many of its known hosts are widely available in Australia including avocado, pomegranate, grape, strawberry, banana, stone fruit, mango, rose and *Eucalyptus* (CABI 2019a; Cerna et al. 2009; Migeon & Dorkeld 2019; Vasquez et al. 2008) *Oligonychus punicae* is distributed in South America, North America, Asia and Europe (CABI 2019a; Cerna et al. 2009; Jeppson, Keifer & Baker 1975; Migeon & Dorkeld 2019). Its wide host range and ability to inhabit areas with wide climatic ranges suggest it has the potential to establish and spread in Australia.	Yes. *Oligonychus punicae* is associated with economic damage of several economically significant horticultural crops, including avocado, pomegranate, grape, strawberry, banana, stone fruit and mango, as well as native Australian plants such as *Eucalyptus* (CABI 2019a; Cerna et al. 2009; Vasquez et al. 2008). This mite is considered an important pest of avocado in California and Mexico (Cerna et al. 2009; Flechtmann 1996; Peña & Wysoki 2008; Wysoki et al. 2002). It can cause discolouration, reduction in leaf photosynthesis and premature leaf drop in host plants (Jeppson, Keifer & Baker 1975; Wysoki et al. 2002).	Yes

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Oligonychus yothersi (McGregor, 1914) [Tetranychidae] Avocado red mite	Yes (Migeon & Dorkeld 2019; Ripa & Larral 2008)	No records found	Yes. Although Jeppson, Keifer and Baker (1975) and Waite and Martinez Barrera (2002) state that *O. yothersi* only occurs on the upper surface of leaves of avocado, evidence was found that this mite causes scarring on the surface of avocado fruit (Paull & Duarte 2011).	Yes. *Oligonychus yothersi* is polyphagous and many of its known hosts are widely available in Australia including avocado, guava, pomegranate, grape, apple, mango, lychee and *Eucalyptus* (Bolland, Gutierrez & Flechtmann 1998; Jeppson, Keifer & Baker 1975; Migeon & Dorkeld 2019; Wysoki et al. 2002). *Oligonychus yothersi* is distributed in South America, Central America, Mexico, Hawaii, USA, China and Iran (Bolland, Gutierrez & Flechtmann 1998; CABI 2019a). Its wide host range and ability to inhabit areas with wide climatic ranges suggest it has the potential to establish and spread in Australia.	Yes. *Oligonychus yothersi* is polyphagous with a wide host range and is associated with economic damage of several significant horticultural crops including avocado, guava, pomegranate, grape, apple and mango, as well as native Australian plants such as *Eucalyptus* (Bolland, Gutierrez & Flechtmann 1998; CABI 2019a). The mite feeds on the upper leaf surface, resulting in leaf discolouration, reduction in leaf photosynthetic ability and premature leaf drop in its host plants (Jeppson, Keifer & Baker 1975; Wysoki et al. 2002).	Yes

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Panonychus citri (McGregor, 1916) [Tetranychidae] Citrus red mite	Yes (Migeon & Dorkeld 2019)	Yes. Present only in isolated areas of NSW (PHA 2009; Plant Health Australia 2019). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019). Domestic restrictions for the movement of host material of this pest into Vic. and SA from other Australian states/territories where this pest is present only include planting material, not fruit (DJPR 2019; PIRSA 2019).	Yes. *Panonychus citri* feeds on the leaves of avocado, but can be found in association with branches and fruit (Futch, Childers & McCoy 2017; Gibson 1968; NSW DPI 2017).	Yes. *Panonychus citri* is polyphagous and many of its known hosts are widely available in Australia including citrus, apple, avocado, rose, almond, pear, peach, cherry and several broadleaf evergreen ornamentals (Alford 2007; Bolland, Gutierrez & Flechtmann 1998; Shinkaji 1979). *Panonychus citri* is distributed throughout the world including Asia, Europe, Africa and North and South America (Bolland, Gutierrez & Flechtmann 1998; CABI 2019a; Migeon & Dorkeld 2019). Its wide host range, its presence in some areas of Australia, and its ability to inhabit areas with wide climatic ranges suggest that *P. citri* has the potential to establish and spread in Australia where it is currently not present.	Yes. *Panonychus citri* is polyphagous with a wide host range and is associated with economic damage of several significant horticultural crops including citrus, apple, avocado, rose, almond, pear, peach, cherry and several broadleaf evergreen ornamentals (Alford 2007; Bolland, Gutierrez & Flechtmann 1998; Shinkaji 1979). It causes discolouration of the leaves (silvering, yellowing or speckling) and causes a bleached appearance on fruit of its hosts. Severe infestations may weaken the host plant causing defoliation, fruit drop and dieback of young shoots or twigs (Alford 2007; NSW DPI 2017).	Yes (EP, WA)

Pest	Present in Chile	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 mite	Yes (Migeon & Dorkeld 2019)	Yes. NSW, SA, Tas., Vic., WA (Government of Western Australia 2019; Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Polyphagotarsonemus latus (Banks, 1904) [Tarsonemidae] Broad mite	Yes (Ripa & Larral 2008)	Yes. NSW, NT, SA, Vic., WA (Government of Western Australia 2019; Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Tegolophus myersi (Keifer, 1939) [Eriophyidae]	Yes (Peralta 1993)	No records found	No. *Tegolophus myersi* can be found on buds, petioles and leaves of avocado (Peralta 1993). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Tetranychus urticae Koch 1836 [Tetranychidae] Two-spotted spider mite	Yes (CABI 2019a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
BACTERIA						
Pantoea agglomerans (Ewing and Fife 1972) Gavini et al. 1989 Synonym: *Erwinia herbicola* (Löhnis 1911) Dye 1964 [Enterobacteriales: Enterobacteriaceae] Bacterial soft rot, Bacterial blast	Yes. Widespread worldwide (Bradbury 1986)	Yes. NSW, Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pectobacterium carotovorum subsp. *carotovorum* (Jones 1901) Hauben *et al.* 1999 Synonym: *Erwinia carotovora* subsp. *carotovora* (Jones 1901) Bergey et al. 1923 [Enterobacteriales: Enterobacteriaceae] Bacterial soft rot	Yes (CABI 2019a)	Yes. (CABI 2019a). ACT, NSW, Qld, SA, Vic., WA (Plant Health Australia 2019; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
Pseudomonas syringae van Hall 1902 (Approved Lists 1980) [Pseudomonadales: Pseudomonadaceae] Bacterial canker	Yes (CABI 2019a)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Rhizobium radiobacter (Beijerinck and van Delden 1902) Young et al. 2001 Synonym: *Agrobacterium tumefaciens* (Smith and Townsend 1907) Conn 1942 (Approved Lists 1980) [Rhizobiales: Rhizobiaceae] Crown gall	Yes (Bradbury 1986; CABI 2019a)	Yes. NSW, Qld, SA, Tas., Vic., WA (Bradbury 1986; Plant Health Australia 2019; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Xanthomonas campestris (Pammel 1895) Dowson 1939 (Approved Lists 1980) [Xanthomonadales: Xanthomonadaceae] Bacterial canker	Yes. As *Xanthomonas campestris* pv. *campestris* (SAG 2002)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
CHROMALVEOLATA						
Globisporangium debaryanum (R. Hesse) Uzuhashi, Tojo & Kakish. Synonym: *Pythium debaryanum* R. Hesse [Pythiales: Pythiaceae] Root rot of avocado, damping off	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Globisporangium ultimum (Trow) Uzuhashi, Tojo & Kakish. Synonyms: *Pythium ultimum* var. *ultimum* Trow; Pythium ultimum Trow [Pythiales: Pythiaceae] Root rot of avocado, damping off	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora cactorum (Lebert & Cohn) J. Schröt. [Peronosporales: Peronosporaceae] Fruit rot of avocado	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phytophthora cinnamomi Rands [Peronosporales: Peronosporaceae] Avocado root rot, trunk canker	Yes (Minter & Peredo López 2019; SAG 2005b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora citricola Sawada [Peronosporales: Peronosporaceae]	Yes (Minter & Peredo López 2019). Hong et al. (2009) redescribed the avocado subgroup of *P. citricola* as *P. mengei* from US collections. It is not clear whether Chilean or Australian *P. citricola* on avocado would be *P. mengei* as well.	Yes. NSW, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora citrophthora (R.E. Sm. & E.H. Sm.) Leonian [Peronosporales: Peronosporaceae] Avocado trunk canker	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora cryptogea Pethybr. & Laff [Peronosporales: Peronosporaceae] Phytophthora root and crown rot	Yes (Farr & Rossman 2019; Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Phytophthora megasperma Drechsler [Peronosporales: Peronosporaceae] Root rot of avocado	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Phytophthora nicotianae Breda de Haan Synonym: *Phytophthora nicotianae* var. *parasitica* (Dastur) G.M. Waterhouse [Peronosporales: Peronosporaceae] Root rot of avocado	Yes (CABI 2019a; Minter & Peredo López 2019)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
FUNGI						
Alternaria alternata (Fr.) Keissl. [Pleosporales: Pleosporaceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, NT, Tas., SA, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Armillaria mellea (Vahl) P. Kumm. [Agaricales: Physalacriaceae] Armillaria root rot	Yes (SAG 2005b).	No. Plant Health Australia (2019) has a single record each for NSW and Qld; however, these are likely to be *A. luteobubalina* and not *A. mellea* (CABI 2019a).	No. Affects roots and stems (Ohr & Zentmyer 1994; Williams et al. 1986). No evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Aspergillus niger Tiegh. [Eurotiales: Trichocomaceae]	Yes (CABI 2019a; Minter & Peredo López 2019)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Athelia rolfsii (Curzi) C.C. Tu & Kimbr. [Atheliales: Atheliaceae]	Yes (CABI 2019a; Farr & Rossman 2019)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Aureobasidium pullulans (de Bary) G. Arnaud [Dothideales: Dothioraceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Botryosphaeria dothidea (Moug. ex Fr.) Ces. & De Not. [Botryosphaeriales: Botryosphaeriaceae]	Yes (SAG 2005b)	Yes. NSW, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Botrytis cinerea Pers. [Helotiales: Sclerotiniaceae] Grey mould	Yes (SAG 2005b)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Calonectria cylindrospora (Ellis & Everh.) Rossman, L. Lombard & Crous Synonyms: *Calonectria morganii* Crous, Alfenas & M.J. Wingf.; *Cylindrocladium scoparium* Morg. [Hypocreales: Nectriaceae]	Yes (Gallegos Cespedes 2005; Valenzuela & Peredo 1989). However, records of this species from Chile are considered unconfirmed (Crous 2002).	No. Although *C. cylindrospora* (as *Cylindrocladium scoparium*) has been recorded from Australia prior to 1997(Plant Health Australia 2019; Shivas 1989), this pest is now considered restricted to the Northern Hemisphere and Brazil (Lombard et al. 2010). Most of the *Cylindrocladium scoparium* records published outside mainland USA are considered to refer to *Calonectria pauciramosa* (synonym *Cylindrocladium pauciramosum*) (Crous 2002). Australian isolates of this species examined by Crous (2002) were confirmed as *Cylindrocladium pauciramosum*.	No. *Calonectria* (*Cylindrocladium*) spp. are associated with avocado roots and root disease (Dann et al. 2013). *Calonectria cylindrospora* (as *Cylindrocladium scoparium*) has been reported from roots of *Nothofagus alpina* and needles of *Pinus radiata* in Chile (Valenzuela & Peredo 1989). However, records of this species from Chile are considered unconfirmed (Crous 2002) and no record of an association with avocado plants in Chile was found.	Assessment not required	Assessment not required	No
Cladosporium cladosporioides (Fresen.) G.A. de Vries [Capnodiales: Cladosporiaceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Cladosporium herbarum (Pers.) Link [Capnodiales: Cladosporiaceae]	Yes (Farr & Rossman 2019; SAG 2005b)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum acutatum J.H. Simmonds Synonym: *Glomerella acutata* Guerber & J.C. Correll [Glomerellales: Glomerellaceae] Anthracnose	Yes (CABI 2019a; Farr & Rossman 2019)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. Synonym: *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk [Glomerellales: Glomerellaceae] Anthracnose	Yes (SAG 2005b)	Yes. ACT, NSW, NT, Qld, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Curvularia lunata (Wakker) Boedijn Synonym: *Cochliobolus lunatus* R.R. Nelson & F.A. Haasis [Pleosporales: Pleosporaceae]	Yes (CABI 2019a)	Yes. ACT, NSW, NT, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Cylindrocarpon didymum (Harting) Wollenw. [Hypocreales: Nectriaceae]	Yes (SAG 2005b)	Yes. ACT, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Dialonectria episphaeria (Tode) Cooke Synonym: *Nectria episphaeria* (Tode) Fr.; *Fusarium episphaeria* (Tode) W.C. Snyder & H.N. Hansen [Hypocreales: Nectriaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, Vic. (Plant Health Australia 2019; Wearing & Burgess 1977)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Diaporthe ampelina (Berk. & M.A. Curtis) R.R. Gomes, C. Glienke & Crous Synonym: *Phomopsis viticola* (Sacc.) Sacc. [Diaporthales: Diaporthaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, SA, Vic. (Burges, Taylor & Kumar 2005; Plant Health Australia 2019), Tas. (Mostert, Corus & Kang 2001). Plant Health Australia (2019) has records for WA, but these have been identified as *Diaporthe australafricana* by molecular analysis (Burges, Taylor & Kumar 2005; Poole & Hammond 2011). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019) and specific measures are required for this pathogen for the movement of table grapes from other Australian states/territories where this pathogen is present (DPIRD 2019).	No. *Diaporthe ampelina* is a pathogen of grapevine (*Vitis vinifera*) (Burges, Taylor & Kumar 2005; Hewitt & Pearson 1988). Secondary hosts of *D. ampelina* include other *Vitis* species and *Parthenocissus quinquefolia* (virginia creeper) which are all in the family Vitaceae (Burges, Taylor & Kumar 2005). Only one publication from Mexico reported *P. viticola*, a synonym for *D. ampelina*, to be associated with stem-end rot of avocado fruit (Ochoa Ascencio 2009). However, another publication by the same author reports *P. perseae*, not *P. viticola*, as associated with stem-end rot of avocado fruit in Mexico (Ochoa & Vazquez 2009). No other evidence of an association with avocado fruit was found.	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Diplodia mutila (Fr.) Mont. Synonym: *Botryosphaeria stevensii* Shoemaker [Botryosphaeriales: Botryosphaeriaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, SA, Vic., WA (Plant Health Australia 2019; Wunderlich et al. 2011)	Assessment not required	Assessment not required	Assessment not required	No
Diplodia seriata De Not. Synonym: *Botryosphaeria obtusa* (Schwein.) Shoemaker [Botryosphaeriales: Botryosphaeriaceae]	Yes (Farr & Rossman 2019)	Yes. ACT, NSW, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Dothiorella iberica A.J.L. Phillips, J. Luque & A. Alves Synonym: *Botryosphaeria iberica* A.J.L. Phillips, J. Luque & A. Alves [Botryosphaeriales: Botryosphaeriaceae]	Yes (Farr & Rossman 2019; Valencia et al. 2019)	Yes. SA, Vic., NSW, ACT (Pitt et al. 2010; Plant Health Australia 2019) Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019). However, routine visual inspection is not an adequate measure to detect this pest in host material, and specific measures are not required for this pest for the movement of fruit or planting material of numerous hosts into WA from other Australian states/territories where this pest is present	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Epicoccum nigrum Link [Pleosporales: Didymellaceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium avenaceum (Fr.) Sacc. Synonym: *Gibberella avenacea* R.J. Cook [Hypocreales: Nectriaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019; Shivas 1989)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium equiseti (Corda) Sacc. Synonym: *Gibberella intricans* Wollenw. [Hypocreales: Nectriaceae]	Yes (Piontelli et al. 2002)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium graminearum Schwabe Synonym: *Gibberella zeae* (Schwein.) Petch [Hypocreales: Nectriaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium lateritium Nees Synonym: *Gibberella baccata* (Wallr.) Sacc. [Hypocreales: Nectriaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium oxysporum Schltdl. [Hypocreales: Nectriaceae]	Yes (SAG 2005b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Fusarium sambucinum Fuckel Synonym: *Gibberella pulicaris* (Fr.) Sacc. [Hypocreales: Nectriaceae]	Yes (Farr & Rossman 2019; Minter & Peredo López 2019)	Yes. ACT, NSW, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Fusarium solani (Mart.) Sacc. [Hypocreales: Nectriaceae]	Yes (CABI 2019a)	Yes. NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Ilyonectria destructans (Zinssm.) Rossman, L. Lombard & Crous Synonyms: *Cylindrocarpon destructans* (Zinssm.) Scholten; *Neonectria radicicola* (Gerlach & L. Nilsson) Mantiri & Samuels [Hypocreales: Nectriaceae]	Yes (Besoain & Piontelli 1999)	Yes. ACT, NSW, Qld, Tas., Vic., SA, WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. Synonym: *Botryosphaeria rhodina* (Berk. & M.A. Curtis) Arx [Botryosphaeriales: Botryosphaeriaceae] Stem-end rot of avocado	Yes (Menge & Ploetz 2003; Minter & Peredo López 2019)	Yes. NSW, NT, Qld, SA, WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Leptosphaerulina trifolii (Rostr.) Petr. [Pleosporales: Pleosporaceae]	Yes (Farr & Rossman 2019; Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Macrophomina phaseolina (Tassi) Goid. [Botryosphaeriales: Botryosphaeriaceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Microthia havanensis (Bruner) Gryzenh. & M.J. Wingf. Synonym: *Cryphonectria havanensis* (Bruner) M.E. Barr [Diaporthales: Cryphonectriaceae]	Yes (Minter & Peredo López 2019)	No records found	No. Reported from dead branches of avocado (Gryzenhout et al. 2006). No record of an association with avocado fruit was found.	Assessment not required	Assessment not required	No
Neofusicoccum australe (Slippers, Crous & M.J. Wingf.) Crous, Slippers & A.J.L. Phillips [Botryosphaeriales: Botryosphaeriaceae] Stem canker, dieback	Yes (CABI 2019a)	Yes. NSW, SA, Vic., WA (Pitt et al. 2010; Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Neofusicoccum luteum (Pennycook & Samuels) Crous, Slippers & A.J.L. Phillips Synonym: *Fusicoccum luteum* Pennycook & Samuels [Botryosphaeriales: Botryosphaeriaceae] Branch canker, stem-end rot	Yes (Montealegre 1995)	Yes. NSW, Qld, WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	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, Slippers & A.J.L. Phillips Synonym: *Nattrassia mangiferae* (Syd. & P. Syd.) B. Sutton & Dyko [Botryosphaeriales: Botryosphaeriaceae] Fruit rot	Yes (Minter & Peredo López 2019)	Yes. Qld, WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Neofusicoccum parvum (Pennycook & Samuels) Crous, Slippers & A.J.L. Phillips [Botryosphaeriales: Botryosphaeriaceae]	Yes (CABI 2012; Farr & Rossman 2019)	Yes. NSW, Qld, SA, WA (Pitt et al. 2010)	Assessment not required	Assessment not required	Assessment not required	No
Neofusicoccum vitifusiforme (Van Niekerk & Crous) Crous, Slippers & A.J.L. Phillips Synonyms: *Camarosporium eucalypti* G. Winter; *Dichomera eucalypti* (G. Winter) B. Sutton; *Neofusicoccum corticosae* Crous & Summerell [Botryosphaeriales: Botryosphaeriaceae] Branch canker	Yes (Espinoza, Briceño & Latorre 2008)	Yes (Farr & Rossman 2019). NSW, Qld, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Neonectria ditissima (Tul. & C. Tul.) Samuels & Rossman Synonyms: *Nectria ditissima* Tul. & C. Tul.; *Nectria galligena* Bres. [Hypocreales: Nectriaceae] European canker	Yes (Minter & Peredo López 2019)	No records found	No. *Neonectria ditissima* causes canker on the limbs and trunk on avocado (Aguilera-Montãnez & Salazar-Garcia 1991; Ceja-Torres et al. 2000). No record of an association with avocado fruit was found. Furthermore, *N. ditissima* has never been reported on avocado plants in Chile.	Assessment not required	Assessment not required	No
Neopestalotiopsis clavispora (G.F. Atk.) Maharachch., K.D. Hyde & Crous Synonym: *Pestalotiopsis clavispora* (Atk.) Steyaert [Amphisphaeriales: Pestalotiopsidaceae] Stem-end rot	Yes (Farr & Rossman 2019; Valencia, Torres & Latorre 2011)	Yes. *Neopestalotiopsis clavispora* was identified from isolates of endophytic fungi collected from stems of *Mimosa pigra* in the NT (Sacdalan 2015).	Assessment not required	Assessment not required	Assessment not required	No
Nigrospora oryzae (Berk. & Broome) Petch Synonym: *Khuskia oryzae* H.J. Huds. [Trichosphaeriales: Not assigned]	Yes. Cosmopolitan distribution (Farr & Rossman 2019)	Yes. ACT, NSW, NT, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Penicillium expansum Link [Eurotiales: Trichocomaceae] Blue mold	Yes (SAG 2005b)	Yes. NSW, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Penicillium italicum Wehmer [Eurotiales: Trichocomaceae] Blue mold	Yes (SAG 2005b)	Yes. ACT, NSW, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Periconia byssoides Pers. [Pleosporales: Not assigned]	Yes (Farr & Rossman 2019; Minter & Peredo López 2019)	Yes. NSW, NT, Qld (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Pestalotiopsis guepinii (Desm.) Steyaert [Amphisphaeriales: Pestalotiopsidaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, Qld, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Pestalotiopsis versicolor (Speg.) Steyaert [Amphisphaeriales: Pestalotiopsidaceae]	Yes (Minter & Peredo López 2019)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Pseudocercospora purpurea (Cooke) Deighton Synonym: *Cercospora purpurea* Cooke [Capnodiales: Mycosphaerellaceae] Cercospora spot, Pseudocercospora spot	No. Reports of *P. purpurea* in Chile, such as Minter and Peredo López (2019) and Mujica and Vergara (1980), are based on an unreliable record from 1943 (Anon 1943). Under Chile's agricultural surveillance program, pest surveillance is conducted annually. As part of this program, over 3,300 avocado orchards accounting for around 29,000 hectares of avocado plantings have been surveyed from 2009 to 2017 and *P. purpurea* has never been detected.	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No
Rhizoctonia solani J.G. Kühn Synonym: *Thanatephorus cucumeris* (A.B. Frank) Donk [Cantharellales: Ceratobasidiaceae] Seed and root rot	Yes (SAG 2005b)	Yes. ACT, NSW, NT, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Rhizopus stolonifer (Ehrenb.) Vuill. [Mucorales: Mucoraceae] Fruit rot	Yes (Minter & Peredo López 2019)	Yes. NSW, NT, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Sclerotinia sclerotiorum (Lib.) de Bary [Helotiales: Sclerotiniaceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Hall, McMahon & Wicks 2002; Plant Health Australia 2019).	Assessment not required	Assessment not required	Assessment not required	No
Trichoderma viride Pers. [Hypocreales: Hypocreaceae]	Yes (Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, SA, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No
Trichothecium roseum (Pers.) Link [Hypocreales: Not assigned] Fruit rot	Yes (Farr & Rossman 2019; Minter & Peredo López 2019)	Yes. ACT, NSW, Qld, Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Verticillium albo-atrum Reinke & Berthold [Glomerellales: Plectosphaerellaceae]	Yes (SAG 2005b)	Yes. Qld, SA, Tas., Vic. (Plant Health Australia 2019) Records of this pest in WA on *Lycopersicon esculentum* and *Solanum tuberosum* are doubtful (Shivas 1989). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019). However, routine visual inspection is not an adequate measure to detect this pest in host material, and specific measures are not required for this pest for the movement of fruit or planting material of numerous hosts into WA from other Australian states/territories where this pest is present.	Assessment not required	Assessment not required	Assessment not required	No
Verticillium dahliae Kleb. [Glomerellales: Plectosphaerellaceae]	Yes (Menge & Ploetz 2003; SAG 2005b)	Yes. ACT, NSW, Qld, SA, Tas., Vic., WA (Plant Health Australia 2019)	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
VIROIDS						
Avocado sunblotch viroid (ASBVd) [Avsunviroidae: Avsunviroid]	Yes (Ramella et al. 2006). However, apart from the conference abstract by Ramella (2006) no other evidence of this viroid in Chile could be found. Chile has regulations in place to prohibit the use for propagation of seeds from avocado fruit imported for human consumption from countries where ASBVd is present (SAG 2013).	Yes. Recorded only from some areas of NSW, NT, Qld and Vic., and considered very rare (Geering & Steele 2009; Geering 2018). A clean planting material scheme for avocados has been established in Australia since 1978, ensuring planting material is free from diseases (Geering 2018). Regulated as a Declared Organism (Prohibited (s. 12)) by WA under the *Biosecurity and Agriculture Management Act 2007* (Government of Western Australia 2019). However, routine visual inspection is not an adequate measure to detect this viroid in host material, and specific measures are not required for this viroid for the movement of avocado fruit into WA from other Australian states/territories where this viroid is present.	Assessment not required	Assessment not required	Assessment not required	No

Pest	Present in Chile	Present within Australia	Potential to be on pathway	Potential for establishment and spread	Potential for economic consequences	Pest risk assessment required
Potato spindle tuber viroid (PSTVd) [Pospiviroidae: Pospiviroid]	No. A previous report of PSTVd in Chile (Shamloul et al. 1997) is considered invalid (CABI 2019a; EPPO 2019)	Assessment not required	Assessment not required	Assessment not required	Assessment not required	No

Appendix B: Issues raised in stakeholder comments

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

Issue 1: Methodology for the assessment of pests potentially associated with the pathway.

Response: The department has conducted this risk analysis, including the pest categorisation process, in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c). As stated in Section 2.1 of ISPM 11, 'The categorization process examines for each pest whether the criteria in the definition for a quarantine pest are satisfied' and 'The opportunity to eliminate an organism or organisms from consideration before in-depth examination is undertaken is a valuable characteristic of the categorization process.'

Pests of concern that are not specifically associated with the imported commodity (in this case commercially produced avocado fruit from Chile), such as arthropod pests which do not feed on or complete parts of their life cycle on the fruit, may occasionally arrive via the fruit pathway. These pests are considered contaminating pests (see 'Section 1.2.4 Contaminating pests' of the report). The risks posed by contaminating pests/organisms are identified and addressed using existing operational procedures that require inspection of all consignments using random samples of 600 units, or equivalent procedures. The department will investigate whether any pest identified through these processes may be of biosecurity concern to Australia, and thus may require remedial action.

Further information on processes in place for interceptions of uncategorised pests and pests that were categorised as not likely to be on the import pathway is provided in 'Section 5.3 Uncategorised pests' of the report.

Issue 2: Status of *Pseudococcus maritimus* and *Oligonychus punicae* in Chile.

The department has reviewed further the claim that *Pseudococcus maritimus* and *Oligonychus punicae* are not present in Chile, and therefore do not require risk management measures.

Response: The department re-examined the available evidence relating to the presence of *Pseudococcus maritimus* and *Oligonychus punicae* in Chile (Flechtmann 1996; García Morales et al. 2019; Gimpel & Miller 1996; Klein Koch & Waterhouse 2000; Quiros Manterola 1998). There are numerous reports in the literature of *Pseudococcus maritimus* and *Oligonychus punicae* in Chile. No evidence was received to support the assertion that the reporting of these two pests in the references cited in the draft report was erroneous. The department maintains the status of these pests in the final report.

However, additional text has been added in 'Section 4.3 Grape mealybug' of the report to acknowledge contradictory evidence and uncertainty about the presence of *P. maritimus* in Chile. Also, 'Section 4.5.1 Likelihood of entry' of the report notes that there is a lack of evidence of economic damage caused by *O. punicae* in Chile. However, *O. punicae* has been reported in the literature on avocado in Chile (Flechtmann 1996), and for these reasons, the department considers these pests to be present in Chile and requiring further assessment.

If new information becomes available to support the claims that *Pseudococcus maritimus* and/or *Oligonychus punicae* are not present in Chile, the department will consider this information and may review the assessments of these two pests.

Issue 3: Host status of Hass avocado for *Ceratitis capitata*.

Response: The department recognises that hard mature Hass avocado fruit is not a host of *Ceratitis capitata* as a number of studies have shown that *C. capitata* is not able to infest hard mature Hass avocado fruit (De Lima 1995; Liquido et al. 2011). Therefore, the hard condition of Hass avocado fruit is considered an appropriate measure option for the management of *C. capitata* (see 'Section 5.1.4 *Recommended measure 3: Hard condition of fruit for the Hass cultivar only*'). Under this measure, Hass fruit must be harvested from trees while in the hard condition and be stored in secure conditions after harvest. These safeguarding measures are considered necessary as overripe avocado fruit, including Hass fruit, has been known to be able to become infested with *C. capitata* (De Lima 1995; Hancock et al. 2000).

Issue 4: Brown marmorated stinkbug (BMSB, *Halyomorpha halys*).

The department is aware that brown marmorated stinkbug (BMSB, *Halyomorpha halys*), which is a quarantine pest for Australia, has recently been detected in Chile. The outbreak in Chile is so far limited to an urban area in Santiago (Faúndez & Rider 2017; Leskey & Nielsen 2018). BMSB is not included in the pest categorisation process (Appendix A) of this report for avocados from Chile as it is not considered associated with avocado fruit. However, if BMSB was detected on avocado consignments, including on packaging material, on arrival in Australia, it would be treated as a contaminant pest and phytosanitary action would be required. If BMSB was detected repeatedly on avocado consignments, the department would apply appropriate risk management measures to ensure that the appropriate level of protection for Australia is achieved.

Other issues

The department has made a number of changes to the risk analysis following consideration of stakeholder comments on the draft report and subsequent review of scientific literature. These include:

- amendments to text in the pest categorisation table (Appendix A) to further support the assessment that pests (for example *Pellaea stictica*, *Oiketicus kirbyi* and *Helicoverpa zea*) should not be considered associated with the avocado fruit export pathway
- the removal of one fungal species, *Neofusicoccum ribis*, from the pest categorisation table (Appendix A) after further consideration of scientific literature on the taxonomic status of this species and consultation with plant pathologists
    - *Neofusicoccum ribis* only infects *Ribes* species and is not associated with avocado
- the inclusion of one additional fungal species, *Dothiorella iberica*, in the pest categorisation table (Appendix A) following review of further scientific literature determining that this species is present in Chile and can be associated with avocado fruit
    - *Dothiorella iberica* was subsequently assessed as present in Australia and therefore was not assessed further in the pest categorisation

- revision of the pest statuses of *Calonectria cylindrospora* and *Eotetranychus sexmaculatus* in Australia to 'not present' after further consideration of scientific literature on the taxonomic status of these species and as a result, assessment of their potentials to be on the pathway
  - both pests were assessed as not being associated with the avocado fruit export pathway and therefore were not assessed further in the pest categorisation process
- amendments in the pest risk management section (Chapter 5) to include requirements for containers and updating of the hyperlink to information on packaging requirements
- minor corrections, rewording and editorial changes for consistency, clarity and web-accessibility.

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 2019b).
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).
Appropriate level of protection (ALOP) for Australia	The *Biosecurity Act 2015* defines the appropriate level of protection (or ALOP) for Australia as a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to very low, but not to zero.
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2019b).
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.
Australian territory	Australian territory as referenced in the *Biosecurity Act 2015* refers to Australia, Christmas Island and Cocos (Keeling) Islands.
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.
Biosecurity measures	The *Biosecurity Act 2015* defines biosecurity measures as measures to manage any of the following: biosecurity risk, the risk of contagion of a listed human disease, the risk of listed human diseases entering, emerging, establishing themselves or spreading in Australian territory, and biosecurity emergencies and human biosecurity emergencies.
Biosecurity import risk analysis (BIRA)	The *Biosecurity Act 2015* defines a BIRA as an evaluation of the level of biosecurity risk associated with particular goods, or a particular class of goods, that may be imported, or proposed to be imported, into Australian territory, including, if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or the class of goods, to a level that achieves the ALOP for Australia. The risk analysis process is regulated under legislation.
Biosecurity risk	The *Biosecurity Act 2015* refers to biosecurity risk as the likelihood of a disease or pest entering, establishing or spreading in Australian territory, and the potential for the disease or pest causing harm to human, animal or plant health, the environment, economic or community activities.
Commodity	A type of plant, plant product, or other article being moved for trade or other purpose (FAO 2019b). In this report the commodity is fresh avocado fruit.
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 2019b).
Contaminating pest	A pest that is carried by a commodity, packaging, conveyance or container, or present in a storage place and that, in the case of plants and plant products, does not infest them (FAO 2019b).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2019b).
Crawler	Intermediate mobile nymph stage of certain Arthropods.
Cultivar	A cultivated variety; an assemblage of cultivated individuals distinguished by any characters significant for the purposes of agriculture, forestry or horticulture, and which, when reproduced, retains its distinguishing features (Western Australian Herbarium 2019).

Term or abbreviation	Definition
Diapause	Period of suspended development/growth occurring in some insects, in which metabolism is decreased.
The department	The 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 2019b).
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 2019b).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2019b).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2019b).
Fumigation	Treatment with a chemical agent that reaches the commodity wholly or primarily in a gaseous state (FAO 2019b)
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.
Goods	The *Biosecurity Act 2015* defines goods as an animal, a plant (whether moveable or not), a sample or specimen of a disease agent, a pest, mail or any other article, substance or thing (including, but not limited to, any kind of moveable property).
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 2019b).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2019b).
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 2019b).
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 2019b).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced or used (FAO 2019b).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2019b).
International Plant Protection Convention (IPPC)	The IPPC is an international plant health agreement, established in 1952, that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. The IPPC provides an international framework for plant protection that includes developing International Standards for Phytosanitary Measures (ISPMs) for safeguarding plant resources.
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPPC (FAO 2019b).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2019b).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians).

Term or abbreviation	Definition
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin et cetera, forming part of a consignment (FAO 2019b). 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 2019b).
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	Established, authorized or performed by a national plant protection organization (FAO 2019b).
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 2019b).
Orchard	A contiguous area of avocado trees operated as a single entity. Within this report a single orchard is covered under one registration and is issued a unique identifying 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 2019b).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2019b).
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 2019b).
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 2019b).
Pest free place of production	Place of production in which a specific pest is absent as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2019b).
Pest free production site	A production site in which a specific pest is absent, as demonstrated by scientific evidence, and in which, where appropriate, this condition is being officially maintained for a defined period (FAO 2019b).
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 2019b).
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 2019b).
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact (FAO 2019b).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2019b).
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 2019b).

Term or abbreviation	Definition
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 2019b).
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 2019b).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2019b).
Phytosanitary measure	Phytosanitary relates to the health of plants. 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 2019b). In this risk analysis the term 'phytosanitary measure' and 'risk management measure' may be used interchangeably.
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2019b).
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 2019b).
Place of production	Any premises or collection of fields operated as a single production or farming unit (FAO 2019b).
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 2019b).
Practically free (of a consignment, field or place of production)	Without pests (or a specific pest) 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 2019b).
Production site	A defined part of a place of production, that is managed as a separate unit for phytosanitary purposes (FAO 2019b). In this report, a production site is a continuous planting of avocado 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, pests or beneficial organisms for inspection, testing, treatment, observation or research (FAO 2019b).
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 2019b).
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 2019b).
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 2019b).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2019b).
Restricted risk	Restricted risk is the risk estimate when risk management measures are applied.

Term or abbreviation	Definition
Risk analysis	Refers to the technical or scientific process for assessing the level of biosecurity risk associated with the goods, or the class of goods, and if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or class of goods to a level that achieves the ALOP for Australia.
Risk management measure	Are conditions that must be met to manage the level of biosecurity risk associated with the goods or the class of goods, to a level that achieves the ALOP for Australia. In this risk analysis, the term 'risk management measure' and 'phytosanitary measure' may be used interchangeably.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2019b).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organisations, 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 2019b).
Trash	Soil, splinters, twigs, leaves and other plant material, other than fruit as defined in the scope of this risk analysis. For example, stem and leaf material, seeds, soil, animal matter/parts or other extraneous material
Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2019b).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk management 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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