Importation of Fresh Lemons (*Citrus limon* (L.) Burm. f.) from Chile into the Continental United States

A Qualitative, Pathway-Initiated Pest Risk Assessment

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Version 1

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Executive Summary

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) prepared this risk assessment document to examine plant pest risks associated with importing commercially produced fruit of lemon, *Citrus limon* (L.) Burm. f. (Rutaceae), for consumption from Chile into the continental United States. We considered the pathway to include the following processes and conditions: minimal harvest handling and post-harvest culling. All processes and conditions considered during the risk assessment process become mandatory conditions for entry of the commodity.

Based on the scientific literature, port-of-entry pest interception data, and information from the government of Chile, we developed a list of all potential pests with actionable regulatory status for the continental United States that are known to occur in Chile and that are known to be associated with the commodity plant species anywhere in the world. From this list, we identified and further analyzed three organisms that have a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing.

Of the pests selected for further analysis, we determined that the following are *not* candidates for risk management, because they received a Negligible overall risk rating for likelihood of introduction via the import pathway: *Proeulia auraria* and *P. chrysopteris* (Lepidoptera: Tortricidae).

We determined that the following pest is a candidate for risk management, because it **met the threshold to likely cause unacceptable consequences of introduction**, and it received an overall **likelihood of introduction** risk rating **above** Negligible:

Pest type	**Taxonomy**	**Scientific name**	**Likelihood of introduction overall rating**
Arthropod	Acari: Tenuipalpidae	*Brevipalpus chilensis* Baker	Medium

Detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are part of the pest risk management phase within APHIS and are not addressed in this document.

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1. Introduction

1.1. Background

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the Center for Plant Health Science and Technology, USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), to evaluate the risks associated with the importation of commercially produced fresh fruit of lemon (*Citrus limon* (L.) Burm. f.) for consumption from Chile into the continental United States.

The International Plant Protection Convention (IPPC) provides guidance for conducting pest risk analyses. The methods used here are consistent with guidelines provided by the IPPC, specifically the International Standard for Phytosanitary Measures (ISPM) on 'Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms' (IPPC, 2011). The use of biological and phytosanitary terms is consistent with the 'Glossary of Phytosanitary Terms' (IPPC, 2012).

Three stages of pest risk analysis are described in international standards: Stage 1, Initiation; Stage 2, Risk Assessment; and Stage 3, Risk Management. This document satisfies the requirements of Stages 1 and 2.

This is a qualitative risk analysis; we express the risk based on ratings for the likelihood of pest introduction and consequences associated with importing lemon from Chile. The details of the methodology and rating criteria are found in the *Guidelines for Plant Pest Risk Assessment of Imported Fruit and Vegetable Commodities* (PPQ, 2012).

The appropriate risk management strategy for a particular pest depends on the risk posed by that pest. Identification of appropriate phytosanitary measures to mitigate pest risk is undertaken in Stage 3 (Risk Management) and is not covered in this risk assessment. Risk management will be specified in a separate document.

1.2. Initiating event

We prepared this assessment in response to a request by Servicio de Agricultura y Ganadaria (SAG) de Chile for USDA authorization to allow the importation of commercially produced fresh lemon fruit (*Citrus limon* (L.) Burm. f.) for consumption from Chile into the continental United States using a systems approach instead of fumigation (Vergara et al., 2007). The importation of fruits and vegetables for consumption into continental United States is regulated in 7 CFR §319.56 (2012). Currently, the entry of this commodity from Chile into the continental United States is not authorized without fumigation under 7 CFR §319.56; SAG Chile seeks a change in this Federal Regulation.

1.3. Determination of the necessity of a weed risk assessment for the commodity

In some cases, the imported commodity may have the potential to become invasive in the import area. The likelihood that this may happen is evaluated in a weed risk assessment, conducted separately from the commodity risk assessment.

Weed risk assessments do not need to be conducted for plant species that are widely established (native or naturalized) or widely cultivated in the import area, for commodities that are already enterable into the import area from other countries, or when the plant part(s) cannot not easily propagate on their own or be propagated. We determined that a weed risk assessment is not needed for the commodity, because *C. limon* is naturalized and cultivated in the continental United States (CIPM, 2012; Kartesz, 2010), and it is already enterable into the continental United States from other countries (APHIS, 2012a).

1.4. Description of the pathway

The IPPC (2011) defines a pathway as "any means that allows the entry or spread of a pest." In the context of commodity pest risk assessments, the *pathway* is the commodity to be imported, together with all the processes the commodity undergoes that may have an impact on pest risk. In this risk assessment, the specific pathway of concern is the importation of commercially produced fresh fruit of lemon (*Citrus limon* (L.) Burm. f.) for consumption from Chile into the continental United States; the movement of this commodity provides a potential pathway for the introduction and/or spread of plant pests.

The following description of this pathway focuses on the conditions that may affect plant pest risk, including morphological and physiological characteristics of the commodity, as well processes the commodity will undergo from production in Chile through importation and distribution in the continental United States. These conditions provided the basis for creating the pest list and assessing the likelihood of introduction of the pests selected for further analysis; therefore, all components of the pathway, as they are described in this section, should be considered mandatory conditions for importation of the commodity.

1.4.1. Description of the commodity

Lemon is a citrus fruit thought to be native to Southeast Asia (Ghosh et al., 2001; Morton, 1987). This fruit is currently imported from Chile with fumigation (APHIS, 2012a). Due to the fumigation requirement, the lemons require a large amount of methyl bromide. The use of a systems approach is an attempt to reduce the total amount of methyl bromide.

For this risk assessment, we considered that only the fruit of lemon (and no other plant parts) would be imported.

1.4.2. Production and harvest procedures in the exporting area

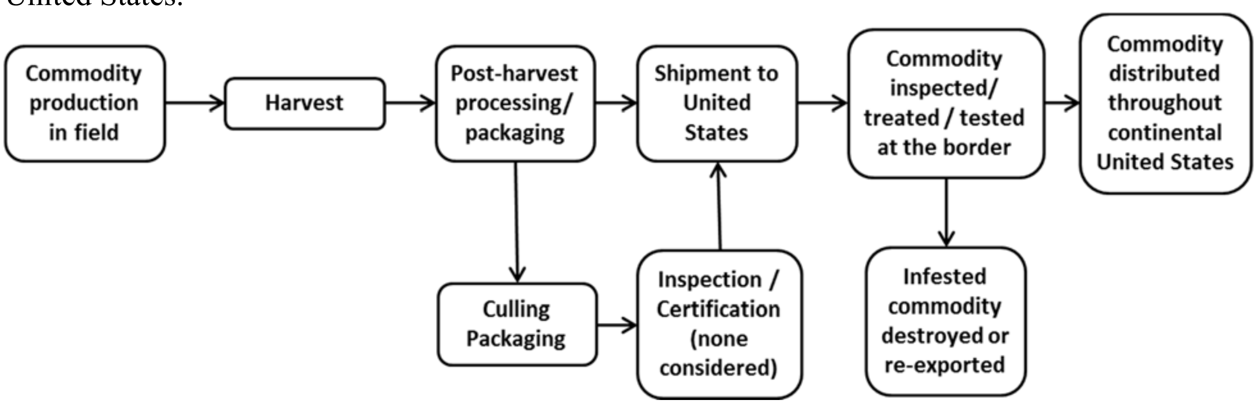
Besides minimal handling of the fruit at harvest, we are not considering any production and harvesting procedures in the exporting area as part of this assessment.

1.4.3. Post-harvest procedures in the exporting area
Besides minimal post-harvest culling, we are not considering any post-harvest procedures in the exporting area as part of this assessment.

1.4.4. Shipping and storage conditions
Shipments of lemon fruit to the United States from Chile are refrigerated at 10-12 °C and remain in transit for two to four weeks (Vergara et al., 2007).

1.4.5. Summary of the pathway
Below we summarize the pathway for the importation of fresh fruit of lemon (*Citrus limon* (L.) Burm. f.) for consumption from Chile into the continental United States (Fig. 1).

Figure 1. Pathway diagram for imports of fresh fruit of lemon from Chile into the continental United States.



2. Pest List and Pest Categorization

In this section, we identify the plant pests with actionable regulatory status for the continental United States that could potentially become established in the continental United States as a result of the importation of lemon fruit from Chile, and we determine which of these pests meet the criteria for further analysis. Pests are considered to be of regulatory significance if they are actionable at U.S. ports-of-entry. Actionable pests include quarantine pests, regulated non-quarantine pests, pests considered for or under official control, and pests that require evaluation for regulatory action.

2.1. Pests considered but not included on the pest list

2.1.1. Pests with doubtful evidence for association with the commodity
Neosilba pendula (Bezzi) occurs in Chile (Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991), and we found one report of it being associated with lemon (Klein Koch and Waterhouse, 2000). That report states that it is not an important pest of citrus in Chile. Moreover, it is generally a secondary pest that only attacks fruit that have been damaged primarily by tephritid fruit flies (Aguiar-Menezes et al., 2002; McAlpine and Steyskal, 1982; White and Elson-Harris, 1992; Zikan, 1944) or that are over-ripe (Gonzalez, 1989). We found no evidence

of it being a primary pest on lemon or other citrus hosts. Considering the above factors, we conclude that this is insufficient evidence for an association of *N. pendula* with commercial lemon fruit, and we did not include it in the pest list.

Also, we did not include the incompletely identified organisms *Lepidosaphes* sp. (Hemiptera: Diaspididae) and *Pseudococcus* sp. (Hemiptera: Pseudococcidae) on the pest list, because the only evidence we found for their association with lemon in Chile was one interception each (in ships stores and permit cargo, respectively) on lemon from Chile at U.S. ports-of-entry (PestID, 2012). We consider this insufficient evidence for association with the commodity.

2.1.2. Doubtful presence of the pest in the export area

Anastrepha fraterculus, formerly reported from Chile, is now considered eradicated in Chile (CABI, 2012). Similarly, although *C. capitata* was reported in Chile in the past (e.g., Prado, 1991), the government of Chile instituted a national program to eradicate it, and APHIS now recognizes all regions of Chile as pest-free for *C. capitata* (Notice of Determination of Pest-Free Areas in the Republic of Chile [Docket No. APHIS-2009-0082], 2010). Therefore, we did not include either pest on the pest list.

2.1.3. Organisms with non-actionable regulatory status

We found evidence of the organisms listed in Appendix A being associated with lemon and being present in Chile, but because they have non-actionable regulatory status for the United States, we did not include them in the pest list.

2.1.4. Organisms identified only to the genus level

In commodity import risk assessments, the taxonomic unit for pests selected for evaluation beyond the pest categorization stage is usually the species (IPPC, 2011), as assessments focus on organisms for which biological information is available. Therefore, we generally do not assess risk for organisms identified only to the genus level, in particular if the genus in question is reported in the import area. Often there are many species within a genus, and we cannot know if the unidentified species occurs in the import area, and whether it has actionable regulatory status. Furthermore, even if the genus is absent from the import area and it has actionable status, because such an organism has not been fully identified, we cannot properly analyze its likelihood and consequences of introduction.

In light of these issues, we do not include organisms identified only to the genus level in the main pest list. Instead, we address them separately in this sub-section. The information here can be used by risk managers to determine if measures beyond those intended to mitigate fully identified pests are warranted.

Table 1. Organisms identified to the genus level that are reported on *Citrus limon* in Chile and that have actionable or undetermined regulatory status.

Pest Name	Evidence of presence on lemon in Chile	Genus present in continental United States?	Regula-tory status[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
ARTHROPODS						
Hemiptera: Aleyrodidae						
Paraleyrodes sp.	Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003	Yes (Evans, 2008)	U	Leaf (Renato and Larral, 2003)	No	
Acari: Tarsonemidae						
Tarsonemus sp.	PestID, 2012	Yes (Bridges and Moser, 1986; Delfinado, 1978)	U	Fruit (PestID, 2012)	Yes	The association with lemon in Chile is based on six interceptions at U.S. ports-of-entry on lemon fruit from Chile (three in permit cargo, two in ships' stores, and one in ships quarters).
FUNGI						
Aschochyta sp.	Farr et al., 2009	Yes (Farr et al., 2009)	U	Leaf, stem (Farr et al., 2009)	No	

[1]A=Actionable, U=Undetermined. If the genus does not occur in continental United States, the organism has actionable status. If the genus occurs in continental United States, the organism has undetermined regulatory status, because we cannot know if the unidentified species is one that occurs in continental United States.

[2]The plant part(s) listed are those for the plant species under analysis. If the information is extrapolated, such as from plant part association on other plant species, this is noted.

[3]"Yes" indicates the pest has a reasonable likelihood of being associated with the harvested commodity.

Pest Name	Evidence of presence on lemon in Chile	Genus present in continental United States?	Regula-tory status[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Diplodia sp.	Farr et al., 2009	Yes (Farr et al., 2009)	U	Leaf, fruit, stem (Farr et al., 2009)	Yes	Most members of the genus are cosmopolitan fungi or are likely to be species already on the pest list.
Fusarium sp.	Farr et al., 2009	Yes (Farr et al., 2009)	U	Leaf, fruit, stem (Farr et al., 2009)	Yes	Same remark as for *Diplodia* sp.
Phoma sp.	Farr et al., 2009	Yes (Farr et al., 2009)	U	Leaf, fruit, stem (Farr et al., 2009)	Yes	Same remark as for *Diplodia* sp.
Phytophthora sp.	Farr et al., 2009	Type 1 (Farr et al., 2009)	U	Leaf, root, stem (Farr et al., 2009); fruit (Farr and Rossman, 2012)	Yes	Same remark as for *Diplodia* sp.

2.2. Pest list

In Table 2, we list the actionable pests associated with lemon that occur in Chile. The list comprises those actionable pests that occur in Chile on any host and are reported to be associated with lemon whether in Chile or elsewhere in the world. For each pest, we indicate 1) the part of the imported plant species with which the pest is generally associated, and 2) whether the pest has a reasonable likelihood of being associated, in viable form, with the commodity following harvesting from the field and prior to any post-harvest processing. We developed this pest list based on the scientific literature, port-of-entry pest interception data, and information provided by the government of Chile. Pests in shaded rows are pests identified for further evaluation, as we consider them reasonably likely to be associated with the harvested commodity; we summarize these pests in a separate table (Table 3).

Table 2. Actionable pests reported on *Citrus limon* (in any country) and present in Chile (on any host).

Pest Name	Evidence of presence in Chile	Host Status[4]	Plant part(s) association[5]	On harvested plant part(s)?[6]	Remarks[7]
ARTHROPODS					
Acari: Tenuipalpidae					
Brevipalpus chilensis Baker	Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003	Type 1 (CABI, 2012; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003)	Leaf, fruit, stem (CABI, 2012); leaf, fruit (Gonzalez, 2006); fruit (Renato and Larral, 2003)	Yes	Plant part associations based on feeding behavior of the species on lemon specifically (CABI, 2012; Gonzalez, 2006) and also citrus in general (CABI, 2012; Renato and Larral, 2003).
Coleoptera: Bostrichidae					
Dexicrates robustus (Blanchard)	Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991	Type 2 (Klein Koch and Waterhouse, 2000; Prado, 1991)	Wood (Gonzalez, 1989)	No	This is considered a secondary pest (Gonzalez, 1989) and only occasionally present on lemon in Chile (Prado, 1991). Plant part association based on feeding behavior on kiwi and grape (Gonzalez, 1989).

[4] Type 1 is a natural host, i.e., a plant species that becomes infested or infected by a plant pest in nature under natural conditions (e.g., natural, cultivated and/or unmanaged plants), and the plant pest is sustained on that plant species. Type 2 is a conditional host, i.e., a plant species that is only a host or a non-host under certain conditions. Type 3 is a natural non-host (pests for which the plant has this status are not included in the pest list). Type 4 refers to situations when the plant is not a food source but serves as a fomite, which is an object or material (including a harvested plant part) that may be contaminated with a pest and that could transmit that pest from one place to another.

[5] The plant part(s) listed are those for the plant species under analysis. If the information is extrapolated, such as from plant part association on other plant species, this is noted.

[6] "Yes" indicates simply that the pest has a reasonable likelihood of being associated with the harvested commodity; the level of pest prevalence on the harvested commodity (low, medium, or high) is qualitatively assessed in Risk Element A1 as part of the likelihood of introduction assessment (section 3).

[7] Geographic Distribution: US = United States, AL = Alabama, CA = California, FL = Florida, HI = Hawaii, LA = Louisiana, TX = Texas

Pest Name	Evidence of presence in Chile	Host Status[4]	Plant part(s) association[5]	On harvested plant part(s)?[6]	Remarks[7]
Coleoptera: Curculionidae					
Naupactus xanthographus (Germar)	Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003	Type 1 (Klein Koch and Waterhouse, 2000; PPQ, 2002; Prado, 1991; Renato and Larral, 2003; Ripa, 1986) See discussion in section 2.3.	Root (larvae), leaf (adult) (Bosq, 1934; Pinto and Zaviezo, 2003; Renato and Larral, 2003); root (Ripa, 1986) See discussion in section 2.3.	No	
Hemiptera: Aleyrodidae					
Aleurothrixus porteri Quaintance & Baker	Klein Koch and Waterhouse, 2000; Prado, 1991	Type 1 (Klein Koch and Waterhouse, 2000; Prado, 1991)	Leaf (Quaintance and Baker, 1916; Vergara et al., 2007)	No	
Siphoninus phillyreae Haliday	CABI, 2012; Klein Koch and Waterhouse, 2000; Muñoz and Beéche, 1995	Type 1 (Nguyen and Hamon, 2012)	Leaf (CABI, 2012; Hill, 1987; Nguyen and Hamon, 2012)	No	Present in the United States (CA, FL, HI) (Evans, 2007; Nguyen and Hamon, 2012). Plant part association based on its feeding behavior on its hosts in general.
Hemiptera: Aphididae					
Toxoptera citricidus (Kirkaldy) [syn. *T. citricida* (Kirkaldy)]	CABI, 2012; Prado, 1991	Type 1 (CABI, 2012; Johnston, 1950; Prado, 1991)	Leaf (Halbert and Brown, 1996); leaf, flower bud (CABI, 2012)	No	Present in the United States (FL, HI) (CABI, 2012; Giacometti and Storey, 1952; Halbert and Brown, 1996). Plant part association is based on its feeding behavior on citrus in general.

Pest Name	Evidence of presence in Chile	Host Status[4]	Plant part(s) association[5]	On harvested plant part(s)?[6]	Remarks[7]
Hemiptera: Cicadidae					
Tettigades chilensis (Amyot & Serville)	Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Quiroga et al., 1991	Type 2 (Prado, 1991)	Branch, stem (Quiroga et al., 1991); twigs, rhizosphere (Gonzalez, 1989)	No	We only found one report for its association with lemon, in which it is only a secondary or occasional pest of lemon (Prado, 1991). Plant part association is based on feeding behavior on *Simmondsia chinesis* (Quiroga et al., 1991) and its host plants in general (Gonzalez, 1989).
Hymenoptera: Formicidae					
Solenopsis gayi (Spinola)	Klein Koch and Waterhouse, 2000; Larraín et al., 1995	Type 2 (Klein Koch and Waterhouse, 2000) See discussion in section 2.3.	Bark, trunk, root (Larraín et al., 1995)	No	Plant part association is based on damage to *Citrus reticulata* (Larraín et al., 1995). That was the first report of *S. gayi* attacking citrus plants; the authors believe it resulted from habitat destruction and a reduction in other resources.
Lepidoptera: Gracillariidae					
Phyllocnistis citrella (Stainton)	Klein Koch and Waterhouse, 2000; Renato and Larral, 2003	Type 1 (Klein Koch and Waterhouse, 2000; Liu et al., 2008; Renato and Larral, 2003)	Leaf (Liu et al., 2008; Rahman et al., 2005; Yunus and Ho, 1980) See additional discussion in section 2.3.	No	Present in the US (AL, CA, FL, LA, TX) (CABI, 2012; Grafton-Cardwell, 2006; Heppner, 2008).

Pest Name	Evidence of presence in Chile	Host Status[4]	Plant part(s) association[5]	On harvested plant part(s)?[6]	Remarks[7]
Lepidoptera: Noctuidae					
Achaea janata (Linnaeus)	Easter Island (Klein Koch and Waterhouse, 2000)	Type 1 (EcoPort Record, 2012)	Leaf (larvae) (French, 2006); fruit (adult) (CABI, 2007)	No	We found only one report of *C. limon* being a host,which was not an original source (EcoPort Record, 2012). Therefore, we have high uncertainty as to the host status of *C. limon*. Only the highly mobile adult stage feeds on the fruit of its hosts (CABI, 2007). Fruit handling at harvest is highly likely to remove this pest from the commodity.
Lepidoptera: Tortricidae					
Proeulia auraria (Clarke)	Gonzalez Rodriguez, 2003; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003	Type 1 (Klein Koch and Waterhouse, 2000) See additional discussion in section 2.3.	Fruit, leaf (Campos et al., 1981; Gonzalez Rodriguez, 2003; Renato and Larral, 2003); leaf, flower, fruit, stem (CABI, 2012) See additional discussion in section 2.3.	Yes (Larvae only)	Due to their mobility, the free-living adults of this insect are highly unlikely to be associated with harvested fruit. Pupation does not take place in the fruit (CABI, 2012). Therefore, pupae are highly unlikely to be associated with harvested fruit.
Proeulia chrysopteris (Butler)	Brown, 2005; Gonzalez Rodriguez, 2003; Klein Koch and Waterhouse, 2000; Prado, 1991	Type 1 (Klein Koch and Waterhouse, 2000) See additional discussion in section 2.3.	Flower, fruit, leaf, shoot (CABI, 2012; Gonzalez, 1989; Santacroce, 1993)	Yes (Larvae only)	Due to their mobility, the free-living adults of this insect are highly unlikely to be associated with harvested fruit.

Pest Name	Evidence of presence in Chile	Host Status[4]	Plant part(s) association[5]	On harvested plant part(s)?[6]	Remarks[7]
			See additional discussion in section 2.3.		Pupation does not take place in the fruit (CABI, 2012). Therefore, pupae are highly unlikely to be associated with harvested fruit.
Orthoptera: Tettigonidae					
Cosmophyllum pallidulum Blanchard	Gonzalez, 1989; Prado, 1991	Type 2 (Prado, 1991)	Leaf, fruit (early stage) (Vergara et al., 2007)	No	Reported as occasional pest of lemon in Chile (Prado, 1991). Therefore, we assume it attacks lemon only under certain conditions. Because of the size and general mobility of this type of flying insect, the harvesting process is highly likely to remove the pest from the commodity.
Thysanoptera: Thripidae					
Frankliniella australis Morgan (syn: *Frankliniella cestrum* Moulton)	Klein Koch and Waterhouse, 2000; Nakahara, 1997; Prado, 1991	Type 2 (Klein Koch and Waterhouse, 2000) See additional discussion in section 2.3.	Flower (PPQ, 2002; Santacroce, 1993)	No	We had no plant part association information specific to lemon, so it is based on its behavior on other hosts.
Frankliniella gemina Bagnall	Klein Koch and Waterhouse, 2000; Nakahara, 1997	Type 2 (Klein Koch and Waterhouse, 2000) See additional discussion in section 2.3.	Leaf, flower (Cavalleri et al., 2006; de L'Argentier et al., 2005)	No	We had no plant part association information specific to lemon, so it is based on its behavior on other hosts.

Pest Name	Evidence of presence in Chile	Host Status[4]	Plant part(s) association[5]	On harvested plant part(s)?[6]	Remarks[7]
Frankliniella rodeos Moulton	Gonzalez, 1989; Prado, 1991	Type 1 (Prado, 1991; Rizzo, 1977)	Flower (PestID, 2012; Pinent et al., 2011; Vergara et al., 2007); shoot with flower (Cavalleri et al., 2006)	No	The two reports of *F. rodeos* on lemon are just listings of pests in Chile (Prado, 1991) and Argentina (Rizzo, 1977), with no original sources. Consequently, we have high uncertainty that lemon is a Type 1 host. We had no plant part association information specific to lemon, so it is based on its behavior on other hosts.
Scirtothrips inermis Priesner	Klein Koch and Waterhouse, 2000; Prado, 1991	Type 1 (Mound and Walker, 1982; Prado, 1991)	Leaf (Mound and Walker, 1982)	No	Present in the United States (CA) (Anonymous, 1972; Mound and Palmer, 1981; Mound and Walker, 1982; Sakimura, 1986).
FUNGI					
Armillaria luteobubalina Watling & Kile	Farr and Rossman, 2012	Type 1 (Dunne et al, 2002)	Root (Dunne et al,2002)	No	
Diplodia destruens McAlpine	Farr and Rossman, 2012	Type 1 (Farr and Rossman, 2012)	Leaf (Farr and Rossman, 2012)	No	We found only a few, old records of this pathogen being in Chile or Australia, where it was first reported.

2.3. Notes on pests identified in the pest list

Frankliniella australis and ***Frankliniella gemina***. We only found one report of *C. limon* being a host of these two thrips species (Klein Koch and Waterhouse, 2000). Also, this reference (Klein Koch and

Waterhouse, 2000) is just a listing of pests in Chile and does not provide an original source reference(s) for the report on lemon. Based on this evidence, we have moderate uncertainty of lemon being a host.

Naupactus xanthographus. The references we found that list lemon as a host of this species are either non-original source references (Klein Koch and Waterhouse, 2000; PPQ, 2002; Prado, 1991; Renato and Larral, 2003) or based on a host range study under experimental conditions (Ripa, 1986). We found no original source evidence reporting lemon as a host. Also, lemon is not listed as a primary or secondary host of this species by Gonzalez et al. (1989). Based on this evidence, we have moderate certainty of lemon being a Type 1 host. Plant part association is based on how this insect behaves on its host plants in general, as we did not find evidence of how it behaves on lemon specifically. The only evidence we found of this species being associated with fruit is one report saying the adults can feed on "green bunches of grape" (PPQ, 2002); we did not think this was sufficient evidence for the beetle to be associated with lemon fruit.

Phyllocnistis citrella. This species feeds on the leaves of lemon (Liu et al., 2008; Rahman et al., 2005; Yunus and Ho, 1980). There are some reports of this insect being associated with the fruit of its hosts under heavy infestations (e.g., CABI, 2012), but we did not find any evidence for association with lemon fruit specifically. On citrus in general, it is reported to occasionally attack the fruit (Bermudez et al., 2004; Heppner, 1995; Renato and Larral, 2003). Heppner (1995) reports it attacking only young fruit of grapefruit, and the author says it appears that young fruit may be attacked in cases of massive infestations by the insect; that author also hypothesizes that only certain varieties of citrus may be susceptible to fruit attack, which may explain why few reports of fruit attack by this insect exist. We concluded that the pest is highly unlikely to be associated with commercial lemon fruit. Additionally, due to their mobility, free-living adults of *P. citrella* are highly unlikely to be associated with harvested fruit.

Proeulia auraria. We found only one report (Klein Koch and Waterhouse, 2000) for association with lemon, and that report is just a listing of pests in Chile without a reference for the association with lemon. We found no original source evidence reporting lemon as a host. Thus, we have moderate uncertainty of lemon being a host. Plant part association is based on how this species behaves on its host plants in general (CABI, 2012; Campos et al., 1981) or on citrus in general (Gonzalez Rodriguez, 2003; Renato and Larral, 2003), not for lemon specifically, as we found no evidence for plant parts attacked on lemon. It mainly attacks the leaves of its hosts and feeds externally on all plant parts affected (CABI, 2012).

Proeulia chrysopteris.. We found only one report (Klein Koch and Waterhouse, 2000) for association with lemon, and this one report is just a listing of pests in Chile and does not cite a reference for the association with lemon. We found no original source evidence reporting lemon as a host. Thus, we have moderate uncertainty that lemon is a host. Plant part association is based on how this species behaves on its host plants in general (CABI, 2012), not on lemon specifically, as we found no evidence for plant parts attacked on lemon. It feeds externally on all plant parts affected (CABI, 2012; Gonzalez, 1989; Santacroce, 1993).

Solenopsis gayi. Species in the genus *Solenopsis* are primarily predators of other insects (Larraín et al., 1995); therefore, we conclude lemon is a conditional host. We only found one report of this ant being associated with lemon (Klein Koch and Waterhouse, 2000), which is not an original source reference. Therefore, we have high uncertainty for host status.

2.4. Pests selected for further analysis

We identified three pests for further analysis (Table 3). All of these organisms are actionable pests for the continental United States and have a reasonable likelihood of being associated with the commodity plant part at the time of harvest and remaining with the commodity, in viable form, throughout the harvesting process.

Table 3. Pests selected for further analysis.

Pest Type	Taxonomy	Scientific Name
Arthropod	Acari: Tenuipalpidae	*Brevipalpus chilensis*
	Lepidoptera: Tortricidae	*Proeulia auraria* (larvae only)
		Proeulia chrysopteris (larvae only)

3. Assessing Pest Risk Potential

3.1. Introduction

For each pest selected for further analysis, we estimate its overall pest risk potential. Risk is described by the likelihood of an adverse event, the magnitude of the consequences, and uncertainty. In general, we first determine for each pest if there is an endangered area within the import area. The endangered area is defined as the portion of the import area where ecological factors favor the establishment of the pest and where the presence of the pest will result in economically important losses. Once an endangered area has been determined, the overall risk of each pest is then determined by two separate components: 1) the likelihood of its introduction into the endangered area on the imported commodity (i.e., the likelihood of an adverse event), and 2) the consequences of its introduction (i.e., the magnitude of the consequences). In general, we assess both of these components for each pest. However, if we determine that the risk of either of these components is negligible, it is not necessary to assess the other, as the overall pest risk potential would be negligible regardless of the result of the second component. In other words, if we determine that the introduction of a pest is unlikely to have unacceptable consequences, we do not assess its likelihood of being introduced. Likewise, if we determine there is negligible likelihood of a pest being introduced, we do not assess its consequences of introduction.

The likelihood and consequences of introduction are assessed using different approaches.

For the consequences of introduction, we determine if the pest meets the threshold (Yes/No) of likely causing unacceptable consequences of introduction. This determination is based on estimating the potential consequences of introduction in terms of physical losses (rather than monetary losses). The threshold is based on a proportion of damage rather than an absolute value or amount. Pests that are likely to impact at least 10 percent of the production of one or more hosts are deemed “threshold pests.”

For likelihood of introduction, which is based on the likelihoods of entry and establishment, we qualitatively assess risk using the ratings Negligible, Low, Medium, and High. The risk factors comprising the model for likelihood of introduction are interdependent and, therefore, the model is multiplicative rather than additive. Thus, if any one risk factor is rated as Negligible, then the overall likelihood will be Negligible. For the overall likelihood of introduction risk rating, we define the different categories as follows:

High: Pest introduction is highly likely to occur.

Medium: Pest introduction is possible, but for that to happen, the exact combination of required events needs to occur.

Low: Pest introduction is unlikely to occur because one or more of the required events are unlikely to happen, or the full combination of required events is unlikely to align properly in time and space.

Negligible: Pest introduction is highly unlikely to occur given the exact combination of events required for successful introduction.

3.2. Assessment results

3.2.1. *Brevipalpus chilensis*

We determined the overall likelihood of introduction to be Medium. We present the results of this assessment in the table below.

We determined that the establishment of *B. chilensis* in the continental United States is likely to cause unacceptable impacts. We present the results of this assessment in the table below.

Determination of the portion of the continental United States endangered by *Brevipalpus chilensis*

Climatic suitability	The distribution of *B. chilensis* includes Regions III (Atacama) through X (Los Lagos) in Chile (Gonzalez, 1989; Prado, 1991; Renato and Larral, 2003) and the Rio Negro province in Argentina (Beard et al., 2012). Based on a comparison of this distribution with a global map of Plant Hardiness Zones (Magarey et al., 2008), we estimate that this corresponds to Plant Hardiness Zones 8-10 in the continental United States.
Potential hosts at risk in PRA Area	The host range of *B. chilensis* includes the following plants (Beard et al., 2012; Gonzalez, 1983; Gonzalez et al., 1973; Gonzalez, 1958; Jeppson et al., 1975; Klein Koch and Waterhouse, 2000; Prado, 1991) that occur in Plant Hardiness Zones 8-10 in the continental United States (CIPM, 2012; Kartesz, 2010, 2011; Morton, 1987; NGRP, 2012): *Actinidia deliciosa* (kiwi) (Actinidiaceae), *Annona cherimola* (cherimoya) (Annonaceae), *Apium graveolens* (celery) (Apiaceae), *Chrysanthemum* sp. (Asteraceae), *Convolvulus arvensis* (bindweed) (Convolvulaceae), *Diospyros kaki* (Japanese persimmon) (Ebenaceae), *Pelargonium* (geranium), *Viburnum* (Geraniaceae), *Ficus carica* (fig) (Moraceae), *Ligustrum sinense* (privet) (Oleaceae), *Cydonia oblonga* (quince), *Malus domestica* (apple), *Prunus armeniaca* (apricot), *P. dulcis* (almond), *Pyrus communis* (pear), *Rubus idaeus* (raspberry) (Rosaceae), *Citrus* sp. (Rutaceae), and *Vitis vinifera* (grape) (Vitaceae).

Economically important hosts at risk[a]	Besides *Convolvulus arvensis*, which is listed as a state noxious weed for numerous U.S. states (Kartesz, 2010), all the other above listed plants are of economic importance as commercial plants within one or more of Plant Hardiness Zones 8-10 in the continental United States (CIPM, 2012; Crane, 1993; Dave's Garden, 2012; Morton, 1987; NASS, 2009, 2010).
Pest potential on economically important hosts at risk[a]	*Brevipalpus chilensis* has been listed in the literature as a pest on grape, kiwi, and citrus. Jeppson et al. (1975) described it as "a very destructive pest of grapevines in Chile"; Walter et al. (2009) state it "causes serious damage to grapes in Chile." It is mainly a pest of certain varieties of grapes, in particular certain wine grape varieties (CABI, 2012; Gonzalez, 1983). On grapes, this mite feeds on the leaves, which leads to leaf drop and a reduction in new growth (Jeppson et al., 1975). Feeding on the rachis and pedicels may cause these stems and the berries to dehydrate completely (Pearson and Goheen, 1990); under heavy attack, buds are killed by tissue dehydration (Vergara et al., 2007) and fruit production is reduced (Gonzalez, 2006; Pearson and Goheen, 1990). In the 1950s in Chile, this mite caused losses up to 30 percent in vineyards (Gonzalez, 1983). *Brevipalpus chilensis* has also been listed as a pest of kiwi fruit in Chile (Gonzalez, 1986); however, Vergara et al. (2007) report that kiwi fruit does "not suffer economic impact because of this pest." In other host plants, such as citrus, no evidence exists of economic impact (CABI, 2012; Vergara et al., 2007), although Gerson (2003) reports *B. chilensis* as a minor pest of citrus. Control programs, including chemical and cultural control, have been implemented for *B. chilensis* (CABI, 2012; Gonzalez, 1986, 2006; Jeppson et al., 1975; Renato and Larral, 2003).
Defined Endangered Area	Based on the above evidence, the endangered area of *B. chilensis* is considered to be where the above listed economically important hosts occur within Plant Hardiness Zones 8-10.

[a] As defined by ISPM No. 11, supplement 2, "economically" important hosts refers to both commercial and non-market (environmental) plants (IPPC, 2011).

Assessment of the likelihood of introduction of *Brevipalpus chilensis* into the endangered area via the importation of lemon (*C. limon*) fruit from Chile

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	High	C	This mite feeds on the fruit of citrus hosts, including lemon (CABI, 2012; Gonzalez, 2006; Renato and Larral, 2003), and fruit is one of its preferred feeding sites on citrus (Renato and Larral, 2003). We did not consider any production practices that might reduce the prevalence of this pest on the commodity at harvest (§1.4).
Risk Element A2: Likelihood of	High	MC	We only considered minimal post-harvest culling here (§1.4). On fruit, *B. chilensis* mites and their

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
surviving post-harvest processing before shipment			symptoms are not visible to the naked eye (CABI, 2012). Exceptionally high populations of the mite can cause a silver color and a rough texture on the surface of citrus fruits (Renato and Larral, 2003). In mandarin, the small yellow spots caused by the mite on green fruit "virtually disappear" when the fruit changes color with ripening (Renato and Larral, 2003); we expect the same may be true for lemon fruit. Culling of fruit with these symptoms may decrease mite prevalence, but probably only to a small extent. Therefore, we did not change the rating from A1.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	High	C	To maintain the quality of lemon fruits during transport and storage, the recommended conditions are 10-13 °C and 85-90 percent humidity (McGregor, 1987). Lemon shipments to the United States from Chile are refrigerated at 10-12 °C and remain in transit for two to four weeks (Vergara et al., 2007). Jadue et al. (1996) found that at least some *Brevipalpus chilensis* survive storage for 15 days at 0-2 °C and 90 percent humidity. Live *B. chilensis* have been intercepted occasionally at U.S. ports-of-entry on commercial shipments of lemons from Chile (PestID, 2012), demonstrating that they can survive commercial shipment conditions. Consequently, we conclude that the transport and storage conditions for lemons from Chile would not significantly reduce the pest population on the commodity, and therefore the rating for A2 did not change.
Risk Element A: Overall risk rating for likelihood of entry	High	N/A	The overall rating for the likelihood of entry is equal to the rating for A3.
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	Low	MC	*Brevipalpus chilensis* is a slow-moving mite (Renato and Larral, 2003), as is the whole Tenuipalpidae family (Gonzalez, 1989; Hoy, 2011; Jeppson et al., 1975). Spread occurs mainly through plant-to-plant contact (Vergara et al., 2007). Thus, the mite has limited ability to disperse on its own from the fruit to suitable host material in the endangered area.

Risk Element	**Risk Rating**	**Uncertainty Rating[a]**	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Risk Element B2: Likelihood of arriving in the endangered area	High	C	More than 25 percent of the U.S. population lives in Plant Hardiness Zones 8-10 in the continental United States (PPQ, 2012: Supplement 2).
Risk Element B: Combined likelihood of establishment	Medium	N/A	A Low rating for B1 combined with a High rating for B2 results in an overall Medium rating for the overall likelihood of establishment, Risk Element B.
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Medium	N/A	A High rating for entry combined with a Medium rating for establishment results in a Medium rating for the overall likelihood of introduction.

[a]C=Certain, MC=Moderately Certain, MU=Moderately Uncertain, U=Uncertain

Assessment of the consequences of introduction of *Brevipalpus chilensis* into the continental United States (i.e., the PRA area)

Criteria	**Meets criteria? (Y/N)**	**Uncertainty Rating[a]**	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Unknown	U	Analysis here is difficult because until recently the pest was only found in Chile, so its behavior in new environments is largely unknown. Although *B. chilensis* may be a "pest" on citrus (Gerson, 2003) and kiwi (CABI, 2012; Gonzalez, 1986, 2006), we found no evidence of any significant direct impacts on hosts besides grapes. Jeppson et al. (1975) called *B. chilensis* "…a very destructive pest of grapevines." Reports since the 1950s indicate that *B. chilensis* causes reduced production in Chilean grapes, especially in some wine grapes, and requires regular use of pesticides and other control measures (Gonzalez, 1983; Gonzalez, 2006; Jeppson et al., 1975; Pearson and Goheen, 1990; Renato and Larral, 2003). In the 1950s, *B. chilensis* caused losses up to 30 percent (Gonzalez, 1983; Gonzalez, 2006). More recently, however, changes in pesticide use have reduced losses (Gonzalez, 1983; Gonzalez, 2006; Vergara et al., 2007). Mite monitoring and control are part of routine management for grapes (i.e., CIPM, 2012; UC IPM, 2009), but may not

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
			adequately control *B. chilensis.* Based on the available information, we cannot be certain that *B. chilensis* is likely to significantly impact grapes or other potential hosts, including potential non-commercial hosts, in the United States. Therefore, we answered "unknown" here, and focused our analysis on potential trade impacts.
Risk Element C2: Spread potential	N/A	N/A	N/A
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Unknown	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	Yes	C	*Brevipalpus chilensis* a pest of quarantine concern for Australia, Brazil, Costa Rica, Japan, Mexico, South Korea, Peru, South Africa, and Taiwan (APHIS, 2012b; Biosecurity Australia, 2005; CABI, 2012; FreshFruitPortal.com, 2010). In the last five years (2007-2011), all of these countries have imported fresh grapes and citrus from the United States, and all but Brazil and South Africa have imported U.S. kiwifruit (FAS, 2012). Comparing total exports of U.S. citrus, kiwifruit, and grape with exports to those countries (FAS, 2012), we estimate that over 10 percent of each of these commodities is exported.
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	Yes	MC	South Africa already requires an AD that California grapes are from a state "free of" *B. chilensis* (APHIS, 2012b). Brazil and Australia require that Chilean grapes be fumigated for *B. chilensis*, and Brazil recently halted imports of grapes from Argentina after finding *B. chilensis* in a shipment (Biosecurity Australia, 2005; FreshFruitPortal.com, 2012). Mexico also requires methyl bromide fumigation of grapes, kiwi, and persimmons from Chile to mitigate several pests, including *B. chilensis* (CABI, 2012; FreshFruitPortal.com, 2010). Additionally, some of the countries above require an Additional

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
			Declaration (AD) that commodities are "free of" the related mite, *Brevipalpus lewisi*. Therefore, should *B. chilensis* be introduced into the continental United States, one or more of these trading partners are very likely to require additional phytosanitary measures for U.S. exports.
Risk Element D: Pest is likely to cause significant trade impacts	Yes	N/A	Because the answer to Risk Element D2 is "Yes," the pest is considered likely to cause significant trade impacts.
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	Because the pest is likely to cause significant trade impacts, it is considered likely to cause unacceptable consequences in the PRA area.

[a] C=Certain, MC=Moderately Certain, MU=Moderately Uncertain, U=Uncertain

3.2.2. *Proeulia auraria*

We determined the overall likelihood of introduction for larvae of *P. auraria* to be Negligible. We present the results of this assessment in the table below.

Because the likelihood of entry is Negligible, determination of the endangered area and assessment of the likelihood of establishment and consequences of introduction were not necessary.

Assessment of the likelihood of introduction of *Proeulia auraria* larvae **into the endangered area via the importation of lemon (*C. limon*) fruit from Chile**

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Low	MU	As mentioned above (§2.3), lemon seems to be a conditional host that is attacked only occasionally and under certain unknown conditions. Also, *P. auraria* larvae mainly attack leaves, not fruit (CABI, 2012). They feed externally on all plant parts affected and will abandon a feeding source when disturbed (CABI, 2012). Thus, these larvae likely have a low prevalence on this commodity.

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Negligible	MC	The larvae of *P. auraria* cause obvious symptoms on attacked plant parts, including fruit (i.e., external feeding scars and associated silk and frass) (CABI, 2012; Gonzalez Rodriguez, 2003; Renato and Larral, 2003). Additionally, the larvae feed externally and reach up to 22 mm in length (CABI, 2012; Renato and Larral, 2003). Thus, infested fruit are highly likely to be rejected during post-harvest processing. We therefore decreased the previous rating by one level.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	N/A	N/A	
Risk Element A: Overall risk rating for likelihood of entry	Negligible	N/A	The overall rating for the likelihood of entry is equal to the rating for A2.
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	N/A	N/A	N/A
Risk Element B2: Likelihood of arriving in the endangered area	N/A	N/A	N/A
Risk Element B: Combined likelihood of establishment	N/A	N/A	Because the likelihood of entry, Risk Element A, is Negligible, assessment of Risk Element B is not needed.
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Negligible	N/A	Because the likelihood of entry, Risk Element A, is Negligible, the overall likelihood of introduction is Negligible.

[a]C=Certain, MC=Moderately Certain, MU=Moderately Uncertain, U=Uncertain

3.2.3. *Proeulia chrysopteris*

We determined the overall likelihood of introduction for larvae of *P. chrysopteris* to be Negligible. We present the results of this assessment in the table below.

Because the likelihood of entry is Negligible, determination of the endangered area and assessment of the likelihood of establishment and the consequences of introduction were not necessary.

Assessment of the likelihood of introduction of *Proeulia chrysopteris* larvae into the endangered area via the importation of lemon (*C. limon*) fruit from Chile

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Low	MU	As mentioned above (§2.3), lemon seems to be a conditional host of *P. chrysopteris* that is attacked only occasionally and under certain unknown conditions. Also, at the time of fruit harvest on other host species, most, if not all, of these larvae have abandoned the fruit (CABI, 2012). Finally, the larvae feed externally (CABI, 2012; Gonzalez, 1989; Santacroce, 1993). Thus, these larvae likely have a low prevalence on this commodity.
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Negligible	MC	The larvae of *P. chrysopteris* cause obvious symptoms on attacked plant parts, including fruit (i.e., external feeding scars and associated webbing) (CABI, 2012; Gonzalez, 1989; Gonzalez Rodriguez, 2003; Santacroce, 1993). Also, the larvae feed externally on their host plant parts and reach up to 18 mm in length (CABI, 2012). Consequently, infested fruit are highly likely to be detected during post-harvest processing. Thus, we decreased the previous risk rating (A1) by one level.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	N/A	N/A	Because A2 is Negligible, assessment of Risk Element A3 is not needed.
Risk Element A: Overall risk rating for likelihood of entry	Negligible	N/A	The overall rating for the likelihood of entry is equal to the rating for A2.

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	N/A	N/A	N/A
Risk Element B2: Likelihood of arriving in the endangered area	N/A	N/A	N/A
Risk Element B: Combined likelihood of establishment	N/A	N/A	Because the likelihood of entry, Risk Element A, is Negligible, assessment of Risk Element B is not needed.
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Negligible	N/A	Because the likelihood of entry, Risk Element A, is Negligible, the overall likelihood of introduction is Negligible.

[a]C=Certain, MC=Moderately Certain, MU=Moderately Uncertain, U=Uncertain

4. Summary and Conclusions of Risk Assessment

Of the organisms associated with *C. limon* worldwide and reported in Chile, we identified organisms that are actionable pests for the continental United States and have a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing. We further evaluated these organisms for their likelihood of introduction (i.e., entry plus establishment) and their potential consequences of introduction. Pests that meet the threshold to likely cause unacceptable consequences of introduction and receive an overall likelihood of introduction risk rating above Negligible are candidates for risk management. The results of this risk assessment represent a baseline estimate of the risks associated with the import commodity pathway as described in section 1.4. For this risk assessment, we considered that:

- the commodity would be commercially produced
- only the fruit of lemon (and no other plant parts) would be imported
- the commodity would undergo minimal harvest handling and post-harvest culling
- the commodity would be shipped at 10-12 °C and remain in transit to the United States for two to four weeks
- the area of import would be limited to the continental United States
- the commodity would be for consumption only

Of the three pests selected for further analysis, we determined two are *not* candidates for risk management, because they received a Negligible overall risk rating for likelihood of introduction via the import pathway. We summarize the results for each pest below (Table 4).

The other pest selected for further analysis, *B. chilensis*, is a candidate for risk management, because it meets the threshold to likely cause unacceptable consequences of introduction, and it received an overall likelihood of introduction risk rating above Negligible. We summarize the results below (Table 4).

Detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk are part of the pest risk management phase within APHIS and are not addressed in this document.

Table 4. Summary for pests selected for further evaluation and determined *not* to be candidates for risk management.

Pest	Reason for *not* being a candidate for risk management	Uncertainty statement (optional)[a]
Proeulia auraria (Lepidoptera: Tortricidae)	Negligible likelihood of introduction	We have moderate uncertainty of lemon being a host.
Proeulia chrysopteris (Lepidoptera: Tortricidae)	Negligible likelihood of introduction	We have moderate uncertainty of lemon being a host.

[a]The uncertainty statement, if included, identifies the most important source(s) of uncertainty.

Table 5. Summary for pests selected for further evaluation and determined to be candidates for risk management. All of these pests meet the threshold for unacceptable consequences of introduction.

Pest	Likelihood of introduction overall rating	Uncertainty statement (optional)[a]
Brevipalpus chilensis (Acari: Tenuipalpidae)	Medium	While we had high uncertainty about the likelihood that this pest will cause direct impacts in the endangered area, we had relatively low uncertainty for the other risk ratings for this pest.

[a]The uncertainty statement, if included, identifies the most important source(s) of uncertainty.

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7. Appendix A

Appendix A. Pests with non-actionable regulatory status

We found some evidence of the organisms listed below being associated with *Citrus limon* somewhere in the world and of being present in Chile; however, because these organisms have non-actionable regulatory status for the continental United States, we did not list them in Table 2 of this risk assessment, and we did not evaluate the strength of the evidence for their association with *C. limon* or their presence in Chile. Because we did not evaluate the strength of the evidence, we consider the following pests to have only "potential" association with the commodity and presence in Chile.

Below we list these organisms along with the references supporting their potential association with *Citrus limon*, their potential presence in Chile, their presence in the continental United States (if applicable), and their regulatory status for continental United States (if needed). For organisms *not* present in the continental United States, we also provide justification for their non-actionable status.

Organism	References and/or other notes
ARTHROPODS	
Aceria sheldoni (Ewing) (syn. *Eriophyes sheldoni* Ewing) (Acari: Eriophyidae)	CABI, 2012; Gonzalez, 1989; Hare et al., 1999; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003; UC IPM, 2008
Aleurothrixus floccosus (Maskell) (Hemiptera: Aleyrodidae)	CABI, 2007; Gonzalez, 1989; HDOA, 2008; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Aonidiella aurantii (Maskell) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Aonidiella citrina (Coquillet) (Hemiptera: Diaspididae)	Ben-Dov et al., 2008; CABI, 2007; Klein Koch and Waterhouse, 2000; Prado, 1991
Aonidiella sp. (Hemiptera: Diaspididae)	PestID, 2012; non-actionable status for Diaspididae on commodities for consumption (NIS, 2008)
Aphis gossypii Glover (Hemiptera: Aphididae)	CABI, 2007; Klein Koch and Waterhouse, 2000; Mitchell, 1973; Prado, 1991; Renato and Larral, 2003
Aphis spiraecola Patch. (syn. *A. citricola* Van der Goot.) (Hemiptera: Aphididae)	CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Aspidiotus nerii Bouché (Hemiptera: Diaspididae)	Ben-Dov et al., 2008; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003
Aulacorthum solani (Kaltenbach) (Hemiptera: Aphididae)	Klein Koch and Waterhouse, 2000; Palumbo, 2003
Brevipalpus obovatus Donnadieu (Acari: Tenuipalpidae)	CABI, 2007; HDOA, 2008; Klein Koch and Waterhouse, 2000
Ceroplastes cirripediformis Comstock (Hemiptera: Coccidae)	Ben-Dov et al., 2012; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003

Organism	References and/or other notes
Ceroplastes sinensis Del Guercio (Hemiptera: Coccidae)	Ben-Dov et al., 2012; Klein Koch and Waterhouse, 2000; non-actionable on commodities for consumption (PestID, 2012)
Chrysomphalus aonidum (Linnaeus) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; CABI, 2007
Chrysomphalus dictyospermi (Morgan) (Hemiptera: Diaspididae)	Ben-Dov et al., 2009; Gonzalez, 1989; Klein Koch and Waterhouse, 2000
Coccus hesperidium (Linnaeus) (Hemiptera: Coccidae)	Ben-Dov et al., 2008; CABI, 2007; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Dialeurodes citri (Ashmead) (Hemiptera: Aleyrodidae)	CABI, 2007; Gonzalez, 1989; Prado, 1991
Drosophila simulans (Sturtevant) (Diptera: Drosophilidae)	Vergara et al., 2007; genus non-reportable/non-actionable (PestID, 2012)
Dysmicoccus brevipes (Cockerell) (Hemiptera: Pseudococcidae)	Ben-Dov et al., 2012; CABI, 2007; Klein Koch and Waterhouse, 2000
Ectomyelois ceratoniae (Zeller) (Lepidoptera: Pyralidae)	Gonzalez Rodriguez, 2003; Herbison-Evans and Crossley, 2007; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003; Robinson et al., 2008
Eotetranychus lewisi (McGregor) (Acari: Tetranychidae)	Bolland et al., 1998; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991
Frankliniella occidentalis (Pergande) (Thysanoptera: Thripidae)	CABI, 2007; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003
Heliothrips haemorroidalis (Bouchè) (Thysanoptera: Thripidae)	CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003
Hemiberlesia lataniae (Signoret) (Hemiptera: Diaspididae)	Ben-Dov et al., 2008, 2012; CABI, 2007; HDOA, 2008; Klein Koch and Waterhouse, 2000
Hemiberlesia palmae (Cockerell) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; Klein Koch and Waterhouse, 2000
Hemiberlesia rapax (Comstock) (Hemiptera: Diaspididae)	Ben-Dov et al., 2008; CABI, 2007; Klein Koch and Waterhouse, 2000; Prado, 1991
Icerya purchasi Maskell (Hemiptera: Margarodidae)	Ben-Dov et al., 2008; CABI, 2007; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003
Lepidosaphes beckii (Newman) (Hemiptera: Diaspididae)	Ben-Dov et al., 2008; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003
Lepidosaphes gloverii (Packard) (Hemiptera: Diaspididae)	Ben-Dov et al., 2008; CABI, 2007; PestID, 2012
Linepithema humile (Mayr) (Hymenoptera: Formicidae)	Klein Koch and Waterhouse, 2000; Vergara et al., 2007
Macrosiphum euphorbiae (Thomas) (Hemiptera: Aphididae)	CABI, 2012; Vergara et al., 2007

Organism	References and/or other notes
Morganella longispina (Morgan) (Hemiptera: Diaspididae)	Ben-Dov et al., 2008, 2012; Klein Koch and Waterhouse, 2000{Watson, 2005 #3028}
Myzus persicae (Sulzer) (Hemiptera: Aphididae)	CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991
Naupactus leucoloma Boheman (syn: *Graphognathus leucoloma* Boheman) (Coleoptera: Curculionidae)	CABI, 2012; Prado, 1991
Nezara viridula (Linnaeus) (Hemiptera: Pentatomidae)	CABI, 2007; Klein Koch and Waterhouse, 2000; Prado, 1991
Panonychus citri (McGregor) (Acari: Tetranychidae)	CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Pantomorus cervinus (Boheman) [syn. *Asynonychus cervinus* (Boheman)] (Coleoptera: Curculionidae)	CABI, 2007, 2012; Gyeltshen and Hodges, 2007; Klein Koch and Waterhouse, 2000; Lamb, 2008; Mitchell, 1973; Prado, 1991; Renato and Larral, 2003
Parlatoria camelliae Comstock (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; Vergara et al., 2007
Parlatoria cinerea Hadden in Doane & Hadden (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; Watson, 2012; non-actionable status for Diaspididae on commodities for consumption (NIS, 2008)
Parlatoria ziziphi (Lucas) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; CABI, 2012; evidence for presence in Chile is based on 52 interceptions on plant material from Chile at U.S. ports-of-entry in passenger baggage and ship stores and quarters (PestID, 2012); non-actionable status for Diaspididae on commodities for consumption (NIS, 2008)
Parthenolecanium persicae (Fabricius) (Hemiptera: Coccidae)	Ben-Dov et al., 2008, 2012; CABI, 2007; Vergara et al., 2007
Peridroma saucia (Hübner) (Lepidoptera: Noctuidae)	CABI, 2012
Phyllocoptruta oleivora (Ashmead) (Acari: Eriophydidae)	CABI, 2012; Klein Koch and Waterhouse, 2000; Prado, 1991
Pinnaspis aspidistrae (Signoret) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; Vergara et al., 2007
Pinnaspis strachani (Cooley) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; Klein Koch and Waterhouse, 2000
Planococcus citri (Risso) (Hemiptera: Pseudococcidae)	Ben-Dov et al., 2008; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003
Polyphagotarsonemus latus (Banks) (Acari: Tarsonemidae)	CABI, 1986, 2007; Renato and Larral, 2003

Organism	References and/or other notes
Pseudococcus calceolariae (Maskell) (Hemiptera: Pseudococcidae)	CABI, 2012; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Renato and Larral, 2003; Vergara et al., 2007
Pseudococcus longispinus (Targioni & Tozzeti) (Hemiptera: Pseudococcidae)	Ben-Dov et al., 2012; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991
Pseudococcus viburni (Maskell) (syn: *P. affinis* Maskell) (Hemiptera: Pseudococcidae)	Ben-Dov et al., 2012; Klein Koch and Waterhouse, 2000
Saissetia coffeae (Walker) (Hemiptera: Coccidae)	Ben-Dov et al., 2008; CABI, 2007; Gonzalez, 1989; HDOA, 2008; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Saissetia oleae (Oliver) (Hemiptera: Coccidae)	Ben-Dov et al., 2008; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000
Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae)	CABI, 2012
Tarsonemus cryptocephalus (Ewing) (Acari: Tarsonemidae)	Brown and Jones, 1983; Delfinado, 1976; Klein Koch and Waterhouse, 2000; Lin and Zhang, 2002
Tetranychus ludeni Zacher (Acari: Tetranychidae)	Bolland et al., 1998; Klein Koch and Waterhouse, 2000
Tetranychus urticae Koch (Acari: Tetranychidae)	Bolland et al., 1998; CABI, 2007; Gonzalez, 1989; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Thrips tabaci (Lindeman) (Thysanoptera: Thripidae)	CABI, 2012; Klein Koch and Waterhouse, 2000; Vergara et al., 2007
Toxoptera aurantii (Boyer de Fonscolombe) (Hemiptera: Aphididae)	CABI, 2007; Klein Koch and Waterhouse, 2000; Prado, 1991; Renato and Larral, 2003
Unaspis citri (Comstock) (Hemiptera: Diaspididae)	Ben-Dov et al., 2012; CABI, 2007
Plant Pathogens	
Alternaria alternata (Fr.) Keissl	Fanta and Pérez, 2004
Alternaria citri (Penz.) Mussat	Farr et al, 2009
Botryosphaeria ribis (Grossenb. & Duggar)	Farr et al, 2009
Botrytis cinerea (Pers)	Farr and Rossman, 2012
Citrus cachexia viroid	Valenzuela et al., 2004
Citrus Psorosis Virus	CABI, 2012
Citrus Tatterleaf Virus (CTLV)	Besoain et al., 2004
Citrus Tristeza Virus (CTV)	Besoain et al., 2004
Cladosporium citri Massee	Farr and Rossman, 2012
Cladosporium herbarum (Pers.) Link	Farr and Rossman, 2012

Organism	References and/or other notes
Colletotrichum gloeosporoides (Penz.) Penz. & Sacc (Teleomorph: *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk)	Farr and Rossman, 2012
Colletotrichum acutatum J.H. Simmonds, (Teleomorph): *Glomerella acutata* Guerber & J.C. Correll	Farr and Rossman, 2012
Dematophora necatrix	Farr and Rossman, 2012
Diaporthe citri F.A. Wolf	CABI, 2012; Farr and Rossman, 2012
Diplodia citricola	Farr and Rossman, 2012
Fusarium oxysporum Schltdl. : Fr.	Farr and Rossman, 2012
Fusarium roseum Link : Fr.	Farr and Rossman, 2012
Globisporangium debaryanum (R. Hesse) Uzuhashi, Tojo & Kakish. ≡ *Pythium debaryanum* R. Hesse	Farr and Rossman, 2012
Haematonectria haematococca (Berk. & Broome) Samuels & Rossman (Anamorph: *Fusarium solani* (Mart.) Sacc.)	Farr and Rossman, 2012, CABI, 2012
Limacinia penzigi Sacc	Farr and Rossman, 2012
Macrophomina phaseolina (Tassi) Goid.	Farr and Rossman, 2012
*Neofusicoccum parvum (*Pennycook & Samuels) Crous, Slippers & A.J.L. Phillips, ≡ *Fusicoccum parvum* Pennycook & Samuels, (Teleomorph: *Botryosphaeria parva* Pennycook & Samuels)	Chile Diaz et al., 2011, Adesemoye, 2011
Penicillium crustaceum Stoll	Farr and Rossman, 2012
Penicillium digitatum (Pers. : Fr.) Sacc.	Farr and Rossman, 2012
Penicillium expansum Link	Farr and Rossman, 2012
Penicillium italicum Wehmer	Farr and Rossman, 2012
*Phoma exiqua (*Sacc)	Farr and Rossman, 2012
Phytophthora citrophthora (R.E. Sm. & E.H. Sm.) Leonian	Vial and Latorre, 2004
Phytophthora cryptogea Pethybr. & Laff	Vial and Latorre, 2004
Phytophthora cactorum (Lebert & Cohn) J. Schröt	Farr and Rossman, 2012
Phytophthora capsici Leonian	Farr and Rossman, 2012

Organism	References and/or other notes
Phytophthora cinnamomi var. *cinnamomi* Rands ≡ *P. cinnamomi* Rands	Farr and Rossman, 2012
Phytophthora inundata Brasier, Sánch. Hern. & S.A. Kirk	Vial et al., 2006
Phytophthora nicotianae Breda de Haan, Syn: *P. parasitica* Dastur	Farr and Rossman, 2012, Vial et al., 2006
Pseudomonas syringae pv. *syringae*	Briceño and Besoain, 2004
Rhizopus stolonifer (Ehrenb. : Fr.) Vuill., Syn: *R. nigricans* Ehrenb.	Farr and Rossman, 2012
Schizothyrium pomi (Mont.) Arx ≡*Leptothyrium pomi* (Mont.) Sacc.	Farr and Rossman, 2012
Sclerotinia sclerotiorum (Lib.) de Bary	Farr and Rossman, 2012
Sclerotium rolfsii Sacc., (Teleomorph): *Athelia rolfsii* (Curzi) Tu & Kimbr.	Farr and Rossman, 2012
Thanatephorus cucumeris (A.B. Frank) Donk (Anamorph): *Rhizoctonia solani* J.G. Kühn	Farr and Rossman, 2012
Tylenchus semipenetrans Cobb	Klein Koch and Waterhouse, 2000
Xiphinema vuittenezi Luc, Lima, Weischer and Flegg	Klein Koch and Waterhouse, 2000
Other Pest Groups	
Helix aspersa	Klein Koch and Waterhouse, 2000