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Risk Assessment for the Importation of Fresh Lemon (*Citrus limon* (L.) Burm. f.) Fruit from Northwest Argentina into the Continental United States

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Executive Summary

This pest risk assessment was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology (USDA, APHIS, PPQ, CPHST). It is a qualitative assessment of the plant pest risk associated with the importation of commercially[1] produced and commercially packed fresh lemon fruit (*Citrus limon* (L.) Burm. f.) from Northwest Argentina (NWA) to the continental United States. The conclusions of this risk assessment are dependent on applying all processes and conditions considered in this analysis.

The present assessment follows a quantitative assessment done by APHIS in 1997 for the importation of citrus (grapefruit, lemons, and oranges) from Argentina. The previous assessment provided the basis for a program authorizing the import of citrus from Argentina beginning in 2000. In 2001, the authorization was successfully challenged in court and imports of citrus from Argentina were suspended.

This assessment is independent of the previous assessment. Although it draws from information in the previous document, this assessment uses a more familiar methodology (the USDA Guidelines for Pathway-Initiated Pest Risk Assessment, Version 5.02) and is limited to lemon. The present pest risk assessment also incorporates important new research, experience, and other evidence gained since 1997.

Based on information from SENASA (Servicio Nacional de Sanidad y Calidad Agroalimentaria, the national plant protection organization for Argentina) and our review of the scientific literature, more than 200 pests were found to be associated with *Citrus* spp. in Argentina. From this list we identified seven pests with a reasonable likelihood of being associated with the commodity following harvesting that were also likely to survive post-harvest processing. We identified three mites that are vectors of *Citrus leprosis virus* (CiLV): *Brevipalpus californicus*, *B. obovatus*, and *B. phoenicis*. One additional mite, *Brevipalpus chilensis* also follows the pathway and is a quarantine pest, however it is unknown if this mite also transmits CiLV. One of these pests is a fruit fly: *Ceratitis capitata* (Wiedemann). Two are Lepidoptera: *Cryptoblabes gnidiella* Millière and *Gymnandrosoma aurantianum* Lima.

Three plant pathogens: *Elsinoë australis* Bitanc. & Jenkins (the causal agent of sweet orange scab), *Phyllosticta citricarpa* (McAlpine) Aa (the causal agent of citrus black spot), and *Xanthomonas citri* subsp. *citri* (ex Hasse 1915) Gabriel et al. were also identified. These pathogens are of limited distribution in the United States and are considered quarantine pests. USDA APHIS conducted pest risk assessments examining the likelihood that these pathogens will spread through the movement of commercial citrus fruit intended for consumption

[1] Commercially produced fruit typically require that fruit be free of leaves, twigs, and other plant parts, except for stems that are less than 1 inch long and attached to the fruit. Fruit may also be washed, brushed, chemically treated for diseases and pests, waxed and culled to exclude overripe, misshaped or blemished fruit. The conclusions for this analysis is dependent on applying these processes. Fruit that is not commercially grown or packed are outside the scope of this risk assessment. See Section 2.2.2 for more information.

(USDA/APHIS, 2009; USDA/APHIS, 2010a; USDA/APHIS, 2010b). USDA APHIS has determined that asymptomatic or commercially packed fruit is not an epidemiologically significant pathway for the introduction and establishment of these pathogens into new areas. For the above reasons these pathogens were not analyzed in the pest risk assessment, however additional import requirements will be specified in the risk management document as a condition of entry for citrus fruit from Argentina to the continental Unites States.

A previous revision of the PRA included the plant pathogens *Xylella fastidiosa* (Wells, et al.) (the causal agent of citrus variegated chlorosis strain) as quarantine pathogen likely to follow the pathway. Additional information relating to this pathogen leads us to conclude that the pathogen is unlikely to follow the fruit pathway. Research finalized in 2014 (Cordeiro et al., 2014), in conjunction with surveys conducted by SENASA (SENASA, 2011) demonstrates that lemon trees are resistant to *Xylella fastidiosa* (Wells, et al.)- citrus variegated chlorosis strain (CVC). Furthermore, research now demonstrates that this bacteria is not seed transmitted in citrus (Cordeiro et al., 2014; Coletta-Filho et al., 2014; Hartung et al., 2014), therefore, fruit is not a pathway for the spread of CVC.

We determined that the following pests are candidates for risk management based on their **pest risk potential**:

Pest type	**Taxonomy**	**Scientific name**	**Pest risk potential**
Acari	Tenuipalpidae	*Brevipalpus californicus, B. obovatus* Donnadieu, and *B. phoenicis* (Geijskes) [vectors of *Citrus leprosis virus* (CiLV) [2]]	Medium
		Brevipalpus chilensis (Banks)	High
Insect	Diptera: Tephritidae	*Ceratitis capitata* (Wiedemann)	High
	Lepidoptera: Pyralidae	*Cryptoblabes gnidiella* (Millière)	Medium
	Lepidoptera: Tortricidae	*Gymnandrosoma aurantianum* (Lima)	Medium
Bacteria		*Xanthomonas citri* subsp. *citri* (ex Hasse) Gabriel *et al*.	Not analyzed [a]
Fungi		*Elsinoë australis* Bitanc. & Jenkins	Not analyzed [a]
		Phyllosticta citricarpa (McAlpine) Aa	Not analyzed [a]

[a] Plant pests with limited distribution and under official control in the United States; therefore additional import requirements may be required.

The risk ratings determined in this analysis are contingent on applying all processes and conditions considered in the analysis. Where uncertainties exist about the full implementation of the prescribed procedures, additional safeguards or phytosanitary measures may be warranted. 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.

[2] CiLV is present in Argentina but does not follow the pathway of commercially produced lemons, except as it is vectored by *Brevipalpus* mites, which are in the pathway.

Table of Contents

EXECUTIVE SUMMARY **2**

1. INTRODUCTION **5**
1.1. Regulatory Authority 5
1.2. Previous Pest Risk Assessments 6

2. RISK ASSESSMENT **7**
2.1. Assessment of Weediness Potential 7
2.2. Pests Associated with *Citrus* spp. in Argentina 7
2.2.1. Pest Categorization– Identification of Quarantine Pests and Quarantine Pests Likely to Follow the Pathway 7
2.2.2. Quarantine Pests Likely to Follow the Pathway 8
2.3. Pest Categorization 38
2.3.1. Fruit Flies 38
2.3.2. Armored Scales 41
2.3.3. Citrus Leprosis Virus and *Brevipalpus* spp. Vectors 42
2.3.4. *Xylella fastidiosa* (Wells, et al.) Citrus variegated chlorosis strain 44
2.3.4. *Elsinoë australis* (the causal agent of sweet orange scab), *Phyllosticta citricarpa* (the causal agent of citrus black spot), and *Xanthomonas citri* subsp. *citri* (the causal agent of citrus canker) 46
2.4. Quarantine Pests Likely to Follow the Pathway 46
2.5. Consequences of Introduction 47
Risk Element 1: Climate–Host Interaction 47
Risk Element 2: Host Range 50
Risk Element 3: Dispersal Potential 51
Risk Element 4: Economic Impact 52
Risk Element 5: Environmental Impact 54
2.6. Likelihood of Introduction. 56
Sub-Element 1: Quantity Imported Annually 56
Sub-Element 2: Harvested Fruit is Infested 57
Sub-Element 3: Survives Packing and Post- Harvest Treatment 58
Sub-Element 4: Survives Shipments 59
Sub-Element 5: Fruit Moved to Suitable Habitat 60
Sub-Element 6: Pest Find Suitable Host and Establish 61
2.7. Pest Risk Potential and Conclusion 63

3. CONTACTS **64**

4. REFERENCES **65**

APPENDIX 1: UPDATES TO THE DRAFT PRA IN RESPONSE TO PUBLIC AND PEER REVIEW COMMENTS. **88**

APPENDIX 2: UPDATES TO THE PRA BETWEEN 2008 AND 2015 IN RESPONSE TO NEW SCIENTIFIC INFORMATION. **91**

1. Introduction

The Plant Epidemiology and Risk Analysis Laboratory (PERAL) of the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology (USDA, APHIS, PPQ, CPHST) prepared this pest risk assessment to examine plant pest risks associated with the importation of commercially produced fresh lemons, *Citrus limon* (L.) Burm. f. (Rutaceae), from Northwest Argentina into the continental United States.

Commercially produced fresh lemons, *Citrus limon* (L.) Burm. f. (Rutaceae), are grown, processed, and packed in accordance with citrus production standards as defined by SENASA (SENASA, 2007a) and verified by USDA-APHIS (USDA/APHIS, 2007a-b). Such practices include washing in detergent, brushing, drying, chemical dips, surface treatment with fungicides, and waxing. The commodity includes short, clipped stems (~ 0.5 cm) and excludes fruit that is over-mature or overripe, dark yellow or bronze in color, damaged, rotted, spotted, or misshapen. Fruit not commercially grown or packed are beyond the scope of this risk assessment.

This assessment estimates risk in qualitative terms– High, Medium, and Low. Details of the methodology and rating criteria can be found in the Guidelines for Pathway-Initiated Pest Risk Assessment, Version 5.02 (USDA-APHIS, 2000). The Guideline is used as a baseline methodology for this PRA. Deviations from the Guideline occur when alternative risk factors more accurately characterize the risk. The majority of pests identified in this risk assessment have ample scientific information regarding field control and monitoring programs. This information allowed us to characterize the probability that harvested fruit will be infested. Sub element 2: Harvested fruit is infested; has therefore been added to the risk assessment.

This risk assessment uses a summation of values from risk elements to arrive at a pest risk potential of High, Medium, or Low as defined in the Guidelines. To retain consistency in the application of the rating scale, we remove a risk element from the PRA to counter the additional risk element. In examining the available information for risk element 4: Not be detected at the port of entry (as stated in the Guidelines), we determined this element informed the risk the least, due to the absence of reliable information on this element for most pests and was thus removed from the analysis.

The International Plant Protection Convention (IPPC) provides guidance for conducting pest risk analyses. The methods used for this assessment are consistent with guidelines provided by IPPC and the use of biological and phytosanitary terms conforms to the IPPC Glossary of Phytosanitary Terms (IPPC, 2007). The IPPC guidelines describe three stages of pest risk analysis: Stage 1, Initiation; Stage 2; Risk Assessment; and Stage 3, Risk Management. This document addresses the requirements of Stages 1 and 2.

1.1. Regulatory Authority

Under Title IV of the Agricultural Risk Protection Act of 2000, also known as the Plant Protection Act (Pub. L. 106-224, 114 Stat. 438, 7 U.S.C. 7701-7772), the USDA has broad authority to regulate the importation and interstate movement of organisms that may directly or indirectly injure, damage, or cause disease in plants. This Act repeals 11 previous laws and

replaces them with one statutory framework that enables the USDA to prohibit or restrict imports, exports, or interstate movements of plant pests, plants, plant products, noxious weeds, biological control agents, and means of conveyance. In a final rule published in the Federal Register on August 14, 2000 (65 FR 49471-49472, Docket No. 00-063-1) the Secretary of Agriculture delegated to the Animal and Plant Health Inspection Service (APHIS) the authority to carry out the Plant Protection Act.

Quarantine 19 (7 CFR § 319.19, *Citrus Canker and Other Citrus Diseases*) prohibits the importation of citrus plants or plant parts except fruit into the United States. Quarantine 28 (7 CFR § 319.28, *Citrus Fruit*) prohibits the importation of citrus fruit from most countries where certain diseases occur, including Argentina. Quarantine 28 further promulgates a general prohibition against the importation of citrus fruit from countries where citrus canker disease occurs. Quarantine 56 (§ 319.56) allows importation, under strict requirements, of citrus fruit from certain countries, e.g., Japan, where citrus canker is present.

1.2. Previous Pest Risk Assessments

APHIS previously allowed the importation of citrus from Argentina, beginning in June 2000, based on a quantitative risk assessment (USDA, 1997). In September 2001, the authorization was successfully challenged in court and importation was stopped.

The risk assessment completed by APHIS in 1997 was for citrus (grapefruit, lemon, and orange). Citrus canker was not present in NWA at that time. Since 2002, Argentina's National Plant Protection Organization (SENASA) has reported outbreaks of citrus canker in the export zone previously considered free of the disease.

The present risk assessment is for the importation of commercially grown and packed fresh *Citrus limon* (L.) Burm. f. (Rutaceae) fruit from Northwest Argentina into the continental United States. Northwest Argentina (NWA) includes the provinces of Salta, Tucuman, Jujuy, and Catamarca. Commercial production areas and packinghouses approved for export in these provinces are defined by SENASA through a system of registration that is required in Argentina for traceability (http://www.sinavimo.gov.ar).

This assessment is independent of the previous assessment. It draws from information in the previous assessment as a baseline for pest listing, but it uses the 5.02 methodology and is limited to lemon. The present pest risk assessment also incorporates important new research, experience, and other evidence gained since 1997. The pest list has been substantially updated based on new information provided by SENASA or found by APHIS. New information and experience has also contributed to a better understanding of several important pests of quarantine concern.

2. Risk Assessment

2.1. Assessment of Weediness Potential

We found no evidence that *Citrus* species have significant potential as weeds. Table 1 shows how weediness potential was assessed and presents the results for *Citrus limon*.

Table 1. Weediness potential of *Citrus limon* (L.) Burm f.

Plant Species: ***Citrus limon* (L.) Burm. f. (Rutaceae) = Lemon**

Phase 1: Consider whether the genus is new to or not widely prevalent in the United States (exclude plants grown under USDA permit in approved containment facilities)

***Citrus limon* (L.) Burm. f. (lemon)** is grown in Arizona, California, Texas, Louisiana, and Florida (NRCS, 2012).

Phase 2: Weediness Potential

Is *Citrus* listed in:

NO *Geographical Atlas of World Weeds* (Holm et al., 1979)
NO *World's Worst Weeds* (Holm et al., 1977)
NO *Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act* (Gunn and Ritchie, 1982)
NO *Economically Important Foreign Weeds* (Reed, 1977)
NO Weed Science Society of America list (WSSA, 1989)

YES Is there any reference in the scientific literature indicating potential weediness (e.g., *AGRICOLA*, *CAB*, *Biological Abstracts*, *AGRIS*; Internet search")? Randall (2002) listed the species with the following status: *C. limon*: weed, naturalized, garden escape, environmental weed, cultivation escape, casual alien (Randall, 2002).

Phase 3: Conclusion

Various species of *Citrus*, including *C. sinensis*, *C. x paradise*, and *C. limon*, are grown throughout the United States. The evidence does not indicate strong tendencies for *Citrus limon* to be potentially invasive or a noxious weed.

2.2. Pests Associated with *Citrus* spp. in Argentina

2.2.1. Pest Categorization– Identification of Quarantine Pests and Quarantine Pests Likely to Follow the Pathway

Our procedures are based on ISPM 11 (IPPC, 2004, 2007 ; IPPC, 2007). The first step in identifying quarantine pests is to present a comprehensive list of pests known to occur in the country or region from which the commodity is to be exported. The list includes all pests in the exporting country associated with the proposed export commodity. Because all pests on the list are associated with the plant species, they are considered to be “of potential economic importance” (IPPC, 2007). The listed pests may or may not also occur in the United States. Comprehensive pest lists are developed because of the dynamic nature of quarantine species (for example, species are introduced into new territories or eradication programs change their distribution).

There are two primary components to the definition of a quarantine pest (IPPC, 2007). First, a pest must be "of potential economic importance" to be included on the comprehensive list of potential quarantine pests. An organism is considered to be of potential economic importance if evidence demonstrates that the organism is harmful and has an association with the plant species being assessed. Second, to be considered a quarantine pest, an organism must satisfy geographic and regulatory criteria; specifically, the pest must not yet be present in the area being assessed, or if present, it should be under official control (IPPC, 2007).

The risk assessment documents the evidence used to determine how each organism satisfies the defining criteria for a quarantine pest. Pertinent geographic and regulatory information with respect to the exporting country and the United States is provided on the comprehensive pest list. If none of the listed pests satisfy the geographic and regulatory criteria for a quarantine pest, further assessment is not necessary. Table 2 shows the comprehensive pest list for *Citrus limon* from Argentina.

The pest list identifies the presence or absence of these pests in the United States, the generally affected plant part or parts, the quarantine status of the pest with respect to the United States, whether the pest is likely to enter the United States on commercially exported *Citrus limon*, and pertinent citations for the distribution and biology of the pest. A pest is considered to "follow the pathway" if it is associated with the commodity and likely to survive with the commodity until entry into the United States.

2.2.2. Quarantine Pests Likely to Follow the Pathway

Quarantine pests identified as likely to be associated with the potential export commodity are subject to Steps 5-7 of the USDA Guidelines. The biology and pest potential for these pests are documented as appropriate to inform the risk assessment; it is therefore reasonable to assume that these quarantine pests:

- will be present in the exporting country;
- will be associated with the commodity at the time of harvest; and
- will remain with the commodity in a viable form during harvesting, packing, and shipping procedures.

Because all pests associated with the plant species are listed, some quarantine pests are unlikely to follow the pathway. For example:

- a pest may be only associated with plant parts other than the plant part that is harvested and shipped, or
- a pest may not be reasonably likely to remain with the commodity during harvest and packing.

The status of the pests listed in Table 2 assumes that the commodity will be commercially produced. Commercially produced fruit are grown, processed, and packed in accordance with citrus production standards defined and regulated by SENASA (SENASA, 2007a) and verified by USDA-APHIS (USDA/APHIS, 2007a-b). Such practices typically include fruit be free of leaves, twigs, and other plant parts, except for stems that are less than 1 inch long and attached to the fruit. Fruit may also be washed, brushed, chemically treated for diseases and pests, waxed and culled to exclude overripe, misshaped or blemished fruit. The production standards proposed

by SENASA are based on a similar systems currently in use for exports of lemons to the EU (SENASA, 2007a; SENASA, 2004). SENASA has been successfully overseeing the production of lemons to the EU for numerous years with no notable compliance issues. USDA-APHIS observed and verified the inclusion of these practices and SENASA's current EU export program oversight during a technical visit to citrus production areas in NWA in 2007 (USDA/APHIS, 2007a-a). The USDA team reviewed production systems, research related to citrus pests to verify elements of the initial version (August 6, 2007) of the PRA, and review phytosanitary measures proposed by SENASA as part of its request to reinitiate exports to the United States (SENASA, 2007a).

Quarantine pests were the focus of observations during the site visit, but the entire production program in NWA, including all phytosanitary measures, were investigated and the observations documented (USDA/APHIS, 2007a-a). As part of the site visit, the USDA team traveled to the province of Tucumán (the center of citrus production in NWA) with SENASA representatives and had opportunities to visit with NPPO field representatives, industry leaders, growers, packinghouse operators, and administration officials. The team found that significant changes in the national plant protection organization had occurred since 2001 when the authorization of citrus from Argentina was successfully challenged in court and importation was stopped. A key change SENASA has implemented is a national survey system and a system to report the occurrence of exotic diseases as well as tracking domestic programs. The SENASA has also boosted support for research organizations. The USDA-APHIS team was able to review research available at the time and found that independent research supported by SENASA was conducted with scientific rigor and was well coordinated and carried out.

Due to the condition of the commodity (i.e. commercially produced fruit) surface feeding pests are not likely to remain in the pathway. In general, washing with detergent and brushing on the packing line are designed to remove dirt and surface insect pests from the fruit. The physical agitation of brushing alone, with no water, removes surface pests. For example, one study examining the effect of brushing on adult Asian Citrus Psyllids (ACP) on oranges found that brushing the fruit without any water removed the majority of adult ACP. Specifically, out of 132 individuals observed in the study, only one individual survived the brushing process (Dossey et al., 2010). In another study, Hansen et al. (2006) determined that brushing was effective at removing spider mites from pome fruits on the packing line. Washing the fruit with soaps and detergents in addition to brushing, removes dirt, sooty mold, scales, spray residues and most of the fruit's natural wax (Wagner and Sauls, 2007). Soaps are effective in killing or removing most small, soft-bodied arthropods, such as aphids, young scales, whiteflies, psyllids, mealybugs, and spider mites (Cranshaw, 2008). Soaps and detergents may remove the protective waxes that cover the insect, causing death through excess loss of water (Cranshaw, 2008). The principal value of soap lies in its capacity to disrupt the cuticle and break down cell membranes resulting in rapid death of insects and mites. With its surface tension much reduced, water readily penetrates insect spiracles, reducing oxygen availability. Thus, a part of soap's mode of action is the "drowning" of exposed insects (Ware and Whitacre, 2004). Waxing the fruit has been demonstrated to further reduce the numbers of surface pests that may be introduced via commercial fruit (Gould and McGuire, 2000). Based on this evidence surface feeding pests are not likely to follow the pathway of commercially produced fruit.

Pests highly unlikely to follow the pathway are not further considered. Supporting information must be documented on the pest list or in the text. The decision to not further analyze a particular pest only applies to the current assessment; a pest may pose a different level of risk for the same commodity from a different country, or for a different commodity (e.g., propagative cuttings) from the same host plant species. If any of the pests should be intercepted in commodity shipments, quarantine action may be taken at the port-of-entry and additional risk analyses may be conducted. Finally, the status of a pest may change (that is, global population dynamics result in changes in the distribution of pests) and the current document may need to be updated if significant changes occur in the future. A significant change would include the appearance of a new serious quarantine pest species in the exporting country or changes in the quarantine status of an existing pest if that organism becomes established in the United States and is deregulated.

Table 2. Pests associated with *Citrus* spp. in Argentina.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
ARTHROPODS					
Acari: Eriophyidae					
Aceria sheldoni (Ewing) [=*Eriophyes sheldoni* (Ewing)]	AR, US (CA, FL, HI)	Buds, fruit	No	No[3]	CABI, 2012; Jeppson et al., 1975
Phyllocoptruta oleivora (Ashmead)	AR, US	Leaves, fruit, stems	No	No[4]	Chiesa Molinari, 1948; Jeppson et al., 1975; Ebeling, 1959
Acari: Tarsonemidae					
Polyphagotarsonemus latus (Banks)	AR, US	Flowers, leaves, fruit, shoots, stems	No	No[4]	CABI, 2012
Acari: Tenuipalpidae					
Brevipalpus obovatus Donnadieu [=*Tenuipalpus pseudocuneatus*][4]	AR, US	Leaves, fruit, stems	Yes[5]	Yes[6]	Childers, 1994; CABI, 2012; Chiesa Molinari, 1948; Jeppson et al., 1975

[3] Surface feeders are highly unlikely to remain associated with the commodity or the pathway through washing with detergent, brushing, drying, waxing, and culling, which are part of standard commercial processing on the packing line. See Section 2.2.2 for more information.

[4] Pests in shaded rows are quarantine pests likely to follow the pathway and are analyzed further.

[5] The *Brevipalpus* mites (*B. californicus*, *B. obovatus*, and *B. phoenicis*) already occur in the United States, but because they are vectors of a quarantine disease, Citrus leprosis virus (CiLV), APHIS regulates these mites from infected regions.

[6] *Brevipalpus* spp. is a vector for the pathogen Citrus leprosis virus, which is present in Argentina. *Brevipalpus* spp. are surface feeders that may be removed from the pathway through washing with detergent, brushing, drying, waxing, and culling, which are part of standard commercial processing in the packinghouse. Based on evidence that some mites may survive standard packinghouse procedures (e.g. Undurraga and Lopez, 1992; GC-SAG, 2002), APHIS determined, that a specific requirement was needed for washing with detergent to be consistent with the approved PPQ treatment (7CFR 319.56-38 (7 CFR § 319.56-38, 2012)) designed to mitigate *Brevipalpus chilensis*. *Brevipalpus* spp. was never intercepted on commercial citrus shipped from Argentina during the period of allowed entry. See section 2.3 for more information.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Brevipalpus phoenicis (Geijskes)[5]	AR, US	Leaves, fruit, stems	Yes[6]	Yes[7]	CABI, 2012
Brevipalpus californicus (Banks)[5]	AR, US	Leaves, fruit, stems	Yes[6]	Yes[7]	Jeppson et al., 1975
Brevipalpus chilensis Baker[5]	AR	Leaves, fruit, stems	Yes	Yes	CABI, 2012; EAN, 2009
Acari: Tetranychidae					
Bryobia rubrioculus (Scheuten)	AR, US	Leaves	No	No	Bolland et al., 1998
Eutetranychus banksi (McGregor)	AR, US	Leaves	No	No	Jeppson et al., 1975; Migeon and Dorkeld, 2007
Panonychus citri (McGregor)	AR, US	Fruit, leaves, shoots, stems	No	No[7]	CABI, 2012
*Panonychus ulmi (*Koch)	AR, US	Leaves	No	No	CABI, 2012; Bolland et al., 1998
Tetranychus cinnabarinus (Boisduval)	AR, US	Leaves	No	No	Maes, 2004; Bentancourt and Scatoni, 1999; CABI, 2012
Tetranychus mexicanus (McGregor)	AR, US	Leaves	No	No	Bolland et al., 1998
Tetranychus urticae (Koch)	AR, US	Leaves	No	No	Bolland et al., 1998
Insecta					
Coleoptera: Anthribidae					
Araecerus fasciculatus (DeGeer)	AR, US	Fruit, roots, seeds, stems	No	Yes	CABI, 2012
Coleoptera: Brentidae					
Brenthus anchorago Brehm	AR, US	Branches	No	No	Chiesa Molinari, 1948; Blatchley and Leng, 1916
Coleoptera: Bostrichidae					
Dexicrates robustus (Blanchard)	AR	Wood	Yes	No	Prado, 1991; Koch and Waterhouse, 2000
Coleoptera: Cerambycidae					
Ancylocera cardinalis (Dalman)	AR	Wood	No	No	Duffy, 1960; Harvard, 2006
Diploschema rotundicolle (Serville)	AR	Wood	Yes	No	Bentancourt and Scatoni, 1999
Eburia octoguttata Germar	AR	Wood	Yes	No	Chiesa Molinari, 1948
Eburia sordida Burmeister	AR	Wood	Yes	No	Chiesa Molinari, 1948

[7] Surface feeders are highly unlikely to remain associated with the commodity or the pathway through washing with detergent, brushing, drying, waxing, and culling, which are part of standard commercial processing on the packing line. See Section 2.2.2 for more information.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Macropophora accentifer (Olivier)	AR	Wood	Yes	No	Chiesa Molinari, 1948; Duffy, 1960
Mallodon spinibarbis Linnaeus	AR	Wood	Yes	No	Maes, 2004; Bentancourt and Scatoni, 1999
Rhopalophora collaris (Germar)	AR	Wood	Yes	No	Chiesa Molinari, 1948; Duffy, 1960
Stenodontes spinibarbis (L.)	AR	Wood	Yes	No	Carrasco, 1978; Chiesa Molinari, 1948; Duffy, 1960
Trachyderes striatus (F.)	AR	Wood	Yes	No	Duffy, 1960
Trachyderes succinctus (L.)	AR	Wood	Yes	No	Duffy, 1960; Kliejunas et al., 2001; Chiesa Molinari, 1948
Trachyderes thoracicus (Olivier)	AR	Wood, fruit	Yes	No[8]	Duffy, 1960; Kliejunas et al., 2001
Coleoptera: Chrysomelidae					
Diabrotica marginata (Harold)	AR	Flowers	Yes	No	Chiesa Molinari, 1948
Diabrotica significata Gahan	AR	Flowers	Yes	No	Chiesa Molinari, 1948
Diabrotica speciosa (Germar)	AR	Leaves, flowers, fruit, roots, shoots, stems	Yes	No[9]	CABI, 2012
Coleoptera: Curculionidae					
Brachystylodes pilosus (Hustache)	AR	Leaves	Yes	No	Costilla, 1994
Naupactus xanthographus (Germar)	AR	Leaves, roots, shoots	Yes	No	Bosq, 1934; Whitehead and Whittle, 1985
Pantomorus cervinus (Boheman)	AR, US	Leaves, roots, stems	No	No	CABI, 2012; Metcalf and Metcalf, 1993b; Wibmer and O'Brien, 1986
Rhynchophorus palmarum (Linnaeus)	AR	Fruit, flowers, leaves, stems	Yes	No[10]	CABI, 2012; EPPO_CABI, 2006

[8] Only adults feed on the fruit surface (Duffy, 1960). Adults are highly mobile (Duffy, 1960) and are highly unlikely to remain on the fruit through harvest.

[9] Only adults feed on the fruit surface (CABI, 2012). Adults are highly mobile and are highly unlikely to remain on the fruit through harvest.

[10] Only *Rhynchophorus palmarum* adults feed on the surfaces of citrus fruit, without causing economic damage. These adult insects are large, conspicuous (black, 4–5 cm in length, approx. 1.4 cm wide, weigh 1.6–2 g), and highly mobile (EPPO_CABI, 2006), and therefore are highly unlikely to remain on fruit after harvest and commercial processing.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Coleoptera: Nitidulidae					
Lobiopa insularis Laporte	AR, US	Fruit	No	Yes	Maes, 2004; Kelts, 2005; Lima and Davies, 1981
Coleoptera: Platypodidae					
Megaplatypus mutates (Chapuis) (syn: *Platypus sulcatus* (Dejean))	AR	Wood	Yes	No	Chiesa Molinari, 1948; Costilla and Venditti, 1992
Platypus parallelus (Fabricius)	AR, US	Wood	No	No	Maes, 2004; Atkinson, 2011
Platypus wesmaeli (Chapuis)	AR	Wood	Yes	No	Chiesa Molinari, 1948
Coleoptera: Scarabaeidae					
Inca clathrata ssp. sommeri Westwood	AR	Decaying wood	Yes	No	Maes, 2004; Mico et al., 2008
Macrodactylus pumilio (Burmeister)	AR	Flowers, leaves, twigs	Yes	No	Blackwelder, 1945; Mariconi and Zamith, 1962
Coleoptera: Scolytidae					
Hypothenemus crudiae (Panzer)	AR, US	Wood	No	No	Maes, 2004; Mercado, 2010
Xyleborus volvulus (Fabricius)	AR, US	Wood	No	No	CABI, 2012
Diptera: Muscidae					
Atherigona orientalis (Schiner)	AR, US	Fruit, leaves, shoots, stems, roots	No	Yes	CABI, 2012
Diptera: Tephritidae					
Anastrepha alveatoides (Blanchard) [11]	AR	Fruit	Yes	No[12]	Norrbom and Kim, 1988; Oroño et al., 2006
Anastrepha chiclayae (Greene)[12]	AR	Fruit	Yes	No[13]	CABI, 2012; Norrbom and Kim, 1988
Anastrepha daciformis (Bezzi)[12]	AR	Fruit	Yes	No[13]	Norrbom and Kim, 1988; Oroño et al., 2006

[11] Citrus is listed as a doubtful host (Norrbom, 2004), but we included this fruit fly in the pest list as a precaution.

[12] Some uncertainty is associated with host usage because "*Citrus* sp." is listed as a host by Norrbom (2004), but the author did not list *Citrus limon* as a host. Based on the lack of detection of any of these species by Augier et al., 2007a; Stein, 2008) in Argentine lemons, and the lack of APHIS interception records of any of these species in *Citrus* spp. or lemons, APHIS does not consider lemons a pathway for these species.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Anastrepha fraterculus (Wiedemann)	AR, US (TX)[13]	Fruit	Yes	No[14]	Oroño et al., 2006; Norrbom and Kim, 1988; CABI, 2012 Jiron et al., 1988; Rizzo, 1977; Rosillo and Portillo, 1971
Anastrepha grandis (Macquart)[12]	AR	Fruit	Yes	No[13]	CABI, 2012; Norrbom, 2004
Anastrepha obliqua (Macquart)	AR[15]	Fruit	Yes	No[16]	Norrbom and Kim, 1988; CABI, 2012
Anastrepha punctata (Hendel)[12]	AR	Fruit	Yes	No[13]	Norrbom and Kim, 1988
Anastrepha rosilloi (Blanchard)[12]	AR	Fruit	Yes	No[13]	Norrbom and Kim, 1988
Anastrepha schultzi (Blanchard)[12]	AR	Fruit	Yes	No[13]	Norrbom and Kim, 1988; Oroño et al., 2006
Anastrepha serpentina (Wiedemann)	AR	Fruit	Yes	No[17]	CABI, 2012; Norrbom, 2003; Norrbom and Kim, 1988

[13] Foote et al., (1993) and White and Elson-Harris (1992) include South Texas in the distribution of *A. fraterculus*. However, the flies trapped occasionally in South Texas and identified as *A. fraterculus* are considered to be distinct from the *A. fraterculus* (South American fruit fly) found in Argentina and other South American countries (personal communication A. Norrbom, R. L. Mangan). The fruit flies identified as *A. fraterculus* in South America do not occur in the United States. Any pests periodically detected within Texas are transients that would trigger an APHIS official control and eradication program.

[14] *Citrus limon* is not a host of *A. fraterculus*. See Section 2.3 below for further information on its non-host status.

[15] In 2012, the NPPO of Argentina reported to EPPO that neither *Anastrepha obliqua* nor *Anastrepha serpentina* occur in Argentina (EPPO, 2011). Argentina reported to EPPO that the record of *A. serpentina* was based on a misidentification, and the specimens collected in Argentina believed to be *A. oblique* were misidentifications. Furthermore Argentina reported that neither *A. obliqua* or *A. serpentina* have been found during the regular surveys for fruit flies carried out in Argentina (EPPO, 2011). APHIS has not yet had the opportunity to review any official survey data from Argentina that demonstrates that these fruit flies are in fact absent from the area. While we continue to review the evidence placing these pests in Argentina they will remain on the pest list. We note that neither species is likely to follow the pathway of commercially produced lemons as stated in footnotes 17 and 18.

[16] USDA-APHIS does not consider *Citrus* spp. a host for this fruit fly (7 CFR § 301.32). This is based on literature records and interception records as recorded in 2004 at www.aphis.usda.gov/plant_health/plant_pest_info/fruit_flies/downloads/obliquahosts112904.pdf. Uramoto et al., 2004 stated that three individuals came from *Citrus* spp. in Brazil, but that they were from an urban setting, not commercial fruit; they were not stated to be lemons; and the quality of the fruit was not recorded (e.g., fallen, damaged, overripe, etc.). Based on the uncertainty of this additional record, the lack of detection of this species (Augier et al., 2007a; Stein, 2008) in Argentine lemons, and the lack of APHIS interception records of this species in citrus or lemons. APHIS does not consider lemons a pathway for this species.

[17] USDA-APHIS does not list *Citrus limon* as a host for this fruit fly, although, *Citrus* spp. are listed (7 CFR § 301.32). Norrbom (2004) does not list *Citrus limon* as a host. Based on the lack of detection of this species (Augier et al., 2007a; Stein, 2008) in Argentine lemons and the lack of APHIS interception records of this species in citrus or lemons, APHIS does not consider lemons a pathway for this species. Inspection for *Anastrepha* spp. in imported lemons is ongoing.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Anastrepha spp.	AR	Fruit	Yes	No[18]	Rizzo, 1977
Ceratitis capitata (Wiedemann)[19]	AR, US (HI)	Fruit	Yes	Yes	CABI, 2012; Rizzo, 1977; Rosillo and Portillo, 1971
Tomoplagia costalimai (Wiedemann)	AR	Fruit	Yes	No[20]	Aczél, 1955; Garcia et al., 2003
Tomoplagia phaedra (Wiedemann)	AR	Fruit	Yes	No[20]	Aczél, 1955; Garcia et al., 2003
Hemiptera: Aleyrodidae					
Aleurothrixus aepim (Goldi)	AR	Leaves	Yes	No	Queiroz and Oliveira, 2001; Evans, 2008
Aleurothrixus porteri Quaintance & Baker	AR	Leaves	Yes	No	Pierce, 1918; Evans, 2008
Aleurocathus woglumi (Ashby)	AR, US (FL, HI, TX)	Leaves	Yes	No	CABI, 2012; Browning et al., 1995; Miller et al., 2000
Aleurothrixus howardi (Quaintance) [=*A. floccosus* (Maskell)]	AR, US (CA, FL, HI, TX, US VI)	Leaves	No	No[21]	Browning et al., 1995; CABI, 2012; Chiesa Molinari, 1948; Metcalf et al., 1962; Metcalf and Metcalf, 1993b; Mound and Halsey, 1978; Rizzo, 1977
Bemisia tabaci (Gennadius)	AR, US	Leaves	No[22]	No	CABI, 2012
Dialeurodes citri (Ashmead)	AR, US	Leaves	No	No	CABI, 2012; Browning et al., 1995
Dialeurodes citrifolii (Morgan)	AR, US	Leaves	No	No	CABI, 2012; Browning et al., 1995
Paraleyrodes citri Bondar	AR, US	Leaves	Yes	No	Anciso et al., 2002; Bentancourt and Scatoni, 1999; Garcia Garcia et al., 1992
Paraleyrodes proximus Teran	AR	Leaves	Yes	No	Valencia, undated; Evans, 2008

[18] *Anastrepha* spp. are unlikely to follow the pathway for lemons due to the various reasons listed for the 10 species of *Anastrepha* on this pest list.
[19] Pests in shaded rows are quarantine pests likely to follow the pathway and are analyzed further.
[20] Aczél (1955) reported that both of these species attack sweet orange and guava fruit. While little is known on the specific life cycle of Tomoplagia spp. all species that have been reared were from flower heads or in galls of species of Asteraceae (Foote et al., 1993). Foote et al., 1993, considered reports of fleshy fruit as hosts doubtful.
[21] Pests are highly unlikely to survive post-harvest cleaning, chemical dip, and waxing. See Section 2.2.2 for more information.
[22] *Bemisia tabaci* is only actionable on tomatoes from the Dominican Republic (PestID, 2012).

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Hemiptera: Aphididae					
Aphis citricola van der Goot	AR, US	Leaves, shoots	No	No	Maes, 2004; WSU, undated
Aphis craccivora (Koch)	AR, US	Leaves, shoots	No	No	CABI, 2012
Aphis fabae (Scopoli)	AR, US	Flower, leaves, shoots	No	No[21]	CABI, 2012
Aphis gossypii (Glover)	AR, US	Flowers, leaves, stems, shoots	No	No	CABI, 2012; Metcalf and Metcalf, 1993b; Palmer, 1952; Rizzo, 1977
Aphis nerii Boyer de Fonscolombe	AR, US	Leaves	No	No	CABI, 2012; Stoetzel, 1994
Aphis spiraecola (Patch)	AR, US	Leaves, fruit, flowers, shoots, stems	No	No[21]	CABI, 2012
Aulacorthum solani Kaltenbach	AR, US	Leaves, Stems	No	No	CABI, 2012; Nearctica, 2007
Brachycaudus helichrysi (Kaltenbach)	AR, US	Leaves, fruit, shoots	No	No[21]	CABI, 2012
Macrosiphum euphorbiae (Thomas) [=*M. solanifolii*]	AR, US	Leaves, stems	No	No	CABI, 2012; Metcalf et al., 1962; Metcalf and Metcalf, 1993b; Palmer, 1952; Rizzo, 1977
Macrosiphum gei (Koch)	AR, US	Leaves	No	No	Palmer, 1952; Chiesa Molinari, 1948
Myzus persicae (Sulzer)	AR, US	Flowers, leaves, shoots	No	No	CABI, 2012; Chiesa Molinari, 1948; Palmer, 1952
Rhopalosiphum maidis (Fitch)	AR, US	Leaves, shoots, stems	No	No	CABI, 2012
Toxoptera aurantii Boyer de Fonscolombe	AR, US	Leaves, flowers	No	No	CABI, 2012; Bentancourt and Scatoni, 1999
Toxoptera citricidus (Kirkaldy) (=*T. citricida*)	AR, US (FL, HI)	Leaves	Yes	No	Blackman and Eastop, 1994; Brown et al., 1988; CABI, 2012; EPPO/CABI, 1997d; Rizzo, 1977
Hemiptera: Cicadellidae					
Acrogonia flaveoloides Young	AR	Leaves, shoots	Yes	No	de Coll et al., 1998
Bahita spiniventris Linnavuori	AR	Leaves, shoots	Yes	No	de Coll et al., 1998

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Bucephalogonia xanthophis (Berg)	AR	Shoots	Yes	No	Beltrán et al., 2004; Redak et al., 2004
Ceresa ustulata Fairmaire	AR	Leaves, shoots	Yes	No	de Coll et al., 1998
Chlorotettix latocinctus DeLong	AR	Leaves, shoots	Yes	No	de Coll et al., 1998
Chlorotettix minimus Baker	AR	Leaves, shoots	Yes	No	de Coll et al., 1998
Ciminius platensis (Berg)	AR	Leaves	Yes	No	Remes-Lenicov et al., 1999; Ferreira et al., 2003
Curtara concava (De Long & Freytag)	AR	Leaves, shoots	Yes	No	Beltrán et al., 2004; Dietrich, 2008
Curtara samera DeLong & Freytag	AR	Leaves, shoots	Yes	No	de Coll et al., 2000
Diedrocephala variegata (Fabricius)	AR	Leaves, shoots	Yes	No	Beltrán et al., 2004; Dietrich, 2008
Dilobopterus costalimai Young	AR	Leaves, shoots, stems	Yes	No	Beltrán et al., 2004; Redak et al., 2004
Empoasca spp.	AR	Leaves	Yes	No	CABI, 2012
Entylia carinata (Forster)	AR, US	Leaves, shoots	No	No	de Coll et al., 2000
Frequenamia spiniventris Linnavuori & DeLong	AR	Leaves shoots	Yes	No	Beltrán et al., 2004; Dietrich, 2008
Hortensia similis Walker	AR	Leaves shoots	No	No	Beltrán et al., 2004; de Coll et al., 1998
Macugonalia cavifrons Stål	AR	Leaves, shoots	Yes	No	de Coll et al., 2000
Macugonalia leucomelas (Walker)	AR	Leaves, shoots	Yes	No	Redak et al., 2004
Molomea consolida Schröder	AR	Leaves, shoots	Yes	No	de Coll et al., 2000
Molomea lineiceps Young	AR	Leaves, shoots	Yes	No	Beltrán et al., 2004; Dietrich, 2008
Oncometopia facialis Signoret	AR	Leaves, shoots	Yes	No	Virla et al., 2008
Oncometopia tucumana Schröder	AR	Leaves, shoots	Yes	No	Virla et al., 2008
Rotigonalia limbatula (Osborn)	AR	Leaves, shoots	Yes	No	de Coll et al., 2000
Scaphytopius bolivianus Om.	AR	Leaves, shoots	Yes	No	de Coll et al., 2000
Scopogonalia subolivacea Stål	AR	Leaves, shoots	Yes	No	de Coll et al., 1998

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Sibovia sagata (Signoret)	AR	Leaves, shoots	Yes	No	de Coll et al., 2000
Sonesimia grossa Signoret	AR	Leaves, shoots	Yes	No	Beltrán et al., 2004; de Coll et al., 1998
Stirellus picinus f. *elegantulus* Linn	AR	Leaves, shoots	Yes	No	de Coll et al., 1998
Hemiptera: Coccidae					
Ceroplastes grandis (Hempel)	AR	Stems	Yes	No	Chiesa Molinari, 1948; Rizzo, 1977
Ceroplastes rusci (L.)	AR, US (FL)	Leaves, shoots, stems	Yes	No	Avidov and Harpaz, 1969; Hamon and Mason, 2001
Ceroplastes sinensis (Del Guercio)	AR, US (CA, NC, PA, VA)	Leaves, stems	Yes	No	Ben-Dov et al., 2012; Ebeling, 1959; Hamon and Williams, 1984; Kosztarab, 1996; Rizzo, 1977
Ceroplastes subrotunda Leonardi (Syn. *Ceroplastidia subrotunda*)	AR	Leaves, stems, shoots[23]	Yes	No	Ben-Dov et al., 2012; Hamon and Williams, 1984; Granara de Willink and Claps, 2003
Coccus hesperidium (L.) [=*Lecanium hesperidum*]	AR, US	Leaves, stems	No	No	Ebeling, 1959; Granara de Willink and Claps, 2003; Hamon and Williams, 1984; Rizzo, 1977
Coccus perlatus (Cockerell)	AR	Leaves	Yes	No	Bentancourt and Scatoni, 1999
Eulecanium perinflatum (Cockerell)	AR	Stems	Yes	No	Chiesa Molinari, 1948; Panizzi, 1997
Parasaissetia nigra (Nietner)	AR, US	Leaves, stem	No	No	CABI, 2012
Parthenolecanium corni (Bouché)	AR, US	Leaves, shoots, stems	No	Yes	CABI, 2012
Parthenolecanium perlatum (Cockerell) [=*Lecanium deltae* (Lizer y Trelles); *Mesolecanium deltae* (Lizzy y Trelles)*; Coccus perlatus* (Fernald)]	AR	Leaves	Yes	No	Ben-Dov, 1993; Chiesa Molinari, 1948; Granara de Willink and Claps, 2003; Rizzo, 1977

[23] Due to lack of specific biological information on *Ceroplastes subrotunda*, plant parts affected are based off of closely related species *C. rusci* and *C. sinensis.*

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Parthenolecanium persicae (Fabricius)	AR, US	Leaves, stems	No	No	CABI, 2012; Granara de Willink and Claps, 2003
Pulvinaria flavescens (Brethes)	AR	Leaves	Yes	No	Chiesa Molinari, 1948; Kitayama, 1993
Saissetia coffeae (Walker) [=*S. hemisphaerica*]	AR, US	Fruit, leaves, stems	No	Yes	CABI, 2012; Chiesa Molinari, 1948; Rizzo, 1977
Saissetia neglecta (DeLotto)	AR, US	Leaves, stems	No	No	Ben-Dov et al., 2012; USDA-ARS-SEL, 2006
Saissetia oleae (Olivier)	AR, US	Leaves	No	No	Chiesa Molinari, 1948; Granara de Willink and Claps, 2003; Hamon and Williams, 1984; Rizzo, 1977
Hemiptera: Diaspididae					
Abgrallaspis cyanophylli (Signoret) [=*Hemiberlesia cyanophylli*]	AR, US	Leaves, fruit, stems	No	Yes	Ben-Dov et al., 2012; Claps et al., 2001; Watson, undated l
Acutaspis paulista (Hempel) [=*Melanaspis paulista*]	AR	Leaves, stems	Yes	No	Ben-Dov et al., 2012; Watson, undated f; Granara de Willink and Claps, 2003
Acutaspis scutiformis (Cockerell)	AR, US (TX)	Leaves	Yes	No	Chiesa Molinari, 1948;Granara de Willink and Claps, 2003; Ben-Dov et al., 2012; Nakahara, 1982
Aonidiella aurantii (Maskell)	AR, US	Fruit, leaves, stems	No	Yes	Burger and Ulenberg, 1990; Claps and Terán, 2001; Claps et al., 2001; Granara de Willink and Claps, 2003; Metcalf et al., 1962; Metcalf and Metcalf, 1993b; Rizzo, 1977
Aonidiella citrina (Craw)	AR, US	Fruit, leaves, stems	No	Yes	CABI, 2012; Claps et al., 2001

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Aspidiotus nerii (Bouché) [=*Aspidiotus hederae*]	AR, US	Stems, leaves, fruit	No	Yes	Chiesa Molinari, 1948; Claps and Terán, 2001; Claps et al., 2001; Granara de Willink and Claps, 2003; Kosztarab, 1996; Nakahara, 1982; Rizzo, 1977
Chrysomphalus aonidum (L.) [=*Chrysomphalus ficus*]	AR, US	Leaves, fruit, stems	No	Yes	Claps and Terán, 2001; Claps et al., 2001; Granara de Willink and Claps, 2003; Kosztarab, 1996; Nakahara, 1982; Rizzo, 1977; Pratt, 1983
Chrysomphalus dictyospermi (Morgan)	AR, US	Branches, leaves, fruit	No	Yes	CABI, 2012; Rizzo, 1977
Chrysomphalus pinnulifer (Maskell)	AR	Leaves	Yes	No	Ben-Dov et al., 2012; Watson, undated c
Diaspidiotus perniciosus (Comstock) [= *Quadraspidiotus perniciosus*]	AR, US	Leaves, fruit, stems	No	Yes	CABI, 2012
Fiorinia fioriniae (Targioni-Tozzettii)	AR, US	Leaves	No	No	Ben-Dov et al., 2012; Watson, undated h Claps et al., 2001; Granara de Willink and Claps, 2003
Hemiberlesia diffinis (Newstead)	AR, US (FL, GA, LA, MD, MS, NC, NJ, TX)	Leaves, bark	Yes	No	Ben-Dov et al., 2012; Claps et al., 2001
Hemiberlesia lataniae (Signoret)	AR, US	Fruit, leaves, stems	No	Yes	CABI, 2012
Hemiberlesia palmae [=*Borchseniaspis palmae*]	AR, US	Fruit, leaves	No	Yes	Ben-Dov et al., 2012; Claps and Terán, 2001; Claps et al., 2001; Granara de Willink and Claps, 2003; Watson, undated g
Hemiberlesia rapax (Comstock)	AR, US	Fruit, leaves, stems	No	Yes	Kosztarab, 1996; Chiesa Molinari, 1948; Granara de Willink and Claps, 2003; Nakahara, 1982; Watson, undated j

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Howardia biclavis (Comstock)	AR, US	Bark, stems	No	No	Watson, undated m; Claps et al., 2001; Ben-Dov et al., 2012
Ischnaspis longirostris (Signoret)	AR, US	Leaves, fruit, stems	No	No	Ben-Dov et al., 2012; CABI, 2012; Espinosa et al., 2009
Lecanodiaspis dendrobii (Douglas)	AR	Stems	Yes	No	Chiesa Molinari, 1948; Granara de Willink and Claps, 2003
Lepidosaphes beckii (Newman) [=*Mytilococcus beckii*, *Cornuaspis beckii*]	AR, US	Leaves, fruit, stems	No	Yes	CABI, 2012; Rizzo, 1977
Lepidosaphes gloverii (Packard) [=*Insulaspis gloveri*]	AR, US	Fruit, leaves, stems	No	Yes	CABI, 2012
Lindingaspis rossi (Maskell)	AR, US	Leaves, stems	No	No	Ben-Dov et al., 2012; Claps et al., 2001; Watson, undated n
Pseudaulacaspis pentagona (Targioni Tozzetti)	AR, US	Leaves, stems	No	No	CABI, 2012; Bentancourt and Scatoni, 1999
Melanaspis paulista (Hempel)	AR	Leaves, stems	Yes	No	Chiesa Molinari, 1948; Foldi, 2001
Mycetaspis personata (Comstock)	AR, US	Leaves	No	No	Ben-Dov et al., 2012; Watson, undated i
Parlatoria cinerea (Hadden)[24]	AR	Leaves, fruit, roots, stems	Yes	Yes	Avidov and Harpaz, 1969; Claps and Terán, 2001;Granara de Willink and Claps, 2003; Watson, undated b
Parlatoria oleae (Colvée)	AR, US	Leaves, fruit, stems, trunk	No	Yes	Watson, undated o; Ben-Dov et al., 2012; Claps et al., 2001
Parlatoria pergandii (Comstock) [=*P. pergandei*]	AR, US	Bark, leaves, fruit, shoot, stem	No	Yes	Claps et al., 2001; CABI, 2012; Dekle, 1976; Rizzo, 1977; Granara de Willink and Claps, 2003
Parlatoria proteus (Curtis)	AR, US	Leaves, bark, stems fruit	No	Yes	Ben-Dov et al., 2012; Claps et al., 2001; Watson, undated p

[24] Not analyzed further due to the very low likelihood of establishment for armored scales. See Section 2.3.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Parlatoria ziziphi (Lucas)[25]	AR, US (FL)	Fruit, leaves, stems	[Yes][26]	Yes	CABI, 2012; Ben-Dov et al., 2012
Pinnaspis aspidistrae (Signoret)	AR, US	Leaves, fruit, stems	No	Yes	Chiesa Molinari, 1948; Claps and Terán, 2001; Claps et al., 2001; Dekle, 1976; Granara de Willink and Claps, 2003; Nakahara, 1982; Rizzo, 1977
Pinnaspis strachnani (Cooley)	AR	Fruit, leaves, stems	No	Yes	CABI, 2012; Claps et al., 2001
Pseudaonidia trilobitiformis (Green)	AR, US (FL)	Leaves	Yes	No	CABI, 2012; Ben-Dov et al., 2012
Unaspis citri (Comstock)	AR, US (CA, FL LA)	Leaves, fruit, stems	No	Yes	CIE, 1962; Claps and Terán, 2001; Claps et al., 2001; Granara de Willink and Claps, 2003; Dekle, 1976; Nakahara, 1982; Rizzo, 1977
Hemiptera: Margarodidae					
Icerya purchasi (Maskell) [=*Pericerya purchasi*]	AR, US	Leaves, shoots, stems	No	Yes	CABI, 2012
Hemiptera: Membracidae					
Ceresa ustulata Fairmaire	AR	Leaves, shoots	Yes	No	de Coll et al., 1998
Hemiptera: Ortheziidae					
Orthezia insignis (Browne)	AR, US (FL)	Flowers, leaves, shoots, stems	No	No	CABI, 2012; Chiesa Molinari, 1948; Morrison, 1952
Praelongorthezia praelonga (Douglas) (= *Orthezia praelonga* (Douglas))	AR	Leaves, stems	Yes	No	Costa et al., 2006
Hemiptera: Pseudococcidae					
Dysmicoccus brevipes (Cockerell)	AR, US	Leaves, fruit, shoots, stems	No	No[27]	CABI, 2012
Ferrisia terani (Williams & Granara de Willink)	AR	Leaves, fruit, shoots, stems[28]	Yes	No[29]	CABI, 2012; Granara de Willink and Claps, 2003

[25] Not analyzed further due to the very low likelihood of establishment for armored scales. See Section 2.3.

[26] Brackets ("[ ]") indicate that this is a quarantine significant species with limited distribution in the United States and is being considered by APHIS for official control (NIS, 2006).

[27] Surface feeders are highly unlikely to remain associated with the commodity or the pathway through washing with detergent, brushing, drying, waxing, and culling, which are part of standard commercial processing on the packing line. See Section 2.2.2 for more information.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Ferrisia virgata (Cockerell)	AR, US	Leaves, fruit, shoots, stems	No	No[29]	CABI, 2012; Granara de Willink and Claps, 2003
Nipaecoccus nipae (Maskell)	AR, US	Leaves, fruit, shoots, stems	No	No[29]	CABI, 2012
Phenacoccus madeirensis Green	AR, US	Leaves, stems	No	No	Ben-Dov et al., 2012; CABI, 2012
Phenacoccus manihoti (Matile-Ferrero)	AR	Leaves, shoots, stems[29]	Yes	No	CABI, 2012
Phenacoccus tucumanus (Granara de Willink)	AR	Leaves	Yes	No	Culik et al., 2006; Granara de Willink and Claps, 2003; Williams and Granara de Willink, 1992
Planococcus citri (Risso)	AR, US	Leaves, fruit, flowers, shoots, stems	No	No[29]	CABI, 2012
Planococcus minor (Maskell)	AR, US	Leaves, fruit, stems	No	No[29]	Stocks and Roda, 2011; Granara de Willink and Claps, 2003;
Pseudococcus comstocki (Kuwana)	AR, US	Leaves, fruit, stems	No	No[29]	CABI, 2012; Kosztarab, 1996
Pseudococcus cryptus (Hempel) (= *Pseudococcus spathoglottidis* Lit)	AR, US (HI, VI)	Leaves, stems	Yes	No	Ben-Dov, 1994; Lit Jr., 1992
Pseudococcus longispinus (Targioni-Tozzetti)	AR, US	Flowers, leaves, fruit, stems	No	No[33]	CABI, 2012; Kosztarab, 1996; Granara de Willink and Claps, 2003
Pseudococcus viburni Signoret	AR, US	Flowers, leaves, fruit, stems	No	No[33]	Bentancourt and Scatoni, 1999; Dapoto et al., 2011; Ben-Dov et al., 2012
Hemiptera: Psyllidae					
Diaphorina citri (Kuwayama)	AR, US (AL, AZ, CA, Fl, GA, HI, LA, MS, SC, TX)	Leaves, fruit, shoots	Yes[30]	No[31]	CABI, 2012; Mead, 1998; 7 CFR § 319.19, 2012

[28] *Ferrisia virgata* was detected on *Citrus aurantium* (Granara de Willink and Claps, 2003). We found no evidence of this species affecting other citrus species. Granara de Willink and Claps, 2003) indicate that this pest is very rare on citrus and does not cause damage.

[29] Literature indicates that citrus is rarely infested by *Phenacoccus manihoti*, and that this species may not be able to survive more than on generation on this host (CABI, 2012).

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Heteroptera: Coreidae					
Athaumastus haematicus (Stal)	AR	Fruit[32]	Yes	No	Chiesa Molinari, 1948
Hypselonotus interruptus (Hahn)	AR	Fruit[34]	Yes	No	Chiesa Molinari, 1948
Sphictyrtus fasciatus (Burmeister)	AR	Shoots (buds)	Yes	No	Chiesa Molinari, 1948
Heteroptera:Lygaeidae					
Oncopeltus stali Berg.	AR	Leaves, flowers, fruit	No	No	Waipara et al., 2006; Cordo et al., 2004
Heteroptera:Pentatomidae					
Edessa meditabunda (Fabricius)	AR	Flowers, leaves, stems, fruit, seeds	Yes	No[33]	CABI, 2012;Chiesa Molinari, 1948
Edessa pictiventris Stål	AR	Fruit, seeds	Yes	No[35]	Chiesa Molinari, 1948; Panizzi, 1997
Edessa polita (Lepeletier & Serville)	AR	Fruit, seeds	Yes	No[35]	Chiesa Molinari, 1948; Panizzi, 1997
Edessa quadridens Fabricius	AR	Fruit, seeds	Yes	No[35]	Chiesa Molinari, 1948; Panizzi, 1997
Nezara viridula (L.)	AR, US	Leaves, flowers, fruit, seeds, shoots, stems	No	No[35]	Chiesa Molinari, 1948; Henry and Froeschner, 1988; CABI, 2012;
Heteroptera: Piesmatidae					
Piesma cinereum (Say)	AR, US	Buds, leaves, seeds, stems	No	No	Chiesa Molinari, 1948; Henry and Froeschner, 1988; Mitchell, 2004
Hymenoptera: Eucharitidae					
Orasema sp.	AR, US	Leaves	No	Yes	Carey, 2000; Chiesa Molinari, 1948 ; Johnson et al., 1986
Hymenoptera: Formicidae					
Acromyrmex hispidus Santschi	AR	Leaves	Yes	No	Brener and Ruggiero, 1994; Condor, 1973; Pagnoccaa et al., 2001

[30] *Diaphorina citri* is under official control in the United States (7 CFR § 319.19, 2012)

[31] Surface feeders are highly unlikely to remain associated with the commodity or the pathway through washing with detergent, brushing, drying, waxing, and culling, which are part of standard commercial processing. See Section 2.2.2 for more information.

[32] These insects were documented causing damage to citrus in Argentina (Chiesa Molinari, 1948) and we assumed they attack the fruit. They are likely surface feeders and highly unlikely to remain on the fruit through harvest.

[33] Stinkbugs feed on the fruit surface (Panizzi, 1997) and they are highly unlikely to remain on the fruit through harvest.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Acromyrmex lundi (Guérin)	AR	Leaves, whole saplings	Yes	No	Bernal, 1995; Brener and Ruggiero, 1994
Acromyrmex sp.	AR, US	Leaves	Yes	No	CABI, 2012; Rizzo, 1977
Atta cephalotes (Linnaeus)	AR	Leaves	Yes	No	CariPestNet, undated; Condor, 1973
Atta sexdens (L.)	AR	Leaves	Yes	No	CABI, 2012; Brener and Ruggiero, 1994
Atta sp.	AR, US	Leaves	Yes	No	CABI, 2012
Linepithema humile (Mayr) [= *Iridomyrmez humilis*]	AR, US	Fruit, shoots, stems	No	No	Rizzo, 1977; Krushelnycky, 2004
Solenopsis invicta (Buren)	AR, US	Fruit, leaves, seeds	No[34]	No	Knapp and Wojcik, 1992; CABI, 2012
Isoptera: Termitidae					
Nasutitermes costalis (Holmgren) (Holmgren) (Syn: *N. corniger* Motschulsky)	AR, US (FL)	Stems	Yes	No	CABI, 2012; Scheffrahn et al., 2002; Scheffrahn et al., 2005
Lepidoptera: Gacillariidae					
Phyllocnistis citrella (Stainton)	AR, US (AL, CA, FL, LA, TX)	Leaves, Fruit	Yes	No[35]	CABI, 2012
Lepidoptera: Hesperiidae					
Achlyodes thraso ssp. *thraso* (Jung)	AR, US	Leaves[36]	No	No	Maes, 2004; Kendall, 1965
Lepidoptera: Limacodidae					
Sibine trimaculata (Sepp)	AR	Leaves	Yes	No	Chiesa Molinari, 1948
Lepidoptera: Noctuidae					
Agrotis ipsilon (Hufnagel)	AR, US	Fruit, leaves, stems	No	No[37]	CABI, 2012
Helicoverpa armigera Hübner	AR	Fruit, flowers, leaves, shoots, stems	Yes	No[38]	Murúa et al., 2014; Annecke and Moran, 1982; EPPO/CABI, undated; Nair et al., 1975; CABI, 2012

[34] Not regulated if commodity destination is AL, AR, FL, GA, LA, MS, NC, SC, and TX, (PestID, 2012).

[35] Larvae occasionally feed on the surface of fruit (CABI, 2012). This pest is highly unlikely to remain with the fruit through harvest.

[36] Due to lack of specific biological information on *Achlyodes thraso* ssp. *thraso*, plant parts affected are based on evidence from closely related species *Achlyodes thraso* ssp. *tamenund* (Kendall, 1965).

[37] Surface feeders are highly unlikely to remain associated with the commodity or the pathway through washing with detergent, brushing, drying, waxing, and culling, which are part of standard commercial processing. See Section 2.2.2 for more information.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Helicoverpa zea (Boddie)	AR, US	Fruit, flowers, leaves, seeds, shoots	No	Yes	CABI, 2012
Peridroma saucia (Hübner)	AR, US	Fruit, flowers, leaves, seeds, stems, shoots	No	No[39]	CABI, 2012
Spodoptera eridania (Stoll)	AR, US	Fruit, leaves	No	No[40]	CABI, 2012
Spodoptera frugiperda (Smith)	AR, US	Fruit, flowers, leaves, shoots, stems	No	No	CABI, 2012
Spodoptera ornithogalli (Guenée) (Syn: *Prodenia ornithogalli* Gn.)	AR, US	Leaves	No	No	Chiesa Molinari, 1948; CABI, 2012
Trichoplusia ni (Hübner)	AR, US	Leaves	No	No	CABI, 2012
Lepidoptera: Papilionidae					
Heraclides anchisiades capys (Hubner) [= *Papilio anchisiades capys* (Hubner)]	AR	Leaves	Yes	No	Bustos, 2008; Chialchia, 2008; Leite et al., 2010
Heraclides (Priamides) anchisiades ssp. *idaeus* (Linnaeus)	AR, US	Leaves, flowers	No	No	Maes, 2004; Hoskins, undated
Heraclides (Calaides) androgeus ssp. *epidaurus* (Godman & Salvin)	AR, US	Flowers	No	No	Maes, 2004; Schwartz, 1989
Heraclides thoas brasiliensis (Rothschild & Jordn) [= *Papilio thoas brasiliensis* (R.& J.)]	AR	Leaves	Yes	No	Chialchia, 2008; Anonymous, 1950
Heraclides thoas thoantiades (Burmeister) [=*Papilio thoas thoantiades* (Burmeister)]	AR	Leaves	Yes	No	Chiesa Molinari, 1948; Bustos, 2008; Anonymous, 1950
Papilio spp.	AR	Leaves	Yes	No	Rizzo, 1977

[38] Larvae may attack developing citrus fruit (Nair et al., 1975 ; Annecke and Moran, 1982), but are unlikely to be associated with mature fruit at harvest or to remain with fruit through harvest and processing. Fruit-piercing moths may feed on the surface of the fruit (CABI, 2012). This pest is therefore highly unlikely to remain with the fruit through harvest.

[39] *Peridroma saucia* larvae feed on the surface of the fruit (CABI, 2012). This pest is therefore highly unlikely to remain with the fruit through harvest or packing.

[40] *Spodoptera eridania* larvae feed on the surface of the fruit (CABI, 2012). This pest is therefore highly unlikely to remain with the fruit through harvest or packing.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Lepidoptera: Psychidae					
Oiketicus kirbyi Guilding	AR	Leaves	Yes	No	Zhang, 1994; Condor, 1973; Arce et al., 1987
Oiketicus platensis Berg	AR	Leaves, Flowers, buds, fruit	Yes	No[41]	Bentancourt and Scatoni, 1999; Rizzo, 1977
Lepidoptera: Pyralidae					
Amyelois transitella (Walker)	AR	Fruit,	No	No	Legner and Silveira-Guido, 1983; CABI, 2012 ; Siegel et al., 2006
Cryptoblabes gnidiella (Millière)[42]	AR, US (HI)	Fruit, leaves, stems, flowers, seeds	Yes	Yes	CABI, 2012; Silva and Mexia, 1999; SINAVIMO, 2008; Bagnoli and Lucchi, 2000
Lepidoptera: Tortricidae					
Argyrotaenia sphaleropa Meyrick	AR	Leaves, fruit	Yes	No[43]	Meneguim and Hohmann, 2007; Ebeling, 1959
Bonagota cranaodes (Meyrick)	AR	Leaves, fruit	Yes	No[44]	Bentancourt and Scatoni, 1999
Gymnandrosoma punctidiscanum Dyar, (Syn *Ecdytolopha punctidiscana* Dyar); Other: (*Gymnandrosoma punctidiscana* Dyar	AR, US	Fruit	No	Yes	Nasca et al., 1981; Adamski and Brown, 2000
Gymnandrosoma aurantianum (Lima) [=*Ecdytolopha aurantiana*, *E. aurantiana*][45]	AR	Fruit	Yes	Yes	SINAVIMO, 2008b; CABI, 2012; Rizzo, 1977
Thysanoptera: Thripidae					
Frankliniella insularis (Franklin)	AR, US	Leaves, flowers	No	No	Maes, 2004; Davidsona and Balda, 2009
Frankliniella occidentalis (Pergande)	AR, US	Leaves, flowers	No	No	Bentancourt and Scatoni, 1999; CABI, 2012

[41] Larvae of *Oiketicus platensis* primarily feed on leaves but may also feed on the surface of the fruit (Bentancourt and Scatoni, 1999). They are unlikely to remain with the fruit through harvest or packing.
[42] Pests in shaded rows are quarantine pests likely to follow the pathway and are analyzed below.
[43] *Argyrotaenia sphaleropa* feeds on the surface of the fruit (Meneguim and Hohmann, 2007). This pest is therefore highly unlikely to remain with the fruit through harvest.
[44] *Bonagota cranaodes* feeds on the surface of the fruit (Bentancourt and Scatoni, 1999). This pest is therefore highly unlikely to remain with the fruit through harvest.
[45] Pests in shaded rows are quarantine pests likely to follow the pathway and are analyzed below.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Frankliniella rodeos Moult.	AR	Shoots, flowers	Yes	No	Cavalleri et al., 2006; Rizzo, 1977
Heliothrips haemorrhoidalis Bouché	AR, US	Leaves, fruit, flowers	No	No[47]	Bentancourt and Scatoni, 1999; CABI, 2012
Thrips palmi (Karny)	AR, US (FL, HI)	Leaves, fruit, shoots[46]	Yes	No[47]	Breithaupt, 2002; CABI, 2012
ALGAE					
Cephaleuros virescens (Kunze) [Trentepohliacae]	AR, US	Leaves, fruit, twigs	No	No[48]	Wellman, 1977
FUNGI					
Alternaria alternata (Keissl) [Ascomycetes: Pleosporales]	AR, US	Fruit, leave, stems, seeds	No	No	CABI, 2012; Farr et al., 2012; Timmer and Chung, 2007a
Alternaria citri (Ellis & Pierce) [Ascomycetes: Pleosporales]	AR, US	Leaves, fruit, twigs	No	Yes	Farr et al., 2012; Timmer et al., 2000
Armillaria luteobubalina Watling & Kile [Basidiomycetes, Agaricales]	AR	Roots	Yes	No	CABI, 2012; Farr et al., 2012;Coetzee et al., 2003
Aspergillus niger (Tiegh) [Ascomycetes: Eurotiales]	AR, US	Fruit	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Athelia rolfsii (Curzi) Tu & Kimbr. [=*Corticium rolfsii*] [Anamorph: *Scerotium rolfsii* (Sacc.)] [Basidiomycetes: Polyporales]	AR, US	Fruit, flowers, leaves, stems, roots	No	Yes	CABI, 2012
Bionectria ochroleuca (Schwein) Schroers & Samuels [=*Nectria ochroleuca*] [Anamorph: *Clonostachys rosea f. rosea* (Link: Fr.) Schroers et al.] [Ascomycetes: Hypocreales]	AR, US	twigs	No	No	Farr et al., 2012

[46] *Citrus* spp. is likely a rare host for *Thrips palmi*, as supported by U.S. port-of entry interception records where *T. palmi* had only been intercepted once on citrus since 1984 (PestID, 2012).

[47] Surface feeders are highly unlikely to remain associated with the commodity or the pathway through washing with detergent, brushing, drying, waxing, and culling, which are standard commercial processing for lemons from approved facilities. See Section 2.2.2 for more information.

[48] Will not be associated with commercially produced fruit due to removal during fruit washing.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Botrytis cinerea (Pers. Fr.) [Anamorph*: **Botryotinia fuckeliana*** (de Bary) Whetzel] [Ascomycetes: Helotiales]	AR, US	Fruit, flowers, leaves, twigs	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Botryosphaeria dothidea (Moug.) Ces. & De Not [Syn. *B. ribis*) Grossenb. & Dugar); Anamorph *Fusicoccum aesculi* Corda] [Ascomycetes: Dothideales]	AR, US	Leaves, stems	No	No	Farr et al., 2012
Botryosphaeria ribis Grossenb. & Duggar [Anamorph *Neofusicoccum ribis* (Slippers, Crous & M. J. Wingfield) Crous, Slippers & A. J. L. Phillips] [Ascomycetes: Dothideales]	AR, US	Fruit, stems	No	Yes	Farr et al., 2012
Capnodium citri (Mont.) [Ascomycetes, Capnodiales]	AR, US	Fruit, leaves	No	No[48]	Farr et al., 2012; Timmer et al., 2000;
Ceratocystis fimbriata Ellis & Halst. [Ascomycetes: Microascales]	AR, US	Fruit, leaves, roots, stems	No	Yes	CABI, 2012; Montoya and Wingfield, 2006
Colletotrichum acutatum (Simmonds ex Simmonds) [Ascomycetes: Phyllachorales]	AR, US	Fruit, flowers, leaves	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Curvularia lunata (Wakker) Boedijn [Ascomycetes, Pleosporales]	AR, US	Leaves	No	No	Farr et al., 2012
Diaporthe citri (F. A. Wolf) [Anamorph: *Phomopsis citri* H. Fawc.] [Ascomycetes: Diaporthales]	AR, US	Leaves, fruit, twigs	No	Yes	Farr et al., 2012; Timmer et al., 2000
Elsinoë australis (Bitancourt & Jenk.) [Anamorph: *Sphaceloma australis* Bitancourt & Jenk.] [Ascomycetes: Myriangiales]	AR, US (TX, LA, MS, FL, AZ)	Leaves, fruit, twigs	Yes	No[49]	Farr et al., 2012; Timmer et al., 2000; USDA APHIS, 2010; EPPO/CABI, 1997c

[49] See Section 2.3 below for further information.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Elsinoë fawcettii (Bitancourt & Jenk.) [Anamorph: *Sphaceloma fawcettii var. fawcettii* Jenkins] [Ascomycetes: Myriangiales]	AR, US	Fruit, leaves, twigs	No	Yes	Farr et al., 2012; Timmer et al., 2000; CMI, 1974
Sphaceloma fawcettii* var *scabiosa (McAlpine & Tryon) A.E. Jenkins [Ascomycetes: Myriangiales][50]	AR	Fruit, leaves, twigs	Yes	No	EPPO/CABI, 1997c; Jenkins et al., 1953
Fusarium oxysporum (Schlechtendahl) [Ascomycetes: Hypocreales]	AR, US	Leaves, flowers, roots, stems	No	No	Farr et al., 2012
Fusarium oxysporum (Schlechtendahl) **f. sp. citri** [Ascomycetes: Hypocreales]	AR, US	Roots, stems	No	No	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Galactomyces geotrichum (E. E. Butler & L. J. Petersen) Redhead & Malloch [***Geotrichum candidum* var. *Citri-aurantii* (Ferraris) Cif. &F. Cif**] [Saccharomycetes: Saccharomycetales]	AR, US	Fruit	No	Yes	Farr et al., 2012; Timmer et al., 2000
Ganoderma lucidum (Curtis) P. Karst. [Basidiomycetes: Polyporales]	AR, US	Roots, stems	No	No	Farr et al., 2012; Timmer et al., 2000; CABI, 2012

[50] Erroneous identification. According to SENASA the first and only report of *Sphaceloma fawcetii* var. *scabiosa* occurred in 1952 in nursery stock. SENASA reviewed this report in 1998, following the guidelines of the ISPM #8 (IPPC, 1998) "Determination of pest status in an area" and concluded that the report of 1952 did not contain enough scientific evidence to confirm the presence of this pest in Argentina. In 2003, SENASA requested that the European Plant Protection Organization (EPPO) remove Argentina from this pest's reported distribution (Larrea, 2008).

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Globisporangium debaryanum (R. Hesse) Uzuhashi, Tojo & Kakish **(= *Pythium debaryanum*** (Auct. non.) R. Hesse) [Oomycetes: Pythiales]	AR, US (CA, HI)	Fruit, seeds, stems, roots	No	Yes	Farr et al., 2012; CABI, 2012
Glomerella cingulata (Stoneman) Spauld. & H. Schrenk [Anamorph: ***Colletotrichum gloeosporioides*** (Penz.) Penz. & Sacc. in Penz.] [Ascomycetes, Incertae sedis]	AR, US	Leaves, stems, flowers, fruit	No	No[51]	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Guignardia bidwellii (Ellis) Viala & Ravaz [Anamorph: *Phyllosticta ampelicida* (Engelm) Aa.] [Ascomycetes: Dothideales]	AR, US	Fruit, flowers, leaves, stems	No	Yes	Farr et al., 2012; CABI, 2012
Guignardia mangiferae (A. J. Roy) [Anamorph: *Phyllosticta capitalensis*] [Ascomycetes: Dothideales]	AR, US (LA, FL)	Fruit, Leaves	No	Yes	Farr et al., 2012; Baayen et al., 2002
Hypocrea lixii (Pat.) [Anamorph: ***Trichoderma harzianum*** Rifai] [Ascomycetes: Hypocreales]	AR, US	Twigs	No	No	CABI, 2012
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. [= *Diplodia natalensis* Pole-Evans] [Ascomycetes: Dothideales]	AR, US	Fruit, flowers, stems, twigs, roots	No	Yes	Farr et al., 2012; CABI, 2012
Macrophomina phaseolina (Tassi) Goid [Syn: *M. phaseoli* (Maubl.) F. S. Ashby] [Ascomycetes: Incertae sedis]	AR, US	Leaves, stems	No	No	Farr et al., 2012
Mycosphaerella citri (Whiteside) [Anamorph: *Stenella citri-grisea* (F. E. Fisher)] [Ascomycetes: Mycosphaerellales]	AR, US (TX)	Leaves, fruit, twigs	No	No[52]	Farr et al., 2012; Timmer et al., 2000; CABI, 2012

[51] Only infects wounded fruit, which is assumed to be generally absent from commercial groves. Wounded fruit are targeted for removal by culling before packing.

[52] *Mycosphaerella* spp. do not produce fruiting bodies on fruit. Fruiting bodies are produced on decaying leaves (Timmer et al., 2000).

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Mycosphaerella loefgreni (Noack) [Ascomycetes: Mycosphaerellales]	AR	Leaves, fruit, twigs	Yes	No[53]	Farr et al., 2012; Timmer et al., 2000
Mycosphaerella lageniformis (Rehm) [Ascomycetes: Mycosphaerellales]	AR, US	Leaves, twigs	No	No[53]	Farr et al., 2012; Wellman, 1977
Nectria haematococca (Berk & Broome) Samuels & Rossman [Anamorph: *Fusarium solani* (Mart.) Sacc.] [Ascomycetes: Hypocreales]	AR, US	Roots, stems	No	No	Farr et al., 2012; Timmer et al., 2000; CABI, 2012; Nemec and Zablotowicz, 1981
Oidium tingitaninum (C. N. Carter) [Ascomycetes: Erysiphales]	AR, US (CA)	Leaves, twigs	No	No	Farr et al., 2012; Wellman, 1977; Timmer et al., 2000
Pellicularia koleroga **(**Cooke) [Basidiomycetes: Ceratobasidiales]	AR, US (KY, FL, LA)	Leaves	No	No	Farr et al., 2012; Wellman, 1977; CABI, 2012
Penicillium digitatum (Pers.:Fr.) Sacc. [Ascomycetes: Eurotiales]	AR, US (CA, FL)	Fruit	No	Yes	Farr et al., 2012; CABI, 2012;
Penicillium italicum (Wehmer) [Ascomycetes: Eurotiales]	AR, US (CA, FL)	Fruit	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Penicillium ulaiense (Hseih, Su & Tzean) [Ascomycetes: Eurotiales]	AR, US (CA)	Fruit	No	Yes	Carrillo, 1995; Farr et al., 2012; Holmes and Eckert, 1993; Skaria et al., 1993
Phyllosticta aurantiicola (Berk. & Cooke) Sacc. [Ascomycetes: Dothideales]	AR, US (LA)	Leaves, twigs	No	No	Farr et al., 2012; Wellman, 1977
Phyllosticta citricarpa (McAlpine) Aa Teleomorph: ***Guignardia citricarpa*** (Kiely) = *P. citricola; Phoma citricarpa* [Ascomycetes: Botryosphaeriales]	AR, US (FL)	Leaves, fruit, stems	Yes	No[53]	USDA APHIS, 2011; CMI, 1964; Kotzé, 1963; Kiely, 1948
Phyllosticta hesperidearum (Cattaneo) Penz. [Ascomycetes: Dothideales]	AR, US (FL, AL, LA)	Leaves, twigs	No	No	Farr et al., 2012; Wellman, 1977

[53] See Section 2.3 below for further information

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Phyllosticta longispora (McAlpine) [Ascomycetes: Dothideales]	AR, US	Leaves, twigs	No	No	Farr et al., 2012; Wellman, 1977
Phytophthora boehmeriae (Sawada) [Oomycetes: Pythiales][54]	AR,	Roots, stems, leaves, fruit	Yes	Yes	Frezzi, 1941; Erwin and Ribeiro, 1996b
Phytophthora cactorum (Lebert & Cohn) Schröt. [Oomycetes: Pythiales]	AR, US	Fruit, stems, roots	No	Yes	Farr et al., 2012; CABI, 2012;CMI, 1966; Cooke et al., 2000
Phytophthora cinnamomi Rands [Oomycetes: Pythiales]	AR, US	Roots, stems, wood	No	No	Farr et al., 2012
Phytophthora citricola (Sawada) [Oomycetes: Pythiales]	AR, US (CA)	Fruit, stems, roots	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012; Erwin and Ribeiro, 1996a
Phytophthora citrophthora (R. E. Sm. & E. H. Sm.) Leonian [Oomycetes: Pythiales]	AR, US	Fruit, stems, roots	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Phytophthora cryptogea (Pethybr. & Laff.) [Oomycetes: Pythiales]	AR, US	Leaves, roots, stems	No	No	Farr et al., 2012; CABI, 2012; Vial and Latorre, 2004
Phytophthora hibernalis Carne [Oomycetes : Pythiales]	AR, US	Fruit, leaves, stems	No	Yes	Farr et al., 2012
Phytophthora nicotianae (Breda de Haan) [=*Phytophthora nicotianae* var. *parasitica* (Dastur) G. M. Waterhouse] [Oomycetes: Pythiales]	AR, US	Fruit, leaves, roots, stems	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012; CMI, 1989
Phytophthora palmivora* var. *palmivora (E. J. Butler) [Oomycetes: Pythiales]	AR, US	Fruit, flowers, leaves, roots, stems	No	Yes	Farr et al., 2012; Alfieri et al., 1994a

[54] *Phytophthora boehmeriae* (Sawada). Frezzi (1941) reported *P. boehmeria* as the pathogen causing brown rot on fruit of citrus in Argentina in 1939. Artificial inoculations, conducted in 1941, on sweet orange fruit yielded infection, but no infections occurred when inoculations were done at the base of the stems of sweet orange, Real and Genova lemons, Dr. Caire and Duncan pummels, Persian lime, and Lima Ragnpur plants. Frezzi (1941)-is the only record of *P. boehmeriae* infecting orange fruits, and there have been no subsequent records in the literature linking this pathogen to citrus, either in the field or in trade. Moreover the author indicates that the only plant part affected by this pathogen is the fruit. Citrus is considered a widely cultivated plant and *P. boehmeriae* has a large global distribution and occurs in areas that cultivate citrus (Farr et al., 2012). Any impacts or occurrence of *P. boehmeriae* in citrus would have been reported in some capacity if citrus were a significant host for this pathogen. As there are no subsequent reports of *P. boehmeriae* affecting citrus outside of this one report, we did not include this pest on the pest list due to the lack of strong host pathogen association. If additional evidence of natural occurrence of this pathogen infecting citrus is reported, we will reevaluate this assessment.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Pythium ultimum (Trow) [Oomycetes: Pythiales]	AR, US (FL, CA)	Roots, stems	No	No	Farr et al., 2012
Pythium vexans (de Bary) [Oomycetes: Pythiales]	AR, US (HI, CA)	Fruit, leaves, roots	No	Yes	Farr et al., 2012; CABI, 2012
Rosellinia necatrix (Prill) [Anamorph: *Dematophora necatrix* R. Hartig] [Ascomycetes: Xylariales]	AR, US	Roots, stems	No	No	CABI, 2012;
Sclerotinia sclerotiorum (Lib.) de Bary [Anamorph: *Sclerotinia varium* Pers. Fr.] [Ascomycetes: Helotiales]	AR, US (CA)	Fruit, flowers, leaves, stems, twigs	No	Yes	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Septoria arethusa (Penz.) [Ascomycetes: Mycosphaerellales]	AR	Leaves	Yes	No	Farr et al., 2012; Wellman, 1977
Septoria citri (Pass). [Ascomycetes: Mycosphaerellales]	AR, US	Leaves, fruit	No	Yes	Timmer et al., 2000; Farr et al., 2012; Wellman, 1977
Septoria limonum (Pass). [Ascomycetes: Mycosphaerellales]	AR, US (CA)	Fruit	No	Yes	Farr et al., 2012
Spegazzinia tessarthra (Berk. & Curt.) Sacc. [=*Spegazzinia ornata* Sacc.] [Ascomycetes: Incertae sedis]	AR, US (FL)	Leaves	No	No	Farr et al., 2012; Wellman, 1977
Thanatephorus cucumeris (A.B. Frank) Donk [Anamorph: *Rhizoctonia solani* J. G. Kuhn] [Basidiomycetes: Ceratobasidiales]	AR, US	Leaves, seedlings, stems	No	No	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
Thielaviopsis basicola (Berk. & Broome) Farraris [Ascomycetes: Microascales]	AR, US (FL, CA)	Roots	No	No	Farr et al., 2012; Timmer et al., 2000; CABI, 2012
BACTERIA					
Agrobacterium tumefaciens (Smith & Town.) Conn	AR, US	Roots, twigs	No	No	CABI, 2012; CMI, 1980
Pseudomonas fluorescens (Trevisan) Migula	AR, US	Leaves, roots	No	No	CABI, 2012
Pseudomonas syringae pv. *syringae* (van Hall)	AR, US	Leaves, fruit, twigs	No	Yes	Timmer et al., 2000; CMI, 1988
Rhizobium radiobacter (Beijerinck & van Delden) Young et al.	AR, US	Fruit, roots, stems	No	Yes	CABI, 2012

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Xanthomonas citri subsp. *citri* (ex Hasse 1915) Gabriel et al. 1989 [Syn. *X. axonopodis* pv. *citri* (Vauterin, et al.), *X. campestris* pv. *citri* (Hasse) Dye] (Citrus canker A)	AR, US	Leaves, fruit, twigs	[Yes][55]	No[56]	Smith et al., 1997; Sun et al., 2001; Timmer et al., 2000
Xanthomonas axonopodis pv. aurantifolii (Vauterin, et al.) [Syn. *X. campestris pv. aurantifolii* (Hasse) Dye] (Citrus canker B)[57]	AR	Leaves, fruit, twigs	Yes	No	Smith et al., 1997; Timmer et al., 2000
Xylella fastidiosa (Wells, et al.) Citrus variegated chlorosis strain (Syn.: Pecosita, declinamiento, fruta bolita)	AR	Twigs, leaves, fruit, roots	Yes	No[58]	Brlansky et al., 1991; Timmer et al., 2000; SENASA, 2011
PHYTOPLASMAS and SPIROPLASMAS					
'*Candidatus* Liberibacter asiaticus'[59]	AR, US	Twigs, seeds, fruit, roots	Yes	No	Timmer et al., 2000; Texeira et al., 2005; USDA APHIS, 2013; CAFESG, 2014

[55] Brackets ("[ ]") indicate that this is a quarantine significant species with limited distribution in the United States and is under official control (NIS, 2006).

[56] See Section 2.3 below for further information.

[57] Citrus canker disease is caused by several pathovars and variants of the *Xanthomonas citri* (syn. *Xanthomonas axonopodis*) bacterium, namely *Xanthomonas citri* subsp. *citri* and *Xanthomonas axonopodis* pv. *aurantifolii* (Brunnings and Gabriel, 2003). The disease cycle and epidemiology of these pathovars is recognized to be the same with variations in the pathogenicity and hosts (Brunnings and Gabriel, 2003; Gottwald and Graham, 2000). *Xanthomonas axonopodis* pv. *aurantifolii* (citrus canker B) was introduced into a limited area in Argentina in 1927, but has been naturally eradicated (Canteros, 2004; SENASA, 2007b). *Xanthomonas citri* pv. *citri* (citrus Canker A) (SENASA, 2007b) is the only pathovar present in Argentina.

[58] Historically, much uncertainty surrounded the host status of *Citrus limon.* While several reports indicate that lemon trees are resistant to CVC based on lack of infection after artificial inoculation with the bacterium. (e.g., Li et al., 1996a), in two reports asymptomatic lemon trees tested positive for CVC (Agostini and Haberle, 2000; Laranjeira et al., 2000). Research in Brazil demonstrates that lemon trees are resistant to CVC (Cordeiro et al., 2014). Surveys done by SENASA in Argentina during the 2010 and 2011 growing seasons did not detect CVC in any lemon trees (SENASA, 2011). Therefore, *Xylella fastidiosa* – CVC strain is highly unlikely to be associated with lemon trees. Furthermore, research demonstrates that this bacteria is not seed transmitted in citrus (Cordeiro et al., 2014; Coletta-Filho et al., 2014; Hartung et al., 2014), therefore, fruit is not a pathway for the spread of CVC. See section 2.3.4 for more information.

[59] '*Candidatus* Liberibacter asiaticus', also known as citrus greening or Huanglongbing (HLB), was detected from a mandarin tree in Corrientes, Argentina in 2014 (CAFESG, 2014). Citrus Greening was also detected in 2012 and 2013 (SENASA, 2013a; Revista Nea, 2014). Citrus greening is considered a quarantine pest for Argentina and SENASA is providing a regulatory framework for responding to new finds and has an official program for eradicating and preventing the spread of citrus greening in Argentina (SENASA, 2013b). Citrus greening occurs and is under official control in the United States (GA, FL, SC, AL, LA, TX, PR, USVI, AZ, MI, HI) (evidence of the vector in other states--CA, etc.) (USDA APHIS, 2013). Fruit are not considered a pathway in 7CFR 301.76-3 but all HLB infected areas are regulated by 7CFR 301.76-1 through 7CFR 301.76-11 (7 CFR § 301.76, 2012).

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
Spiroplasma citri (Saglio, et al.)	AR, US	Twigs	No	No	CMI, 1993; Ramallo, 1970; Timmer et al., 2000
VIRUSES and VIRUS-LIKE AGENTS					
Citrus cachexia viroid (Syn.: Xyloporosis)	AR, US	Twigs	No	No	CMI, 1972; Timmer et al., 2000
Citrus exocortis viroid	AR, US	Bark, fruit, leaves, roots, twigs	No	No[60]	Timmer et al., 2000
Citrus leprosis virus	AR	Fruit, twigs, roots	Yes	No[61]	Timmer et al., 2000; CABI, 2012
Citrus psorosis associated virus (naturally transmitted strain) (Syn.: Psorosis)	AR, US	Leaves, twigs	No	No	CABI, 2012; Garcia et al., 1994; Garcia et al., 1997; Timmer et al., 2000
Citrus psorosis virus A and B strain Argentine strain	AR	Trunk, leaves	Yes	No	Reyes et al., 2011
Citrus ringspot virus (Syn.: Psorosis B)	AR, US	Leaves, twigs	No	No	Alfieri et al., 1994b; Timmer et al., 2000
Citrus tristeza virus closterovirus	AR, US	Twigs	No	No	Timmer et al., 2000
Eruptive gummosis (Syn.: Impietratura)	AR	Bark, leaves, flowers, fruit, roots, twigs	Yes	No[61]	CABI, 2012; Timmer et al., 2000

[60] Transmission through budwood and grafting.

[61] Citrus leprosis virus (CiLV) was once considered to be present in United States, but extensive surveying revealed that it is no longer present (Childers et al., 2003b). Citrus leprosis virus is vectored by mites of the genus *Brevipalpus.* The fruit alone is not considered a pathway for pathogen dissemination. Symptomatic fruit would likely be culled at the packinghouse. Three *Brevipalpus* spp.–*Brevipalpus obovatus, Brevipalpus phoenicis,* and *Brevipalpus californicus*– are vectors present in Argentina where the disease is present, and could follow the pathway for commercially produced lemons. Therefore mites will be analyzed in this PRA. See section 2.3 for more information.

Pest	Distribution	Plant Part Affected	Quarantine Pest	Follow Pathway	References
NEMATODES					
Hopolaimidae					
Helicotylenchus multicinctus (Cobb) Golden	AR, US	Roots	No	No	CABI, 2012
Longidoridae					
Xiphinema index (Thorne & Allen)		Roots	No	No	Westerdahl, 2006
Tylenchulidae					
Criconemella sp. (De Grisse & Loof)	AR, US	Roots	Yes	No	CABI, 2012
Pratylenchus penetrans (Cobb) Filipjev & Schuurmans Stekhoven	AR, US	Leaves, roots	No	No	CABI, 2012
Tylenchulus semipenetrans (Cobb)	AR, US	Roots	No	No	Timmer et al., 2000
DISEASES of UNKNOWN ETIOLOGY					
Marchitamiento repentino Syn.: Citrus blight	AR, US	Leaves, fruit, roots, stems	No	No	EPPO/CABI, 1997b; Timmer et al., 2000
MOLLUSCA					
Cornu aspersum Müller [= *Helix aspersa* (Muller)]	AR, US	Fruit, flowers, leaves, stems, roots, seeds	[Yes][62]	No[63]	CABI, 2012

[62] Regulated pest for Florida, Alabama, and Puerto Rico (PestID, 2012).
[63] *Cornu aspersum* feeds on the fruit surface (CABI, 2012) and they are highly unlikely to remain on the fruit through harvest.

2.3. Pest Categorization

2.3.1. Fruit Flies

Ceratitis capitata (Wiedemann), the Mediterranean fruit fly (Medfly), is included among the quarantine pests that are listed as infesting lemons, and has been present in Northwest Argentina since 1945. *Anastrepha fraterculus* (Wiedemann) is a native fruit fly species and is a quarantine pest but lemon is not considered to be a host (Augier et al., 2007a, 2007b; Gastaminza et al., 2007a; Gastaminza et al., 2007b; Vera and Willink, 2007; Willink et al., 2007a; Willink et al., 2007c; Willink et al., 2007b). *Anastrepha fraterculus* is indigenous and distributed over the warmer portions of South and Central America (Vera and Willink, 2007).

The current regulated article list in the APHIS domestic Medfly quarantine (7 CFR § 301.78-2 (7 CFR § 301.64 and 301.78, 2012)) lists lemons as follows: "Lemon (*Citrus limon*) except smooth-skinned lemons harvested for packing by commercial packing houses. Smooth-skinned lemons harvested for packing by commercial packing houses" are not currently regulated. The decision to list lemons with the above exception was based in part on research published by Agricultural Research Service (ARS) scientists (Spitler et al., 1984).

The detection of Medfly larvae in lemons from Spain required APHIS to take emergency action to require that Verna lemons from Spain be cold-treated with schedule T107a (APHIS, 2006).

The historical literature on the host status of lemons for Medfly was analyzed in 2007 by APHIS and ARS fruit fly experts (USDA, 2008b). The experts reviewed and analyzed over 90 publications and reports from over the last 93 years, examining evidence related to the host status of lemon. The determination of host status of Medfly and the available risk mitigation options are based on their conclusions. Based on their analysis, APHIS has concluded the following about host status of lemons for Medfly:

- Green lemons are not hosts of Medfly but susceptibility to infestation increases as lemons mature.
- Host susceptibility rises markedly once the fruit is harvested, with noticeable changes (increased susceptibility) detectable within 24 hours.
- Resistance to Medfly is causally linked to:
    - chemical toxicity in rind, and
    - rind thickness and toughness.
- High population pressure increases likelihood of infestation.
    - Repeated oviposition by females into an existing oviposition puncture hole can overcome physical barriers.
- Over-mature lemons (lemons left on trees past the normal harvest) are more susceptible due to:
    - changes in rind chemistry and reduced rind thickness;
    - longer time that the fruit is subject to repeated oviposition by females into existing puncture holes, overcoming physical barriers.
- Drought conditions or other stresses on hosts can affect susceptibility.
- Medfly larvae can develop within the pulp. Medfly anatomy is such that its ovipositor cannot pierce through the rind of the fruit. However, if the rind is damaged or existing oviposition puncture holes are present, females can exploit the damage or holes by

ovipositing into them and the Medfly eggs and larvae will be more likely to survive and develop.
- Medfly will attack less susceptible hosts if more susceptible or preferred hosts are not available.

It was the consensus of the expert APHIS and ARS team conducting the analyses that lemon fruit is not a host for Medfly while still green (not fully mature). It is likely that light yellow lemons are not at a maturity stage where they would be susceptible to Medfly, and lemons are thus now considered a conditional non-host (USDA, 2008b). APPPC (2005) defines "conditional non-host" as "fruit and vegetables at a specified maturity (of a fruit fly species) and specified physical condition that cannot support the development of viable adults of a fruit fly species."

Research was conducted from 2004 to 2007 in Northwest Argentina to address host status of commercial Argentine lemons for fruit flies. This research was reported in Willink, 2007. The hypotheses of the studies were:

- Lemon (*Citrus limon*) is not a host of *Ceratitis capitata* or *Anastrepha fraterculus* under export conditions.
- *Ceratitis capitata* and *Anastrepha fraterculus* adult populations decrease during the export season.

The study methods included:

- Monitoring the adult stages of *C. capitata* and *A. fraterculus* with McPhail and Jackson traps year-round in different, representative locations across the northwest region.
- Fruit sampling in the field year-round.
- Fruit sampling in packinghouses during the export season.
- Resistance trials by forced infestation of fruits in the field and laboratory year- round for both fruit fly species.
- Determining the resistance mechanism in lemons for both species.

In the fruits sampled for packinghouse and field sampling trials, most were of export harvest quality (60-80 mm diameter, 461-500 nm light yellow color, at least 35 percent juice). However, in the field sampling trials 7 percent were fruits from the ground and in the packinghouse study, 50 percent were culls.

Each of the production units sampled for field and lab resistance trials were managed under SENASA certification for black spot and citrus canker and each had several annual grove treatments of abamectin for citrus leafminer, oil for homopterans, and copper for diseases. Five export varieties were included and reported in at least the packinghouse and field resistance trials ('Eureka', 'Lisbon', 'Genoa', 'Fino', and 'Limoneira 8 A').

After executing the planned activities for the period May 2004 through September 2007 and considering the results obtained in different trials, Willink (2007) reported that:

- *Anastrepha fraterculus* did not develop in artificially punctured lemons subjected to forced natural infestation in the laboratory.

- *A. fraterculus* did not develop in un-punctured fruit with 2, 4 and 6 days of storage after collection subjected to forced natural infestation in the laboratory.
- *A. fraterculus* did not develop in un-punctured lemons subjected to forced natural infestation in the field.
- Lemon (*Citrus limon*) **is not a host** for *Anastrepha fraterculus*, according to the Asia and Pacific Plant Protection Commission (APPPC) Regional Standard for Phytosanitary Measures (RSPM) Nº4 (APPPC, 2005) and to Cowley et al. (1992).

On the basis of the results obtained from the monitoring of adult fruit flies:

- Adult *C. capitata* populations in lemon growing areas are low during the export period.
- Adult *A. fraterculus* populations in lemon growing areas are low during the export period.

On the basis of the results obtained from sampling:

- No lemon fruit (collected from trees or from the ground) were found to be infested with juvenile stages of *C. capitata* or *A. fraterculus* during the period May 2004 - September 2007.
- No lemon fruit from export boxes or for discard were found to be infested with juvenile stages of *C. capitata* or *A. fraterculus* during the 2005 - 2007 export periods.

The results of *C. capitata* studies on chemical resistance mechanisms were:

- The components of the lemon rind exert a toxic effect on eggs and larvae.
- This effect was stronger on larvae than on eggs.
- Larvae mortality decreased in the extracts from lemons stored for several weeks after collection.
- Certain aldehydes such as citral (neral and geranial) and coumarin decrease their concentration as fruit storage time increases.
- The addition of citral, coumarin and linalool restored the larvae killing effect in extracts performed in lemons several weeks postharvest.
- These compounds are the agents responsible for larvae mortality.
- The above demonstrates that lemons have chemical resistance mechanisms against *C. capitata* attack.

All of the six methods of study performed (trapping, natural field infestation level on trees and ground, packinghouse natural infestation level, infestation level in fruit artificially infested on trees, infestation level in punctured and un-punctured fruit artificially infested in lab cages, and resistance mechanism studies) were relevant to determining the likelihood of introduction. The methods of Cowley et al. (1992) and the APPPC (2005) were followed for the field and lab infestation trials, and in designating host status. The methods of Follett and Hennessey (2007) were used to determine level of efficacy of the resistance mechanisms. Willink (2007) concluded: All of the six methods of study performed (trapping, natural field infestation level on trees and ground, packinghouse natural infestation level, infestation level in fruit artificially infested on trees, infestation level in punctured and un-punctured fruit artificially infested in lab

cages, and resistance mechanism studies) were relevant to determining the likelihood of introduction. The methods of Cowley et al. (1992) and the APPPC (2005) were followed for the field and lab infestation trials, and in designating host status. The methods of Follett and Hennessey (2007) were used to determine level of efficacy of the resistance mechanisms. Willink (2007) concluded:

> "The efficacy data for the resistance trials are as follows: a) if we consider the quantity of insects used in the trails, after exposing 9,190 fruits to 46,200 *A. fraterculus* females, with no survivors, following Follet and Hennessey (2007) we can expect a 99.01% confidence that resistance is 99.99% effective, and 77.20% confidence that resistance is 99.9968% effective; and b) if we consider the quantity of eggs, considering an estimated 511,803 eggs laid by 46,200 *A. fraterculus* females in 9,190 fruits, we can expect a 100% confidence that resistance is 99.99% effective, and 99.9999% confidence that resistance is 99.9968% effective."

The conclusions reached by APHIS on pathway and host status of lemon for the fruit flies of concern, and consequences and likelihood of introduction were based on the results obtained by Willink (2007), above, USDA (2008), and other scientific literature cited in the assessment.

In previous versions of this PRA, lemons were believed to be a conditional non-host of *A. fraterculus* and were thus analyzed. As a result of research submitted to APHIS by Willink (2007), APHIS no longer considers lemons to be a conditional non-host of *A. fraterculus. A. fraterculus* has, therefore, been removed from the analysis.

2.3.2. Armored Scales

We did not further analyze the quarantine significant armored scales identified in this risk assessment (*Acutaspis paulista, Hemiberlesia diffinis, Lecanodiaspis dendrobii, Parlatoria cinerea,* and *Parlatoria ziziphi*) (Hemiptera: Diaspididae) because, although armored scales may enter on commercial fruit for consumption, they are highly unlikely to become established (Miller, 1985; Zlotina and Hennessey, 2007). A critical review of the literature, APHIS-PPQ operational data, and expert opinion concluded that, even assuming high quantities of imported fruit infested with armored scale species that could be parthenogenetic, highly fecund, polyphagous, invasive, theoretically able to survive in most of the United States, and cause high level consequences, the specific pathway represented by commercially produced fruit shipped without leaves, stems or contaminants constitutes an extremely low risk (Zlotina and Hennessey, 2007). This low risk is explained by the poor ability of armored scales to disperse to new host plants from fruits for consumption, and consequently, by their low probability of establishment (Zlotina and Hennessey, 2007).

The following characteristics of armored scales contribute to their poor dispersal capabilities:

- Legs and wings are absent in females and in feeding immature forms. Males possess wings but are short-lived, do not feed, and tend to mate with nearby females.
- Self-dispersal of armored scales occurs via immature forms, or "crawlers." They are the most vulnerable life stage, and their survival decreases with long-distance wind dispersal. Crawlers can be passively dispersed by wind from one plant to another only during a period of approximately 24 hours. No further dispersal is possible after the crawlers start

feeding as they lose their legs during the first molt and their mouthparts are deeply inserted in the host, anchoring them firmly to the substrate.

- Dispersal from fruit discarded in the environment is considered very unlikely because of low wind speeds at ground level and low survival rate of crawlers on the ground or on decaying fruit or fruit peel. There is a low probability of active dispersal of crawlers via walking from their natal host since they are not capable of rapid movement over bare soil or rough surfaces.

An additional reason for not analyzing the armored scales in this risk assessment is that commercially produced lemon fruit is likely to have a low infestation rate of armored scales due to industry quality standards. Processing, culling, and inspection of fruit infested with armored scales can further reduce the prevalence and survival of this group of pests.

In spite of the general characteristics of armored scales as a group, we assessed the specific characteristics of the species in this document (*Acutaspis paulista*, *Hemiberlesia diffinis*, *Parlatoria cinerea*, and *Parlatoria ziziphi*) and found that they are not known to possess characteristics that deviate from the general characterization that would lead us to rank them as low risk.

Two of these pests, *Parlatoria cinerea* and *Parlatoria ziziphi*, were analyzed previously and rated Low for the sub-element: "pest finds suitable host and is able to incite disease/establish," which is consistent with the criteria of the above passages. Due to the extreme low likelihood of establishment of armored scales from the importations of commercial fruit, APHIS does not consider this pathway as a threat and thus we removed the analyses for those pests.

2.3.3. *Citrus Leprosis Virus* and *Brevipalpus* spp. Vectors

Citrus leprosis virus (CiLV) was considered to be present in the United States prior to 2003, but after extensive surveying in Florida and Texas during 2001-2003, Childers et al. (2003b) concluded that CiLV no longer exists in Florida or Texas. The disappearance of CiLV from the United States was not linked to any known eradication effort.

When the disease is severe, extreme crop loss and tree debilitation occurs (Timmer et al. 2000). Plants belonging to the genus *Citrus*, especially grapefruits (*C. paradisi*) and oranges (*Citrus sinensis*) are natural hosts of CiLV (Rodrigues et al., 2003). Lemons and mandarins (*C. reticulata*) are considered less susceptible (EPPO/CABI, 1997a). Other citrus species that are hosts include lime (*C. aurantifolia*) and citron (*C. maedica*) (Bitancourt, 2005). Rodrigues et al. (2005) showed that mites infected with CiLV can transmit the virus to at least one non-citrus species, *Solanum violaefolium* (Solanaceae). It is notable that mites were able to transmit the virus between plants of *S. violaefolium* and that subsequent attempts to transmit the virus by mites from *S. violaefolium* to citrus were unsuccessful (Rodrigues et al., 2005).

CiLV is a virus disease that induces local symptoms on foliage, twigs, and fruits and is naturally transmitted by several species of *Brevipalpus* mites. Each local lesion of CiLV is associated with the infestation by a vector mite. The virus does not appear to move systemically in the host plant, except for a short distance along the mid vein or secondary veins (Rodrigues et al., 2003). Kitajima et al. (1972) reported the occurrence of virus-like particles in leaf tissues symptomatic

for leprosis, but did not find such particles in surrounding, asymptomatic areas (Bastianel et al., 2006).

Two forms of CiLV have been recognized based on particle morphology and cytopathology: the cytoplasmic type (CiLV-C) (Rodrigues et al., 2003) and the nuclear type (CiLV-N) (Colariccio et al., 1995; Kitajima et al., 1972). The most common form of the virus is the cytoplasmic type (CiLV-C), is characterized by its cellular localization and particular cytopathic effect (Rodrigues et al., 2003). This virus, referred to as the cytoplasmic type (CiLV-C), is prevalent in CiLV infested citrus groves (Bastianel et al., 2006; Rodrigues et al., 2003), while the nuclear type (CiLV-N) is of rare occurrence (Bastianel et al., 2006)

Mites that acquire the virus from feeding on citrus trees maintain the ability to transmit the virus for their lifetime, through successive molts, even if only subsequently fed on non-susceptible plants (Rodrigues et al., 2003). This suggests that the virus is of the circulative type, multiplying within the organs of the *Brevipalpus* mite vector before being transmitted to susceptible plants by the feeding of those infected mites (Rodrigues et al., 2003). CiLV particles are not transovarially transmitted (Rodrigues et al., 2003; Rodrigues et al., 1997); therefore, progeny coming from an infected mother mite would not acquire the virus unless the progeny could themselves feed on infected plant tissue.

CiLV is vectored by *Brevipalpus* mites which colonize most *Citrus* spp. and many other plant species (Rodrigues et al., 2003). *Brevipalpus obovatus* has been reported in the United States along the east, west, and the Gulf coast, including the citrus producing states of Florida, California, and Louisiana (Childers et al., 2003a). *Brevipalpus phoenicis* and *B. californicus* have been reported in Florida, Texas and California. (Childers et al., 2003a). *Brevipalpus chilensis* is not present in the United States (CABI, 2012). *Brevipalpus* mites have also been found infesting more than 900 plant species, which include 316 host plants for *B. californicus*, 451 for *B. obovatus*, 486 host plants for *B. phoenicis* (Childers et al., 2003b), and 13 for *B. chilensis* (CABI, 2012). *B. chilensis* has been reported on citrus in Chile, but its potential as a vector of CiLV has not been evaluated (CABI, 2012), but it is possible that this pest could also vector CiLV.

The virus cannot be transmitted or spread from the lemon fruit into the United States without a vector; therefore, the exported lemon fruits themselves are not a pathway of introduction for CiLV. The only plausible pathway of introduction involving the movement of commercial lemon fruit is a scenario in which infected adults or nymphs move from the imported lemons after entry and disperse directly onto citrus in the United States, or possibly onto other virus host plants which could then be infected by the feeding of those mites and possibly sustain a viruliferous population of the mites which could then spread.

Because commercially produced lemons are not a direct pathway for the introduction of CiLV, we did not further analyze this virus. However, viruliferous *Brevipalpus* mites that vector CiLV could follow the pathway of commercially produced fruit. In an earlier version of the PRA, *Brevipalpus* mites were not considered to follow the pathway of commercially produced lemons. Upon re-examining these pests ability to follow the pathway, APHIS determined that without a specific requirement for washing in detergent that closely followed the approved PPQ treatment

(7CFR 319.56-38) (7 CFR § 319.56-38, 2012) designed to mitigate *Brevipalpus chilensis*, APHIS could not reasonably conclude that these pests would be removed from the pathway. That is, whereas the assumptions made originally are still considered valid, APHIS considered the possibility that under some circumstances and in the absence of specific requirements; those assumptions might not be valid. That is the reason why the requirements are being made explicit. *Brevipalpus chilensis* does not occur in the United States and is therefore, considered a quarantine pest for the United States. The *Brevipalpus* mites (*B. californicus*, *B. obovatus*, and *B. phoenicis*) already occur in the United States, but since they are vectors of a quarantine disease (CiLV) APHIS regulates these mites from infected regions. Consequently, we analyzed *B. californicus*, *B. obovatus*, and *B. phoenicis*.

2.3.4. *Xylella fastidiosa* (Wells, et al.) Citrus variegated chlorosis strain

Citrus Variegated Chlorosis (CVC) is a bacterial disease of citrus that is present in Northeast Argentina, and based on survey results provided to APHIS from SENASA, CVC is not known to occur in Northwest Argentina (SENASA, 2011). Numerous vectors of CVC are present throughout Argentina, and there are currently no measures in place known to APHIS that explicitly prevent the spread of CVC into Northwest Argentina.

The primary host of CVC is *Citrus* spp. (Chung and Brlansky, 2005). Historically, much uncertainty surrounded the host status of *Citrus limon.* While several reports indicate that lemon trees are resistant to CVC based on lack of infection after artificial inoculation with the bacterium. (e.g. Li et al., 1996a). Two reports exist of asymptomatic lemon trees testing positive for CVC (Agostini and Haberle, 2000; Laranjeira et al., 2000). In one study, citrus trees in an experimental station in Argentina known to have CVC were sampled and tested for the presence of CVC in 1993, and then again in 1997. A total of 47 lemon trees were tested with a dot immuno-binding assay (DIBA) resulting in 6 positive detections, although none of the trees were symptomatic (Agostini and Haberle, 2000). In another study performed in a high inoculum area an unknown number of lemon trees of the Camargo, Sanguino 2, and Amber cultivars tested positive for CVC using DIBA and PCR (Laranjeira et al., 2000). The molecular diagnostics used in the above tests were acceptable at the time of the studies, but are not considered appropriate for current studies on CVC. Newer diagnostics are more specific for CVC detection.

Research published in 2014 in Brazil reduced the uncertainty surrounding host status of lemons for CVC (Cordeiro et al., 2014). Researchers collected leaf and fruit samples from lemon and navel orange trees in commercial orchards in the North region of San Pablo State, Brazil. The orchards were located in areas where high inoculum of CVC occurs and abundant vectors are present. No symptoms of CVC were observed in any of the lemon trees samples, while CVC symptomatic orange trees were observed in the collection areas. Mature leaves were randomly collected from lemon trees that were adjacent to symptomatic orange trees. Six lemon cultivars were tested with 6-10 plants sampled per cultivar. Each plant sample consisted of 30 leaves distributed in 6 replications of 5 leaves each. Standard PCR assays were performed on the leaf samples to detect *Xylella fastidiosa*. No lemon samples tested positive for the bacteria. Samples of asymptomatic orange trees also tested negative for the bacteria, while symptomatic orange trees tested positive (Cordeiro et al., 2014).

These research results support earlier surveys conducted by SENASA in Argentina during the 2010 and 2011 growing seasons. Those surveys also did not detect CVC in any of the lemon trees sampled (30 lemon trees sampled tested by ELISA). SENASA conducted additional intensive sampling on lemon trees grown in close proximity to CVC infected orange trees, yielding 236 additional samples that all tested negative using ELISA (SENASA, 2011). The research and surveys indicate that lemon is resistant to CVC.

In addition to the prior uncertainty of host status of lemons for CVC, the likelihood of the pathogen being transmitted via infected lemon seeds was also uncertain. Citrus variegated chlorosis was detected. Research presented at a meeting in 2000 reported the detection of CVC using ELISA and PCR in seeds of symptomatic fruit and in 12% of seedlings sown from symptomatic fruit (Pria Jr. et al., 2000). In addition, Li et al. (2003) also indicated that citrus seeds may be a pathway for CVC. The authors tested 250 seedlings from CVC infected sweet oranges using PCR one month after sowing and detected an average of 23% seed transmission. They reported CVC-like symptoms in some of the seedlings, but those later disappeared. The test plants were unfortunately destroyed before further tests could be done. Still, the research indicated that CVC was seed transmitted in oranges, and that this could be possible for other citrus species and varieties. Li et al. (2003) did not recover bacteria from seeds in “apparently healthy” fruit harvested from plants that were “apparently healthy” in a grove where more than 60% of the trees tested positive. The “apparently healthy” trees later tested negative for *X. fastidiosa* in diagnostic tests of leaf petioles. Li et al. (2003) concluded that the potential for the occurrence of infected seeds within large, asymptomatic fruit from apparently healthy but CVC-diseased trees (as might occur with recently infected trees) was unknown.

Research available in 2014 concludes that *X. fastidiosa* is not seed transmitted in citrus (Cordeiro et al., 2014; Coletta-Filho et al., 2014; Hartung et al., 2014).

One study in Brazil, investigated the likelihood that lemon and orange seeds could transmit CVC (Cordeiro et al., 2014). The study did not detect CVC in lemon trees, fruit seeds, or seedlings even though the samples originating from areas with a high incidence of CVC. The authors also examined sweet orange seeds removed from *X. fastidiosa* positive fruit and did not detect the bacteria in the orange seeds or seedlings 12 months after sowing. For each of the experiments PCR was used to detect *X. fastidiosa.* According to the authors “In our studies, Xfp was detected by PCR in different parts of the internal tissues of fruits harvested from CVC-affected trees of the sweet orange cv. IAPAR 73, but not detected in different parts of the seeds. These results were validated by PCR using the specific primers RST 31/RST 33 for the detection of Xf in citrus leaves and fruits (Minsavage et al., 1994). The set of primers 272-1-int and 272- 2-int (Pooler and Hartung, 1995) also gave identical results (data not shown). Therefore, the PCR technique used in this study was specific and sensitive for detection of Xfp if present in the different citrus tissues.” (Cordeiro et al., 2014).

Similar research conducted by USDA ARS scientists focusing on *Citrus sinensis,* a species highly susceptible to CVC, also found no evidence to indicate that the bacteria is seed transmitted (Hartung et al., 2014). Over two seasons the authors repeatedly tested hundreds of seedlings grown from seed collected from a heavily contaminated grove in São Paulo, Brazil and did not detect *X. fastidiosa* in those seedlings. The seedlings were tested by PCR at 3, 7, 17

months post germination. They tested a total of 757 seedlings by PCR with two or three different PCR-based assays, including the two best qPCR assays available for *Xylella fastidiosa* subsp. *pauca*. In conclusion, they found no evidence that *X. fastidiosa* can be transmitted vertically through seedlings and establish a permanent infection (Hartung et al., 2014).

Finally, a study conducted over seven years also found that *X. fastidiosa* cannot be transmitted vertically from seeds to seedlings (Coletta-Filho et al., 2014). In this study 412 seedling sown from seeds collected from CVC symptomatic (shown to be infected with CVC by PCR) and asymptomatic fruit (shown to not be infected with CVC by PCR) were sampled and observed annually for symptoms of CVC. The authors found no evidence of seed-to-seedling transmission of *X. fastidiosa* (Coletta-Filho et al., 2014).

Based on all of the information now available on CVC, APHIS considers *Citrus limon* to be resistant to *X. fastidiosa* - CVC strain. Furthermore, the current research demonstrates that the bacteria is not seed transmitted in citrus. *Citrus limon* fruit is not a pathway for the spread of CVC.

2.3.4. *Elsinoë australis* (the causal agent of sweet orange scab), *Phyllosticta citricarpa* (the causal agent of citrus black spot), and *Xanthomonas citri* subsp. *citri* (the causal agent of citrus canker)

The pathogens *Elsinoë australis* (the causal agent of sweet orange scab), *Phyllosticta citricarpa* (the causal agent of citrus black spot), and *Xanthomonas citri* subsp. *citri* (the causal agent of citrus canker) are limitedly distributed in the United States and considered quarantine pests. These pests have each been analyzed by USDA APHIS in stand-alone pest risk assessments examining the likelihood that these pathogens will spread through the movement of commercial citrus fruit intended for consumption (USDA/APHIS, 2009; USDA/APHIS, 2010a; USDA/APHIS, 2010b). For *E. australis* and *X. citri* subsp. *citri* the analyses focused on the likelihood that citrus fruit serves as a pathway for introduction under typical commercial citrus production practices, which included washing, brushing, surface disinfestation, and waxing. The *E. australis* analysis also considered a fungicide dip during the packing process. These PRAs determined that fruit is not epidemiologically significant as a pathway for introduction when the above practices are applied. The *P. citricarpa* analysis also analyzed the likelihood that this pathogen will spread through the movement of commercial citrus fruit intended for consumption, however it did not consider a packinghouse procedure in the analysis. The conclusion of this risk assessment is that fruit is not epidemiologically significant as a pathway for the introduction of *P. citricarpa* or establishment of CBS disease. However, because of high uncertainty, USDA-APHIS could require further mitigations during the management phase, which they would explain therein.

2.4. Quarantine Pests Likely to Follow the Pathway

We identified seven pests with a reasonable likelihood of being associated with the commodity following harvesting that were also likely to survive post-harvest processing. These pests are candidates for further analysis because they:

- meet the defining criteria for quarantine pests
- may be associated with the exported fruit
- may have the potential to be introduced into the United States

- have been analyzed by USDA APHIS in stand-alone pest risk assessments

These pests satisfy the defining criteria for being in the pathway: "Any means that allows entry or spread of a pest." (IPPC, 2007).

Table 3. Arthropods selected for further analysis

Organism	Remarks
Brevipalpus californicus[a]	Vector of CiLV
Brevipalpus chilensis	
Brevipalpus obovatus[a]	Vector of CiLV
Brevipalpus phoenicis[a]	Vector of CiLV
Ceratitis capitata	
Cryptoblabes gnidiella	
Gymnandrosoma aurantianum	

[a] Analyzed as *Brevipalpus* spp.

2.5. Consequences of Introduction

In this portion of the analysis, we consider negative outcomes that may occur when the identified quarantine pests are associated with lemon fruit from Argentina and are introduced into the continental United States. We rated the consequences of introduction for each pest according to the five risk elements (described in the Guidelines for Pathway Initiated Pest Risk Assessments Version 5.02 (USDA, 2000). The five risk elements are: Climate – Host Interaction; Host Range; Dispersal Potential; Economic Impact, and Environmental Impact. These risk elements reflect the biology of the pest and its hosts. For each risk element, pests are assigned a rating of Low (1), Medium (2), or High (3). A cumulative risk value is then calculated by summing the ratings for each pest. These ratings are helpful in interpreting detailed results; however, the ratings are considered supplemental information within the context of the overall risk analysis document. These ratings are summarized in Table 4.

<u>Risk Element 1: Climate–Host Interaction</u>

This risk element considers ecological zonation and the interaction between the geographic distribution of the pest and host. When introduced to new areas, pests are likely to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of pests with their biotic and abiotic environments are considered. Estimates are based on the availability of host material and suitable climate conditions. To rate this Risk Element, the U.S. Plant Hardiness Zones (Magarey et al., 2008) were used. Plant Hardiness Zones depict an area of winter hardiness for the plants of agriculture and the natural landscapes lowest temperatures that can be expected each year. These temperatures are referred to as "average annual minimum temperatures." The different zones of hardiness zone maps represent areas of winter hardiness for agriculture and natural landscape plants. The zones are used as a standard tool for describing the climatic suitability of plants, and subsequently plant pests, between countries. For the purpose of this assessment, it is assumed that plant pests follow hardiness distributions similar to their host plants. The ratings for this risk element are based on the relative number of U. S. Plant Hardiness Zones (Magarey et al., 2008), in which the pest

could establish a breeding colony, based on its known climatic range in conjunction with available host material.

Low (1): In a single plant hardiness zone.
Medium (2): In two or three plant hardiness zones.
High (3): In four or more plant hardiness zones.

Brevipalpus chilensis.
Brevipalpus chilensis is only known to occur in Argentina and Chile (CABI, 2012; EAN, 2009). In Chile, *B. chilensis* is distributed from Regions III to X (González, 1989). The annual minimum temperatures in these regions correspond to U.S. Plant Hardiness Zones 8-11 (Magarey et al., 2008). The potential of the pest to establish in four Plant Hardiness Zones in the United States gives a **High (3)** rating.

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**
These three *Brevipalpus* spp. are distributed throughout the United States, from northern areas to the citrus-growing states (Jeppson et al., 1975). Those entering from Argentina on fresh lemons would not be considered quarantine pests except that they could be highly likely to be vectoring citrus leprosis virus (CiLV), present in Argentina. If they should become established in commercial citrus plantings of the United States then they could transmit the pathogen and initiate an outbreak of CiLV, a serious citrus tree disease not distributed in the United States but which once existed in Florida, although it is not currently reported there (Childers and Rodrigues, 2005). Current distribution of *B. obovatus* is from Maine to Florida includes hardiness zones 5-10. CiLV, however is only known to naturally infect *Citrus* spp. (Rodrigues et al., 2003). Therefore likely limiting the distribution of CiLV to areas where citrus is grown. *Citrus* spp. are grown in US Plant Hardiness Zones 8-10 (BLCN, undated; Wright, 2001; NRCS, 2012). The risk rating for this element is **Medium (2).**

Ceratitis capitata.
Ceratitis capitata is found in southern Europe, West Asia, Africa, South and Central America (CABI, 2012), and western Australia (Hassan, 1977). It survives in areas with a Mediterranean climate, corresponding to citrus growing areas. Based on this distribution and its predicted geographic range, it is estimated, based on the comparison of Plant Hardiness Zones (Magarey et al., 2008), that Medfly could establish in U.S. Plant Hardiness Zones 8-11 (Vera et al., 2002). One or more of its potential hosts occur in these zones (NRCS, 2012). The rating for this risk element is **High (3)**.

Cryptoblabes gnidiella.
Cryptoblabes gnidiella does best in warm climates and cannot survive winters in cooler temperate areas (CABI, 2012). It is found in Europe (Austria, Cyprus, France, Greece, Italy, Malta, Portugal, and Spain), Asia (India, Israel, Lebanon, Pakistan, Thailand, and Turkey), Africa (Egypt, Liberia, Morocco, Nigeria, Sierra Leone, and South Africa), the Caribbean (Bermuda), North America (United States—Hawaii), South America (Argentina, Uruguay), and Oceania (New Zealand) (CABI, 2012). We estimated the potential distribution of *C. gnidiella* using the degree-day model reported by Ringenberg et al. (2005). We simulated the degree-day model using the North Carolina State University APHIS Plant Pest Forecast System (NAPPFAST) (2007) predictive modeling system. We considered areas where *C. gnidiella* could

complete five generations as conducive for permanent establishment (Yehuda et al., 1991). The results indicated that *C. gnidiella* could establish in U.S. Plant Hardiness Zones 6-11. (Figure 1). The risk rating for this element is **High (3)**.

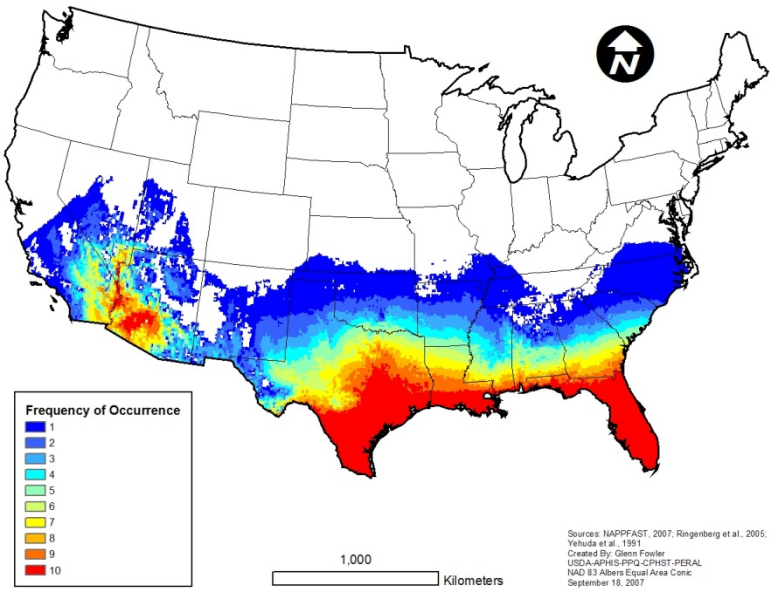

Figure 1. Predicted U.S. distribution of *C. gnidiella* based on the ten-year frequency of occurrence of required degree days to complete five generations.

***Gymnandrosoma aurantianum*.**

We estimated the potential U.S. distribution of *G. aurantianum* using the degree-day model reported by Garcia (1998) as cited in Parra et al. (2004). We simulated the degree-day model using the NAPPFAST (2007) predictive modeling system. We considered areas where *G. aurantianum* could complete seven generations as conducive for permanent establishment based on its biology in Brazil (Garcia, 1998 as cited in Parra et al., 2004). The results indicate that *G. aurantianum* could establish in U.S. Plant Hardiness Zones 6-11 (Figure 2).The risk rating for this element is **High (3)**.

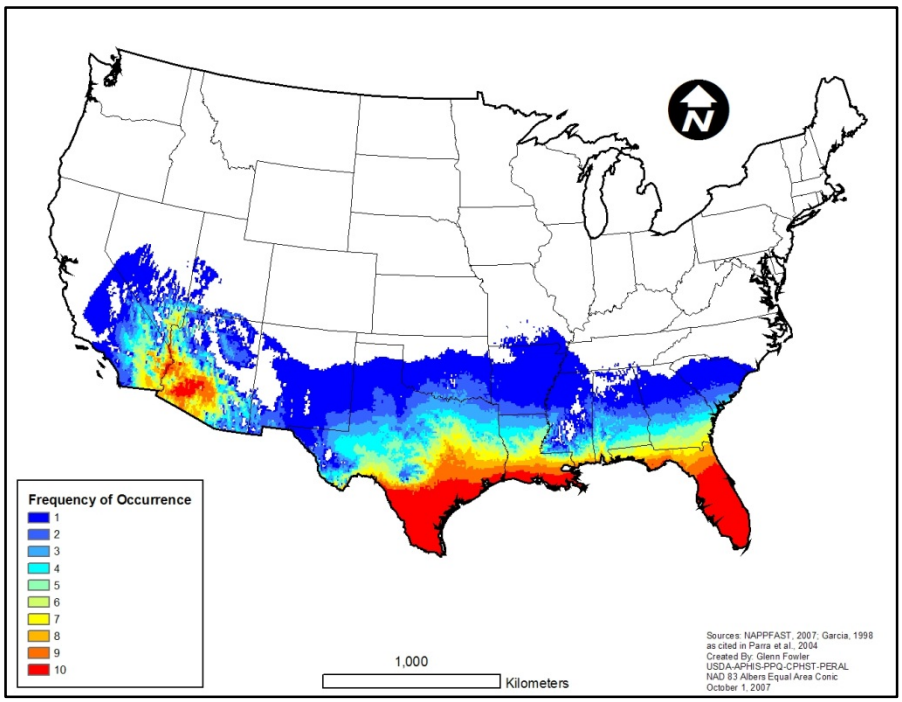

Figure 2. Predicted U.S. distribution of *G. aurantianum* based on the ten-year frequency of occurrence of required degree-days to complete seven generations.

Risk Element 2: Host Range

The risk posed by a plant pest depends on its ability to establish a viable, reproductive population and its potential for causing plant damage. For arthropods, risk is positively correlated with host range.

Low (1): Pest attacks a single species or multiple species within a single genus.
Medium (2): Pest attacks multiple species within a single plant family.
High (3): Pest attacks multiple species among multiple plant families.

Brevipalpus chilensis.

Brevipalpus chilensis attacks hosts in multiple plant families including Actinidiaceae, Annonaceae, Asteraceae, Ebenaceae, Geraniaceae, Moraceae, Oleaceae, Rutaceae, Scrophulariaceae and Vitaceae (CABI, 2012). The risk rating for this element is **High (3).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**

Brevipalpus spp. are highly polyphagous. Their hosts include *Citrus* spp. (*C. aurantium, C. limon, C. reticulata,* and *C. sinensis*). Hosts also include over 50 genera of ornamentals, fruit trees, vegetable and field crops, such as apple, strawberry, eggplant, cotton, etc. (CABI, 2012; Jeppson et al., 1975). CiLV is only known to naturally infect citrus hosts (Rodrigues et al., 2003); therefore, the risk rating for this element is **Medium (2).**

Ceratitis capitata.

Ceratitis capitata is highly polyphagous, with hosts varying from region to region (CABI, 2012). The host range includes plants in the following families: Anacardiaceae, Arecaceae, Chrysobalanaceae, Cucurbitaceae, Ebenaceae, Lauraceae, Loganiaceae, Malpighiaceae,

Meliaceae, Moraceae, Myrtaceae, Oleaceae, Passifloraceae, Podocarpaceae, Rosaceae, Rubiaceae, Rutaceae, Sapotaceae, Solanaceae, and Sterculiaceae (CABI, 2012; Aguiar-Menezes et al., 2002; White and Elson-Harris, 1992). Under certain environmental conditions lemons (*Citrus limon*) are conditional non-hosts for *C. capitata* (APHIS, 2006). The risk rating for this element is **High (3)**.

Cryptoblabes gnidiella.
Cryptoblabes gnidiella is polyphagous and attacks multiple plant species in the following plant families: Anacardiaceae, Annonaceae, Fabaceae, Lauraceae, Liliaceae, Malvaceae, Meliaceae, Moraceae, Poaceae, Punicaceae, Rosaceae, Rubiaceae, Rutaceae, and Vitaceae (CABI, 2012). Examples of economically important hosts *C. gnidiella* attacks include citrus, *Gossypium* (cotton), *Persea americana* (avocado), *Phaseolus* (beans), *Zea mays* (corn), and *Vitis* (grape) (CABI, 2012).CABI, 2012). The risk rating for this element is **High (3).**

Gymnandrosoma aurantianum.
The main host of *G. aurantianum* is citrus, but it is polyphagous and attacks multiple other plant species in multiple families (CABI, 2012), including *Pithecellobium dulce* (Roxb.) Benth., *Psidium guajava* L., *Punica granatum* L., *Eriobotrya japonica* (Thunb.) Lindl., *Prunus persica* (L.) Batsch, and *Sapindus saponaria* L. (Gilligan and Epstein, 2012), which occur in the United States (NRCS, 2012).The risk rating for this element is **High (3).**

Risk Element 3: Dispersal Potential
Pests may disperse after introduction into a new area. The dispersal potential is related to the pest's reproductive potential, inherent mobility, and dispersal facilitation. Factors considered in rating the dispersal potential include the presence of multiple generations per year or growing season, the relative number of offspring or propagules per generation, any inherent capabilities for rapid movement, the presence of natural barriers of enemies, and dissemination enhanced by wind, water, vectors, or human assistance.

Low (1): Pest has neither high reproductive potential nor rapid dispersal capability.
Medium (2): Pest has either high reproductive potential OR the species is capable of rapid dispersal.
High (3): Pest has high biotic potential, e.g., many generations per year, many offspring per reproduction ("r-selected" species), AND evidence exists that the pest is capable of rapid dispersal, e.g., over 10 km/year under its own power; via natural forces, wind, water, vectors, etc., or human assistance.

Brevipalpus chilensis.
Brevipalpus chilensis is multivoltine, with four to five generations per year (González, 1958). Vargas et al. (2005) reported a net reproductive rate of 24.63, an intrinsic population growth rate of 0.09, and a generation time of 34.85 days at a 25ºC, 60 percent relative humidity, and a photoperiod of 16:8 h (L:O). The Tenuipalpidae family is characterized as "slow moving" (Jeppson et al., 1975; Doreste, 1988), which decreases the likelihood that *B. chilensis* will disperse naturally from lemon fruit imported for consumption.. In consideration of the above information, *B. chilensis* is rated **Medium (2).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**

Depending on climate, *Brevipalpus* spp. may exhibit several generations per year, some of which may be parthenogenetic (Jeppson et al., 1975). CiLV is not transovarially transmitted (Rodrigues et al., 2003; Rodrigues et al., 1997), therefore, progeny coming from an infected mother mite would not acquire the disease unless the progeny themselves feed on infected plant tissue. Mites from the family Tenuipalpidae are able to disperse over large distances on the wind (Childers and Rodrigues, 2005) and on nursery plants moved in commerce (CABI, 2012). Therefore, this element's risk rating is **High (3).**

Ceratitis capitata.
Female *C. capitata* may deposit up to 22 eggs per day, and as many as 300-800 eggs in a lifetime (White and Elson-Harris, 1992; Thomas et al., 2005). Eggs are inserted under the skin of host fruit as it begins to ripen (Thomas et al., 2005). Several females may deposit eggs in the same egg cavity, and egg cavities may contain 75 or more eggs (Thomas et al., 2005). In warm climates, breeding is continuous throughout the year, as there are several overlapping generations (Hassan, 1977). Natural dispersal occurs through flight. Adults are capable of flying up to 20 km or more (Fletcher, 1989). *Ceratitis capitata* is dispersed to uninfested areas through the movement of infested fruit (CABI, 2012). In addition, this species may disperse as pupae in soil, or in the growing medium accompanying plants (CABI, 2012). This species has a high biotic potential and capability for rapid dispersal. It is rated **High (3)** for this risk element.

Cryptoblabes gnidiella.
The moth can have between three and nine generations per year and each female can lay an average of 105 eggs (Ringenberg et al., 2005; Wysoki et al., 1993). *Cryptoblabes gnidiella* adults can naturally disperse by flying (Ozturk and Ulusoy, 2011; CABI, 2012). The risk rating for this element is **High (3)**.

Gymnandrosoma aurantianum.
Adults of *G. aurantianum* can fly and the larva is an internal fruit borer, indicating that it could move in harvested fruits (Parra et al., 2001; Bento et al., 2001). The moth can have between seven to eight generations per year and each female can lay approximately 200 eggs (Garcia, 1998 as cited in Parra et al., 2004). The risk rating for this element is **High (3)**.

<u>Risk Element 4: Economic Impact</u>
Introduced pests are capable of causing a variety of direct and indirect economic impacts. These impacts are divided into three primary categories (other types of impacts may occur):

- **lower yield of the host crop,** e.g., by causing plant mortality, or by acting as a disease vector;
- **lower value of the commodity**, e.g., by increasing costs of production, lowering market price, or a combination;
- **loss of foreign or domestic markets due to the presence of a new quarantine pest**.

The ratings for this element are as follows:

Low (1): Pest causes any one or none of the above impacts.
Medium (2): Pest causes any two of the above impacts.
High (3): Pest causes all three of the above impacts.

Brevipalpus chilensis.
Jeppson et al. (1975a) called *B. chilensis* "…a very destructive pest of grapevines." Reports since the 1950's indicate that *B. chilensis* reduced production in Chilean grapes, especially in some wine grapes, and required regular use of pesticides and other control measures (Gonzalez, 2006; Gonzalez, 1983; Pearson and Goheen, 1990). At that time, the mite caused losses up to 30 percent (Gonzalez, 2006;Gonzalez, 1983). However, changes in pesticide use have reduced losses (Gonzalez, 2006; Gonzalez, 1983; Gonzalez, 1983; Gonzalez, 2006; Vergara et al., 2007). Mite monitoring and control are part of routine management for grapes (i.e. UC IPM, 2009), but may not adequately control *B. chilensis. Brevipalpus chilensis* is a pest of quarantine concern for Australia, Brazil, Costa Rica, Japan, Mexico, South Korea, Peru, South Africa, and Taiwan (APHIS, 2012; 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). Based on the above information the risk rating for this element is **High (3).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).** As vectors of CiLV, a citrus tree-killing pathogen to which most varieties of commercial citrus are susceptible, their impact is severe (Childers and Rodrigues, 2005). These three species were ranked as those of highest consequence should they enter from a CiLV country and become established in citrus producing areas of the United States (Childers et al., 2006). CiLV is typically controlled by controlling the vector mites (CABI, 2012). Using chemical sprays for this would likely increase the cost of citrus production. As CiLV is not distributed worldwide (CABI, 2012), its introduction via mite vectors may cause to the loss of foreign markets. Given the potential impacts of CiLV (plant mortality, increased costs of production, and loss of foreign markets), we ranked the *Brevipalpus* spp. **High (3).**

Ceratitis capitata.
Ceratitis capitata is one of the world's most destructive fruit pests. Due to its wide distribution, its ability to tolerate cooler climates, and its wide host range, it is ranked first among economically important fruit fly species (Thomas et al., 2005). Medfly infests more than 250 commercially produced fruit in the Mediterranean (Fimiani, 1989). Its introduction into Hawaii seriously affected small farmers as it attacks 72 commercial hosts in Hawaii alone (Harris, 1989). In some Mediterranean countries, Medfly infests up to 100 percent of stone fruits (Thomas et al., 2005). In Central America, Medfly causes losses of 5 to 15 percent in coffee by increasing labor costs and reducing bean quality (Enkerlin et al., 1989). In addition to substantial yield reductions, Medfly lowers crop values by requiring costly controls (Thomas et al., 2005). Eradication has occurred multiple times in the United States, and costs on average $10 million per introduction[64]. Medfly establishment could result in $1.5 billion in losses annually[65] (USDA-APHIS-PPD, 2002). It has quarantine significance almost worldwide. Countries without the pest use considerable resources to prevent its introduction. The introduction of Medfly into the United

[64] The value reported in USDA-APHIS-PPD, 2002 of $10 million has not been changed to account for inflation between 2002 and 2014.
[65] The value reported in USDA-APHIS-PPD, 2002 of 1.5 billion has not been changed to account for inflation between 2002 and 2014.

States will lead to severe constraints for fruit export (PExD, 2012), resulting in losses of foreign and domestic markets. The rating for this risk element is **High (3)**.

Cryptoblabes gnidiella.
Cryptoblabes gnidiella is a quarantine pest that is not distributed worldwide (CABI, 2012) and thus could cause a loss of markets if introduced into the United States. In citrus it is an internal feeder that punctures fruit and causes premature ripening, blotches, and early fruit drop (Silva and Mexia, 1999; PestID, 2012; CABI, 2012; Moore, 2003). This type of damage can cause substantial losses to citrus crops (Moore, 2003; Silva and Mexia, 1999). In grapes, *C. gnidiella* feeds on grape clusters which can cause them to wilt and fall (Bisotto-de-Oliveira et al., 2007; Ringenberg et al., 2005). On fruit close to harvest, feeding disrupts the berries; leaking juice reduces the quality of wines or depreciates the value of the fruit (Ringenberg et al., 2005). In addition, feeding increases the incidence of fungal and bacteria diseases that cause fruit rot (Bisotto-de-Oliveira et al., 2007; Ringenberg et al., 2005). Several countries actively control *C. gnidiella* populations (e.g. Turkey (Ozturk and Ulusoy, 2011) and Israel (Harari et al., 2007)). Control programs currently in place for other Lepidoptera pests are unlikely to be sufficient for managing this pest. The risk rating for this element is **High (3)**.

Gymnandrosoma aurantianum.
Gymnandrosoma aurantianum is an internal feeder that punctures fruit (Parra et al., 2004). This type of damage can cause substantial losses to citrus crops due to fruit drop and rot, rendering fruit unsuitable for the fresh or processed markets (Parra et al., 2004). *Gymnandrosoma aurantianum* can attack fruit at the early, mid-, and late ripening stages and complete larval development within the host (Parra et al., 2004; Parra et al., 2001). In Brazil, yield losses can be up to 50 percent (Bento et al., 2001). In one major orchard in Trinidad, direct fruit loss reached up to 40 percent in the 1992-93 season (White, 1999). If *G. aurantianum* becomes established in the United States, growers would likely institute an Integrated Pest Management approach to controlling this pest, as is done in other countries (Parra et al., 2004). These measures would likely increase the cost of production. The risk rating is **High (3)**.

<u>Risk Element 5: Environmental Impact</u>
We evaluate the potential of each pest to cause environmental damage by considering if the introduction of the pest is likely to cause significant, and direct environmental impacts, e.g., ecological disruptions, reduced biodiversity. Damages are categorized into four groups: (1) when used within the context of the National Environmental Policy Act (NEPA) (7CFR §372), significance is qualitative and encompasses the likelihood and severity of an environmental impact; (2) a pest that is likely to have a direct impact on other existing species listed by federal agencies as endangered or threatened (50CFR §17.11 and §17.12 50 CFR §17.11 and §17.12 2012), by infesting/infecting a list plant (if the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host); (3) the pest is likely to have an indirect impact on the species listed by federal agencies as endangered or threatened by disrupting the sensitive, critical habitats; and (4) the introduction of such a pest would initiate chemical or biological control programs.

Low (1): None of the above would occur. It is assumed that the introduction of a nonindigenous pest will have some environmental impact (by definition, introduction of a nonindigenous species affects biodiversity).
Medium (2): One of the above would occur.
High (3): Two or more of the above would occur.

Brevipalpus chilensis.
While no plants on the U.S. Threatened and Endangered plant list (USFWS, 2012) are specifically mentioned in the scientific literature as hosts of *B. chilensis*, a considerable number belong to the same families or even genera as confirmed host plants of *B. chilensis*. Examples include the endangered *Prunus geniculata* of Florida and the threatened *Ribes echinellum* of Florida and South Carolina. Given the wide host range, i.e., generalist feeding habits of *B. chilensis*, these threatened or endangered plant species may be attacked by this mite. Chemical control programs used for domestic mite species (University of California, undated) would likely provide some control of *B. chilensis*, as noted in the economic impact discussion. Therefore we rated this element **Medium (2).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**
These *Brevipalpus* species are already established in the United States. Because any mites vectoring leprosis would only impact citrus, which is a non-native crop, the environmental impact would be low. According to the U.S. Fish and Wildlife Threatened and Endangered Species System (TESS), no threatened or endangered species of *Citrus* exist in the United States that CiLV could impact (USFWS, 2012). Therefore the risk rating for this element is **Low (1)**.

Ceratitis capitata.
Because *Ceratitis capitata* is polyphagous, it attacks many species that are closely related (congeners, or same family) to species listed as Threatened or Endangered in the United States (USFWS, 2012). These include the following congeners of known hosts of : *Opuntia treleasei*, *Prunus geniculata*, and *Ziziphus celata* present within the continental United States (USFWS, 2012). Its introduction and establishment in the United States routinely triggers chemical programs, and could trigger biological control programs. The rating for this risk element is **High (3)**.

Cryptoblabes gnidiella.
An endangered or threatened species that *C. gnidiella* could impact is *Allium muznii* (USFWS, 2012). Also, its introduction could also cause the implementation of chemical and/or biological control programs (CABI, 2012; Moore, 2003). The risk rating for this element is **High (3)**.

Gymnandrosoma aurantianum.
None of the known hosts of *G. aurantianum* or their congeners are listed as Threatened or Endangered plants in the United States. Host plants of *G. aurantianum* belong to the Rutaceae, Sapindaceae, and Sterculiaceae families, which contain Threatened and Endangered plants (USFWS, 2012). Also, its introduction could cause the implementation of chemical and/or biological control programs (Molina and Parra, 2006; Parra et al., 2004; Scarpellini and Santos, 1997). The risk rating for this element is **High (3)**.

Table 4. Risk rating for consequences of introduction. Low= 5 to 8; Medium= 9 to 12; High= 13 to 15

Pest	**Climate-Host Interaction**	**Host Range**	**Dispersal Potential**	**Economic Impact**	**Environ-mental Impact**	**Risk Rating**
Arthropod						
Brevipalpus chilensis	High 3	High 3	Medium 2	High 3	Medium 2	High 13
Brevipalpus spp. (*B. californicus*, *B. obovatus*, *B. phoenicis*)	Medium 2	Medium 2	High 3	High 3	Low 1	Medium 11
Ceratitis capitata	High 3	High 3	High 3	High 3	High 3	High 15
Cryptoblabes gnidiella	High 3	High 3	High 3	High 3	High 3	High 15
Gymnandrosoma aurantianum	High 3	High 3	High 3	High 3	High 3	High 15

2.6. Likelihood of Introduction.

In this portion of the assessment we consider two separate components. First, we estimate the amount of commodity likely to be imported (which is the same for all quarantine pests considered). Second, we consider five biological features (i.e., sub-elements) concerning the pest and its interactions with the commodity. The resulting risk ratings are specific to each pest. For each pest, the sum of the sub elements produces a cumulative risk rating for likelihood of introduction. The cumulative risk rating for introduction is considered to be an indicator of the likelihood that a particular pest would be introduced. We summarized these ratings and the value for the Likelihood of Introduction in Table 5.

<u>Sub-Element 1: Quantity Imported Annually</u>

The likelihood that an exotic pest will be introduced depends partly on the amount of potentially infested commodity imported. For qualitative pest risk assessments, the amount of commodity imported is estimated in units of standard 40-foot-long shipping containers. In those cases where the quantity of a commodity imported is provided in terms of kilograms, pounds, number of items, etc., the number of units is converted into units of 40-foot shipping containers.

Low (1 point): <10 containers/year
Medium (2 points): 10–100 containers/year
High (3 points): >100 containers/year

Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*), *Brevipalpus chilensis, Ceratitis capitata, Cryptoblabes gnidiella,* and *Gymnandrosoma aurantianum

The likelihood that an exotic pest will be introduced depends on the amount of the potentially infected commodity that is imported. Argentine exporters estimate that a total of 1,000,000 boxes (each box 18 kg) of lemons will be exported per year (Gatti and Cortese, 2007). Each box should contain approximately 150 fruit. In total, approximately 600-800 standard 40-foot shipping containers are expected annually, based on conversion factor of 20 metric tons per 40-foot shipping containers. The national production of lemons in the entire country is reported to be

1,486,000 metric tons, with an export total for lemons in 2013 of 283,000 metric tons (Federcitrus, 2014).

We estimate the quantity of commodity imported will be greater than 100 containers per year and may approximate the current export total, therefore the Quantity Imported Annually is rated **High (3)** for all pests.

Sub-Element 2: Harvested Fruit is Infested

It is assumed that infestation is likely if fruit originates in areas where the pest/disease occurs, but the magnitude of the hazard at this stage will depend in large part on the proportion of infested/infected fruit and the nature of the infestation/contamination. The incidence of infested/infected fruit will depend primarily on the variety, environmental conditions, and field management.

Brevipalpus chilensis.

Control of *Brevipalpus* spp. in citrus groves can be achieved with the use of chemicals. This reduces the mite population present in the groves. Cultural practices such as pruning, use of windbreaks, control of weeds that may be reservoirs for mites are recommended (Bastianel et al., 2006; Timmer et al., 2000). The risk rating for this element is **Medium (2)**.

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**

In Brazil, *Brevipalpus* spp. mites occur wherever citrus is cultivated, but only where the virus is present is it considered a key pest for the crop to be controlled with chemicals (Bastianel et al., 2006). Chemical control can reduce the vector population present in the groves. Cultural practices such as pruning, use of windbreaks, control of weeds that may be reservoirs for the vector (and possibly for the virus), and control of entry of people and tools (which may carry the vectors) in groves are recommended to reduce the sources of vectors (which spread inoculum) and hence, the incidence and severity of the disease (Bastianel et al., 2006; Timmer et al., 2000). The risk rating for this element is **Medium (2)**.

Ceratitis capitata.

Several methods available for controlling fruit fly populations in the field, including bait sprays, sterile insect technique (SIT), and male annihilation (CABI, 2012). As lemons are a conditional non-host, harvesting lemons prior to maturity should practically eliminate the likelihood of Medfly infestation, since it has only ever been detected in overripe lemons (APHIS, 2006). Argentina currently harvests green fruit in northwest areas between March and May, and yellow fruit between May and August (Gatti, 2007). Green fruit harvested early in the season (March to May) have a very low risk of fruit fly infestation. Yellow fruit harvested later in the season (May to August) have a slightly greater risk of infestation, but SENASA has not reported finding *C. capitata* in lemons despite more than a decade of surveillance (Augier et al., 2007b). When allowed to become ripe beyond what is considered commercially mature, lemons are more susceptible as a conditional non-host for *C. capitata* (APHIS, 2006). Damaged lemons have been demonstrated to be a host (Willink et al, 2007).

Because lemons may be a conditional non-host for *C. capitata*, we rated this element **Medium (2)**.

Cryptoblabes gnidiella.
Cryptoblabes gnidiella is a secondary pest of citrus fruit (Silva and Mexia, 1999). In its early stages it feeds on honeydew excreted on the fruit surface by aphids or mealybugs, and in later stages burrows into the fruit using holes previously made by birds or other borers. Fruit that become infested are typically smaller in size (Moore, 2003), and damage by larvae feeding internally causes the fruit to yellow prematurely and may cause them to drop (Silva and Mexia, 1999). For these reasons, *C. gnidiella* is less likely than some other citrus pests in Argentina to be associated with fruit in the field. *Cryptoblabes gnidiella* has never been reported to infest lemons in Northwest Argentina, despite years of survey and fruit cutting (Augier et al., 2007b; Stein, 2008). Therefore, we rated this sub-element **Low (1).**

Gymnandrosoma aurantianum.
Gymnandrosoma aurantianum is an internal fruit feeder and has been recorded attacking lemons in Argentina (Parra et al., 2004; SINAVIMO, 2005b). It can attack fruit at the early, mid, and late ripening stages and complete larval development within the host (Parra et al., 2004; Parra et al., 2001). Infested fruit may drop before harvest (White and Tuck, 1993), reducing the number of infested fruit harvested. *Gymnandrosoma aurantianum* has never been reported to infest lemons in Northwest Argentina, despite years of survey and fruit cutting (Augier et al., 2007b; Stein, 2008). Consequently, we rated this sub-element **Low (1)**.

<u>Sub-Element 3: Survives Packing and Post- Harvest Treatment</u>
The third sub-element is the likelihood of pest/inoculum surviving the packing process and post-harvest treatment. Field culling is likely to remove symptomatic and damaged fruit prior to arrival. Harvested fruit is transported to the packinghouse where it is subjected to manual and/or optical scanner culling. Citrus fruit is then washed, brushed, chemically treated for diseases and pests, and waxed.

***Brevipalpus chilensis, and Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**
Lemons are exported with stems and calyces attached. These mites, including fecund and parthenogenetic females, are about 0.5 mm in length and press themselves very flat to the surface of the fruit (Jeppson et al., 1975) and can presumably lodge and survive beneath the edges of the calyces. Citrus fruits can be processed in packing houses so as to remove mites before export (EPPO/CABI, 1997a), but 10 to 40 percent of mites on oranges and grapefruits may survive post-harvest treatment if they are protected by the pedicel disk of the fruit (Castro and Astudillo, 2001). This is a significant reduction, but without a specific requirement for washing with detergent that closely mimics the treatment requirement already established for citrus from Chile (7 CFR § 319.56-38, 2012), *B. chilensis* and the other three *Brevipalpus* spp. are unlikely to be completely removed from the pathway. Based on this information, we rated these species **Medium (2).**

Ceratitis capitata.
Internally feeding arthropods are generally highly likely to survive minimal post-harvest treatment, such as washing and culling. Because *Ceratitis capitata* is an internal feeder, it is highly likely to survive post-harvest culling, especially if the infestation of the fruit does not result in obvious damage. Likewise, unless cut, Medfly-infested fruit are highly likely to escape detection during culling (White and Elson-Harris, 1992). The rating for this element is **High (3)**.

Cryptoblabes gnidiella.
Early stages of *C. gnidiella* feed externally (Moore, 2003), and therefore are highly likely be removed during the standard packinghouse processes of washing, brushing, rinsing, drying, and waxing. Later instars usually occur in the fruit (Moore, 2003; CABI, 2012). The symptoms on the fruit vary according to the feeding site, but entrance holes typically have silk and frass around entrance holes (as for the similar species, *Diaphania nitidalis* (Stoll); Metcalf and Metcalf, 1993a), as well as frass (CABI, 2012). In lemons, newly enclosed larva will move directly into the fruit, typically dwelling within the flavedo (Moore, 2003). Infested fruit are therefore likely to be culled during processing, but *complete* removal of all infested fruit is unlikely. Therefore the risk rating for this sub-element is **Medium (2)**.

Gymnandrosoma aurantianum.
Eggs and larvae (prior to boring into the fruit) on the surface of the fruit would likely be removed during standard packinghouse processes of washing, brushing, rinsing, drying, and waxing. Fruit attacked by the citrus borer can develop lesions (CABI, 2012) and a necrotic area in the rind around the larval entrance hole, and also have frass (as occurs for codling moth; Metcalf and Metcalf, 1993a). Infested fruit which did not drop may be discolored, which could distinguish them from healthy fruit (White and Tuck, 1993). Chemical treatments are unlikely to impact *G. aurantianum* larvae residing within fruit (Parra et al., 2004). The risk rating for this sub-element is **Medium (2)**.

Sub-Element 4: Survives Shipments
The fourth sub-element is concerned with the survival of inoculum in fruit during shipping. Shipments of lemon fruit are likely to be refrigerated and spend two to four weeks in transit to the United States.

Brevipalpus chilensis.
Jadue et al. (1996) demonstrated that *B. chilensis* can survive temperatures between 0 to 2°C for a period of 15 days. In adults, no significant differences existed in the mortality rates of cold-treated and control mites for 11 days following treatment. Cumulative oviposition of cold-treated mites was ca. 60 percent that of untreated mites; no significant differences were found in cumulative egg hatch between the two groups. Live *B. chilensis* have been intercepted at U.S. ports-of-entry on different commodities, including lemons, from Chile (PestID, 2012). Based on this evidence the risk rating for this element is rated as **High (3).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**
These three species of *Brevipalpus* are already established in northern, colder areas of the United States. We know of no evidence that shipping temperatures or shipping duration would impact any of these mites. Therefore, the risk rating for this element is **High (3).**

Ceratitis capitata.
The shipping temperature could significantly affect the ability of *C. capitata* to survive shipment. *Ceratitis capitata* is limited in distribution by cold tolerance (CABI, 2012). The USDA has an approved probit9 cold treatment for treating it. The planned shipping temperatures for lemons from Argentina are unknown. Recommended shipping and storage temperatures for lemons are between 7°C and 10°C for one to six months (Cantwell, 2002). Due to the Mediterranean

climate, cold treatments are very detrimental to the quality of lemon fruit grown in Argentina. In this situation, it is unclear what effect shipping temperature will have on Medfly survival, but mortality of the larvae inside the fruit is likely to be low because the recommended high-efficacy treatment temperature is 1.67ºC for 16 days or 2.22ºC for 18 days (USDA, 2012). The rating for this element is **High (3)**.

Cryptoblabes gnidiella.
It is unclear what effect proposed shipping temperatures will have on *C. gnidiella*. We found no evidence that this species would be impacted by transport and storage conditions. Therefore, the risk rating for this sub-element is **High (3)**.

Gymnandrosoma aurantianum.
We found no evidence that this species would be impacted by transport and storage conditions. Several factors may aid the survival of this pest during shipment. *Gymnandrosoma aurantianum* is an internal feeder, can remain viable in green and ripe fruits, and can complete larval development within the host (Parra et al., 2004; Parra et al., 2001). We concluded it was highly likely to survive shipment in harvested fruits. The risk rating for this sub-element is **High (3)**.

Sub-Element 5: Fruit Moved to Suitable Habitat
The fifth sub-element involves shipment of infested/infected fruit to a suitable habitat for establishment/disease development; for this, the geographic location of likely markets is considered. Several biotic and abiotic factors determine the suitability of an area to a particular pest. While temperature constraints and host availability are only two such factors, they are often limiting factors for pest establishment. For the purposes of this assessment a suitable habitat is considered a habitat with adequate temperature range and availability of suitable hosts. Fruit that arrives in the United States does not normally arrive at a single port; instead, it is distributed according to market demand. Demographics derived from United States Census data are useful in predicting the distribution of imported citrus fruit by indicating population centers where demand may be greatest.

***Brevipalpus chilensis, Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*), *Ceratitis capitata, Cryptoblabes gnidiella, Gymnandrosoma aurantianum*,**
In risk element 1, Climate-Host Interaction, we determined the areas in the United States with both suitable host plants and suitable climate, that the pests have the potential to establish a breeding colony. Fruit that arrives in the United States does not arrive at a single state. Rather, the fruit is distributed according to market demands through commercial distribution areas. The distribution channels and the fact that all fruit is for consumption reduce the number of fruit that end up in suitable areas determined in Risk Element #1: Climate–Host Interaction.

U.S. demographics and the distribution of markets are strong indicators of the ultimate destination of fruit. The distribution of the U.S. population according to the 2000 U.S. Census (Figure 8) describes the likely patterns of fruit destined for human consumption (US Census, 2000). Comparing the suitable U.S. Plant Hardiness Zone Map (Magarey et al., 2008) determined in risk element 1 and the U.S. Census map (Figure 8) for each arthropod pest is a useful tool in estimating the risk of imported fruit being moved to a suitable habitat.

Brevipalpus chilensis.
This pest could establish in U.S. Plant Hardiness Zones 8-11. This area includes a smaller area of the West Coast and south, but still includes three of the four most populated states (California, Texas, and Florida). Therefore the risk rating is **Medium (2).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*)**.
These pests are already established in U.S. Plant Hardiness Zones 5-10. This area covers most of the country, and includes several highly populated states. However, CiLV only attacks citrus, which is limited to U.S. Plant Hardiness Zones 8-10. Therefore the risk rating for this element is **Medium (2).**

Ceratitis capitata.
Medfly could establish in U.S. Plant Hardiness Zones 8-11. This area includes a smaller area of the West Coast and south, but still includes three of the four most populated states (California, Texas, and Florida). Therefore the risk rating is **Medium (2)**.

Cryptoblabes gnidiella* and *Gymnandrosoma aurantianum.
These pests could establish in U.S. Plant Hardiness Zones 6-11. This area includes a large portion of the country, including several highly populated states. Therefore the risk rating for this element is **High (3).**

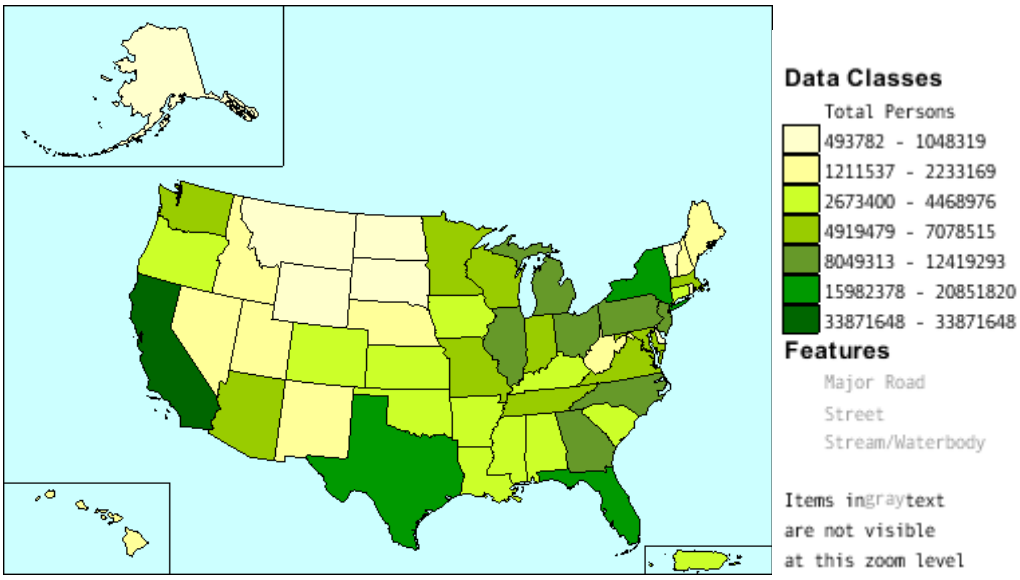

Figure 8. U.S. population density, by state (US Census, 2000).

<u>Sub-Element 6: Pest Find Suitable Host and Establish</u>
The sixth sub-element examines the risk that imported infested fruit will encounter a suitable host within the suitable habitat, and a viable reproductive unit of the insect pest or plant pathogen associated with the fruit is able to complete its life cycle. Assessment of the probability that a plant pest will come into contact with host material must take into account not only the availability, in time and space, of its host plants and of the particular plant parts fed upon or used

for reproduction, but also the pest's inherent powers of movement allowing it to find and colonize hosts successfully.

Brevipalpus chilensis.
Brevipalpus chilensis has a wide host range, including some very common and widely-distributed genera, such as *Convolvulus* and *Ribes* (NRCS, 2012). For example, *Convolvulus arvensis*, field bindweed, is abundant in 49 U.S. states; therefore, suitable hosts would be available throughout most of the United States during the shipping season. However, taking into consideration the limited capacity for active dispersal by this mite, we arrive at a rating of **Medium (2).**

***Brevipalpus* spp. (*B. californicus, B. obovatus, B. phoenicis*).**
These mites are currently widely distributed throughout the United States on many hosts (Jeppson et al., 1975). If the mites escape into the environment, they could land on or find a host. However, taking into consideration the limited active dispersal capacity of these mites, we arrive at a rating of **Medium (2).**

Ceratitis capitata.
Hosts of the extremely polyphagous and highly mobile Medfly should be available throughout its potential area of establishment. This has been demonstrated by repeated incursions (and subsequent eradications) into the continental United States (CABI, 2012; Foote et al., 1993). Hence, we rated this sub-element **High (2)**.

Cryptoblabes gnidiella.
Cryptoblabes gnidiella is polyphagous and attacks multiple plant species in multiple families (CABI, 2012). Also, the adults fly, which can increase the likelihood of locating a host and mating. Consequently, *C. gnidiella* is likely to encounter hosts and establish in areas with suitable climates. As evidence of this, *C. gnidiella* was introduced into South Africa and has become a pest of lemons (Moore, 2003). For gravid females of either species to come into contact with hosts the following would have to happen: 1) multiple infested fruit must be discarded together 2) a male and female emerge, find each other, and mate and 3) female flies to a suitable host. The risk rating for this sub-element is **Medium (2).**

Gymnandrosoma aurantianum.
Gymnandrosoma aurantianum is polyphagous and attacks multiple plant species in multiple families (CABI, 2012). Also, the adults fly, which can increase the likelihood of locating a host and mating (Bento et al., 2001; Parra et al., 2004). Consequently, *Gymnandrosoma aurantianum* is likely to encounter hosts and establish in areas with suitable climates. For gravid females of either species to come into contact with hosts the following would have to happen: 1) multiple infested fruit must be discarded together 2) a male and female emerge, find each other, and mate and 3) female flies to a suitable host. The risk rating for this sub-element is **Medium (2).**

Table 5. Risk Ratings for Likelihood of Introduction. Low= 6 to 9; Medium= 10 to 14; High= 15 to 18.

Pest	Quantity imported annually	Harvested fruit is infected/ infested	Survives packing and post-harvest treatment	Survives shipment	Fruit moved to suitable habitat	Pest find suitable host and is able to incite disease/ establish	Cumulative Risk Ranking
Arthropod							
Brevipalpus chilensis	High 3	Medium 2	Medium 2	High 3	Medium 2	Medium 2	Medium 14
Brevipalpus spp. (*B. californicus*, *B. obovatus*, *B. phoenicis*)	High 3	Medium 2	Medium 2	High 3	Medium 2	Medium 2	Medium 14
Ceratitis capitata	High 3	Medium 2	High 3	High 3	Medium 2	High 3	High 16
Cryptoblabes gnidiella	High 3	Low 1	Medium 2	High 3	High 3	Medium 2	Medium 14
Gymnandrosoma aurantianum	High 3	Low 1	Medium 2	High 3	High 3	Medium 2	Medium 14

2.7. Pest Risk Potential and Conclusion

The sum of the values for the Consequences of Introduction and the Likelihood of Introduction produce the Baseline Pest Risk Potential (PRP). This cumulative total expresses the risk on the following scale: Low= 11 to 18, Medium= 19 to 26 and High= 27 to 33. The Baseline PRP for each quarantine pest is summarized in Table 6.

Table 6. Pest Risk Potential

Pest	Consequences of Introduction Cumulative Risk Rating	Likelihood of Introduction Cumulative Risk Rating	Pest Risk Potential (Total)
Arthropod			
Brevipalpus chilensis	High 13	Medium 14	High 27
Brevipalpus spp. (*B. californicus*, *B. obovatus*, *B. phoenicis*)	Medium 11	Medium 14	Medium 25
Ceratitis capitata	High 15	High 16	High 31
Cryptoblabes gnidiella	High 15	Medium 14	High 29
Gymnandrosoma aurantianum	High 15	Medium 14	High 29

The following guidelines are offered as an interpretation of the Low, Medium, and High Pest Risk Potential ratings:

Low: Pest will typically not require specific mitigations measures; the port-of-entry inspection to which all imported commodities are subjected is likely to provide sufficient phytosanitary security.

Medium: Specific phytosanitary measures may be necessary.

High: Specific phytosanitary measures are strongly recommended. Port-of-entry inspection is not considered sufficient to provide phytosanitary security. Identification and selection of appropriate sanitary and phytosanitary measures to mitigate risk for pests with particular Pest Risk Potential ratings is undertaken as part of the risk management phase is not discussed in this document. The appropriate risk management strategy for a particular pest depends on the risk posed by that pest.

The risk rating for the ***Brevipalpus* spp**. **(*B. californicus, B. obovatus, B. phoenicis*)** is medium for the consequences of introduction and medium for the likelihood of introduction, with an overall pest risk potential of Medium.

For ***Brevipalpus chilensis*** the risk rating is medium for the consequences of introduction and high for the likelihood of introduction, with an overall pest risk potential of High.

Although the consequences of introduction associated with the fruit fly ***Ceratitis capitata*** are high under any circumstances, our ranking for the likelihood of introduction represents the extreme high-range estimate based on assumptions regarding worst-case conditions under which some lemons may be hosts; specifically, the harvesting of overripe fruit under conditions of high population pressure and stress. Natural infestations of Medfly have never been observed with commercially produced lemons from Argentina, but laboratory studies indicate that infestation may be possible.

The risk rating for the two Lepidopteran pests, ***Cryptoblabes gnidiella*** and ***Gymnandrosoma aurantianum*** is high for both the consequences of introduction and likelihood of introduction. Although uncommon, both pests are considered occasional pests of citrus in NWA.

3. Contacts

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Appendix 1: Updates to the draft PRA in response to public and peer review comments.

A draft pest risk assessment (PRA), titled "Risk Assessment for the Importation of Fresh Lemon (Citrus limon (L.) Burm. F.) Fruit from Northwest Argentina into the Continental United States" (August 6, 2007), APHIS published as a notice[66] in the *Federal Register* on August 13, 2007 (72 FR 45216-45217, Docket No. APHIS-2007-0112) in which APHIS advised to the public of the availability of the draft PRA and solicited comments on it for 60 days. On September 27, 2007, APHIS published another notice in the *Federal Register* (72 FR 54891-54892, Docket No. APHIS-2007-0112) in which APHIS extended the comment period on the draft PRA until December 11, 2007. APHIS received 21 comments by that date, from exporters, importers, domestic industry associations, researchers, and the Argentine NPPO.

At the same time, APHIS submitted the draft PRA for expert peer review in accordance with the Office of Management and Budget's bulletin on peer review. APHIS will make all the materials associated with the peer review on the PRA, including the peer reviewers' comments and our responses available at:

http://www.aphis.usda.gov/peer_review/peer_review_agenda.shtml.

We made changes to the August 2007 PRA in response to public comments, peer review comments, and scientific information provided to APHIS. This version of the PRA was made available in 2008. The changes we made are summarized below:

1. A definition for the term “commercially” as: “Commercially produced fruit are grown, processed, and packed in accordance with citrus production standards defined and regulated by SENASA (SENASA, 2007a) and verified by USDA-APHIS (USDA/APHIS, 2007a-b). Such practices typically include fruit be free of leaves, twigs, and other plant parts, except for stems that are less than 1 inch long and attached to the fruit. Fruit may also be washed, brushed, chemically treated for diseases and pests, waxed and culled to exclude overripe, misshaped or blemished fruit.”
2. The classification of *Xanthomonas axonopodis* pv. *citri* has been changed to *Xanthomonas citri* subsp. *citri*.
3. A more complete description of the commodity has been added to the introduction.
4. Deviations from the Guideline 5.02 have been described in the introduction.
5. The following pest were added to the pest list: *Ceroplastes subrotundrus, Acutaspis paulista, Hemberlesia palmae, Fiorinia fioriniae, Mycetaspis personata, Pinnaspis strachnani, Abrallaspis cyanophylli, Howardia biclavis, Lindingaspis rossi, Parlatoria oleae, Parlatoria proteus, Hemiberlesia diffinis, Ecdytolopha aurantiana, Cryptoblabes gnidiella, Bucephalogonia xanthophis, Dilobopterus costalimai, Macugonalia leucomelas, Ferrisia terani,* and *Sphaceloma fawcetti* var. *scabiosa.*

[66] To view the notice, the draft PRA, and the comments we received, go to http://www.regulations.gov/fdmspublic/component/main?main=DocketDetail&d=APHIS-2007-0112.

6. Whole plant has been removed from the plant parts affected for *Polyphagotarsonemus latus*
7. Whole plant has been removed from the plant parts affected for *Brevipalpus phoenicis*
8. Whole plant has been removed from the plant parts affected for *Panonychus citri*
9. Whole plant has been removed from the plant parts affected for the Aphididae family
10. Plant parts other than leaves have been removed from the plant parts affected for the family Aleyrodidae.
11. Fruit has been added to the plant parts affected column for *Hemiberlesia rapax.*
12. Fruit, roots, or seeds were added to the plants part affected for *Xylella fastidiosa* (CVC). At this time there was a high level of uncertainty surrounding this pests association with seeds and thus ability to follow the fruit pathway. Therefore, a full analysis of CVC was added.
13. Vegetative organs and whole plants have been removed from the plant parts affected for *Atherigona orientalis.*
14. Fruit flowers and stems have been removed from the plant parts affected for *Aleurothrixus howardi.*
15. Stems has been removed from the plant parts affected for *Aleurocanthus woglumi*
16. Fruit, flower, and stems have been removed from the plants parts affected for *Dialeurodes citri*
17. Fruit, flower, and stems have been removed from the plants parts affected for *Dialeurodes citrifolii*
18. Roots and whole plant has been removed from the plant parts affected for *Dysmicoccus brevipes*
19. Roots and whole plant has been removed from the plant parts affected for *Phenacoccus manihoti*
20. Roots has been removed from the plant parts affected for *Planococcus citri*
21. *Brevipalpus californicus, B. obovatus,* and *B. phoenicis* were listed as not quarantine pests and not to following the pathway in the previous version of this PRA. These mites are vectors of a quarantine disease they are now listed as quarantine pests and likely to follow the pathway.
22. *Aceria sheldoni* was listed as a quarantine pest, but has since been reclassified as not a quarantine pest.
23. The limited US distribution is now listed for all of the quarantine pests found in the US.
24. The wording in footnote number 4 (in the original PRA) regarding the status of lemons for several fruit fly species has been revised to enhance clarity.
25. The reference (Garcia et al., 2003) that supports that *Tomoplagia* sp. are not known to attack fruit in the field has been incorporated into the PRA.

26. The CFR reference cited in the pest list for *A. serpentina* has been updated.
27. *Ecdytolopha aurantiana* and *Cryptoblabes gnidiella* are analyzed in this version of the PRA.
28. *Brevipalpus californicus*, *B. obovatus*, and *B. phoenicis* are analyzed in this version of the PRA.
29. The analysis on *Anastrepha fraterculus* has been removed from the assessment.
30. The analysis for *Parlatoria ziziphi* and *Parlatoria cinerea* has been removed from the assessment.
31. A section on the host status of lemons for fruit flies has been added to the PRA
32. A section on the low likelihood of establishment of armored scales has been added to the PRA
33. A section on Citrus Leprosis Virus and *Brevipalpus* spp. Vectors has been added to the PRA.
34. A summary of the APHIS criteria (Guidelines version 5.02) has been added to the text of the PRA.
35. Additional information was added regarding citrus variegated chlorosis and changes were made to reflect the fact that northwest Argentina is not a pest-free area for this disease.
36. The risk rating for Dispersal Potential for *Elsinoë australis* has been changed to from Low (1) to Medium (2).
37. The monetary values in the PRA have been qualified for clarity.
38. The risk rating for the Economic Impact for *Elsinoë australis* has been changed from Low (1) to Medium (2).
39. The discussion of Argentina culling operations has been removed from the harvested fruit is infected section.
40. Benomyl has been removed from the list of control options for sweet orange scab analysis as a control option for the Harvested fruit is infested/infected element.
41. The risk rating for Survives Packing and Post Harvest Treatment for *Guignardia citricarpa* has been changed from Medium (2) to High (3).
42. Reference to *Ceratitis capitata* to determine this pests ability to survive shipment, has been removed from the Sub Element 4.
43. The section on evaluating the risk associated with Fruit Moved to a Suitable Habitat has been revised to increase our transparency and to better explain our methodology for determining this risk rating.
44. The risk rating for Pest Find Suitable Host and Establish or Incite Disease for *Elsinoë australis* has been changed from High (3) to Medium (2).

Appendix 2: Updates to the PRA between 2008 and 2015 in response to new scientific information.

This PRA has been updated internally numerous times between 2008 and 2012 in response to additional or new research made available to APHIS. The changes we made are summarized below:

1. The authors consulted additional information pertaining to pests present in Argentina that may be associated with citrus. The following pests were added to the pest list (*note none of the added pests were further analyzed in this PRA):
   Achlyodes thraso ssp. *thraso* (Jung), *Acromyrmex hispidus* Santschi, *Acromyrmex lundi* (Guérin), *Aleurothrixus aepim* (Goldi), *Aleurothrixus porteri* Quaintance & Baker, *Amyelois transitella* (Walker), *Aphis citricola* van der Goot , *Aphis nerii* Boyer de Fonscolombe, *Armillaria luteobubalina* Watling & Kile [Basidiomycetes, Agaricales], *Aulacorthum solani* Kaltenbach, *Bonagota cranaodes* (Meyrick), *Botryosphaeria dothidea* (Moug.) Ces. & De Not, *Botryosphaeria ribis* Grossenb. & Duggar, *Brenthus anchorago* Brehm, *Bryobia rubrioculus* (Scheuten), *Ceratocystis fimbriata* Ellis & Halst. [Ascomycetes: Microascales], *Chlorotettix latocinctus* DeLong, *Ciminius platensis* (Berg), Citrus psorosis virus A and B strain Argentine strain, *Coccus perlatus* (Cockerell), *Curtara concava* (De Long & Freytag), *Curtara samera* DeLong & Freytag, *Curvularia lunata* (Wakker) Boedijn [Ascomycetes, Pleosporales], *Dexicrates robustus* (Blanchard), *Diaphorina citri* (Kuwayama), *Diedrocephala variegata* (Fabricius), *Diploschema rotundicolle* (Serville), *Eburia octoguttata* Germar, *Eburia sordida* Burmeister, *Entylia carinata* (Forster), *Frankliniella insularis* (Franklin), *Frankliniella occidentalis* (Pergande), *Frankliniella rodeos* Moult., *Fusarium oxysporum* (Schlechtendahl) [Ascomycetes: Hypocreales], *Globisporangium debaryanum* (R. Hesse) Uzuhashi, Tojo & Kakish *Pythium debaryanum* (Auct. non.) R. Hesse [Oomycetes: Pythiales], *Heliothrips haemorrhoidalis* Bouché, *Heraclides (Priamides) anchisiades* ssp. *idaeus*, *Heraclides (Calaides) androgeus* ssp. *epidaurus*, *Hypothenemus crudiae* (Panzer), *Hypocrea lixii* (Pat.) [Anamorph: *Trichoderma harzianum* Rifai] [Ascomycetes: Hypocreales], *Inca clathrata ssp. sommeri* Westwood, *Ischnaspis longirostris* (Signoret), *Lobiopa insularis* Laporte, *Macrophomina phaseolina* (Tassi) Goid, *Macugonalia cavifrons* Stål, *Mallodon spinibarbis* Linnaeus, *Molomea consolida* Schröder, *Oiketicus kirbyi* Guilding, *Oiketicus platensis* Berg, *Oncometopia tucumana* Schröder, *Paraleyrodes citri* Bondar, *Paraleyrodes proximus* Teran, *Phenacoccus madeirensis* Green, *Phytophthora nicotianae* (Breda de Haan) [=*Phytophthora nicotianae* var. *parasitica* (Dastur) G. M. Waterhouse], *Platypus parallelus* (Fabricius), *Pseudaulacaspis pentagona* (Targioni Tozzetti), *Pseudococcus viburni* Signoret, *Rotigonalia limbatula* (Osborn), *Scaphytopius bolivianus* Om., *Sibovia sagata* (Signoret), *Spodoptera ornithogalli* (Guenée), *Tetranychus cinnabarinus* (Boisduval), *Tetranychus mexicanus* (McGregor), *Trachyderes striatus* (F.), and *Toxoptera aurantii* Boyer de Fonscolombe.
2. In July 2009, mites believed to be *Brevipalpus chilensis* were discovered on a shipment of grape budwood from Argentina. Prior to this interception, *B. chilensis* was not

officially known to occur in Argentina. In 2010, Acarologist expert, Dr. Ronald Ochoa (USDA, ARS, Systematic Entomology Laboratory) worked with SENASA personnel to positively identify the *Brevipalpus* specimens collected at the U.S. port of entry. There are several species of *Brevipalpus* in Argentina that complicate the identification of *Brevipalpus* specimens to species level, and several species complexes exist. After careful study of the samples collected by SENASA in Argentina, Dr. Ochoa and SENASA scientist are in agreement that the original species intercepted in shipment of grapes to the US (exported as propagative material) in July 2009 are not *B. chilensis* but rather likely a new not yet fully describe *Brevipalpus* species (temporarily named *B.* sp1) within *B. obovatus* complex.

There is no distribution, host or biological information available for *B.* sp1, and this species has still not been fully described. Currently we have no evidence that *B.* sp1 is associated with citrus or CiLV, providing us with no technical justification to list *B.* sp1 as a quarantine pest for lemons from Argentina. As *Brevipalpus* sp1 is found within the *B. obovatus* complex, which is already listed as a quarantine pest and is analyzed in the Argentina lemon PRA, we assume that any mitigations applied to mitigate *B. obovatus* would likely be effective for *B.* sp1 if it were to be found associated with lemons.
As part of Dr. Ochoa's work he identified *Brevipalpus* species from several locations in western Argentina. *Brevipalpus chilensis* was positively identified from Rio Negro, Argentina 2010 (Beard et al., 2012). While this detection is not in the citrus export area, to our knowledge delimiting surveys for *Brevipalpus chilensis* in Argentina have not been conducted. Therefore, we are uncertain of the complete distribution of this mite in Argentina, and since it has been associated with citrus in the literature it could be associated with the pathway. Therefore, *Brevipalpus chilensis* is analyzed in this version of the PRA.

3. The classification of *Guignardia citricarpa* has been changed to *Phyllosticta citricarpa.*
4. The analyses for *Elsinoë australis* (the causal agent of sweet orange scab), *Phyllosticta citricarpa* (the causal agent of citrus black spot), and *Xanthomonas citri* subsp. *citri* (the causal agent of citrus canker) were removed. These pests have each been analyzed by USDA APHIS in stand-alone pest risk assessments examining the likelihood that these pathogens will spread through the movement of commercial citrus fruit intended for consumption (USDA/APHIS, 2009; USDA/APHIS, 2010a; USDA/APHIS, 2010b). For *E. australis* and *X. citri* subsp. *citri* the analyses focused on the likelihood that citrus fruit serves as a pathway for introduction under typical commercial citrus production practices, which included washing, brushing, surface disinfestation, and waxing. The *E. australis* analysis also considered a fungicide dip during the packing process. These PRAs determined that fruit is not epidemiologically significant as a pathway for introduction when the above practices are applied. The *P. citricarpa* analysis also analyzed the likelihood that this pathogen will spread through the movement of commercial citrus fruit intended for consumption, however it did not consider a packinghouse procedure in the analysis. The conclusion of this risk assessment is that fruit is not epidemiologically significant as a pathway for the introduction of *P. citricarpa* or establishment of CBS disease. However, to reduce any lingering uncertainty USDA APHIS determined that a fungicide treatment that eliminates any spores present on the fruit at the time of packinghouse processing provides an appropriate additional safeguard

for *P. citricarpa*. Based on the above conclusions these diseases were not further analyzed in this PRA, however additional import requirements will be specified in the risk management document as a condition of entry for lemon fruit from NWA to the continental Unites States.

5. Research finalized in 2014(Cordeiro et al., 2014), in conjunction with surveys conducted by SENASA (SENASA, 2011) demonstrates that lemon trees are resistant to *Xylella fastidiosa* (Wells, et al.)- Citrus variegated chlorosis strain (CVC). Furthermore, research demonstrates that this bacteria is not seed transmitted in citrus (Cordeiro et al., 2014; Coletta-Filho et al., 2014; Hartung et al., 2014), therefore, fruit is not a pathway for the spread of CVC. Therefore the analysis for this pathogen was removed from the document.
6. *Helicoverpa armigera* Hübner was added to the pest list in 2014 based on the detection of this pest in Argentina (Murúa et al., 2014).