Qualitative Pathway-Initiated Risk Assessment for the Movement of Mature Green 'Sharwil' Avocado, *Persea americana* Mill. from Hawaii into Continental United States

A Pathway-Initiated Risk Assessment

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Executive Summary
This risk assessment examines the risks associated with the movement of avocado (*Persea americana* cv. Sharwil) into the continental United States. A list of avocado pests in Hawaii was prepared based on (1) documents submitted by the Hawaiian Department of Agriculture (HDOA) (2) United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) records of intercepted pests, and (3) scientific literature. The commodity was not found to be a potential weed. Quarantine pests that were identified to the species level, and found likely to follow the pathway, were qualitatively analyzed using the methodology described in the USDA-APHIS Guidelines 5.02. The information allowed APHIS to determine the Consequences of Introduction and the Likelihood of Introduction, in addition to estimating the Baseline Pest Risk Potential of each pest before mitigation.

Information on pests associated with avocado in Hawaii revealed that eleven quarantine insect pests could be introduced into the continental United States via this pathway; one species is rated High risk, and the remaining ten rated Medium risk.

Insect Pest with High unmitigated risk potential:
Bactrocera dorsalis (Hendel) (Diptera: Tephritidae)

Insect Pests with Medium unmitigated risk potential:
Ceroplastes rubens Maskell (Hemiptera: Coccidae)
Coccus viridis (Green) (Hemiptera: Coccidae)
Cryptoblabes gnidiella Millière (Lepidoptera: Pyralidae)
Dysmicoccus neobrevipes Beardsley (Hemiptera: Pseudococcidae)
Epiphyas postvittana (Walker) (Lepidoptera: Tortricidae)
Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae)
Nipaecoccus viridis (Newstead) (Hemiptera: Pseudococcidae)
Paracoccus marginatus (Hemiptera: Pseudococcidae)
Planococcus minor (Hemiptera: Pseudococcidae)
Pseudococcus cryptus Hempel (Hemiptera: Pseudococcidae)

All of these quarantine pests pose phytosanitary risks to American agriculture. Port-of-entry inspections, as a sole mitigative measure, are considered insufficient to safeguard U.S. agriculture from the pest given High risk rating; additional phytosanitary measures are necessary in order to reduce risks to acceptable levels.

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I. Introduction

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the Center for Plant Health Science and Technology, USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), in response to a request to evaluate the risks associated with the importation of commercially produced mature green 'Sharwil' (hereinafter, Sharwil) avocado, *Persea americana* Mill from Hawaii into the continental United States.

The International Plant Protection Convention (IPPC) provides guidance for conducting pest risk analyses. The methods used here are consistent with guidelines provided by the IPPC, specifically the International Standard for Phytosanitary Measures (ISPM) on 'Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms' (IPPC, 2009: ISPM #11). The use of biological and phytosanitary terms is consistent with the 'Glossary of Phytosanitary Terms and the Compendium of Phytosanitary Terms' (IPPC, 2009: ISPM #5).

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

This is a qualitative risk analysis; estimates of risk are expressed in terms of High, Medium, and Low pest risk potentials based on the combined ratings for specified risk elements (PPQ, 2000) related to the probability and consequences of importing this commodity from Hawaii. For the purposes of this assessment High, Medium, and Low probabilities will be defined as:

High: More likely to occur than not to occur
Medium: As likely to occur as not to occur
Low: Less likely to occur than not to occur

The appropriate risk management strategy for a particular pest depends on the risk posed by that pest. Identification of appropriate sanitary and phytosanitary measures to mitigate the risk, if any, for this pest is undertaken as part of Stage 3 (Risk Management). Other than listing possible mitigation options for the pests of concern, we did not discuss risk management in this document.

II. Risk Assessment

2.1 Initiating Event: Proposed Action

This commodity-based, pathway-initiated risk assessment is in response to a request for USDA authorization to allow movement of mature green Sharwil avocado, *Persea Americana*, from Hawaii into northern-tier states of the continental United States during winter months. The movement of mature green Sharwil avocado grown in the Hawaiian Islands is a potential pathway for the introduction of plant pests. Title 7 of the Code of Federal Regulations 318, Part 13 (7CFR § 318.13) provides regulatory authority for the movement of fruits and vegetables from Hawaii into the continental United States.

2.2 Assessment of Weediness Potential of *Persea americana*

This step is important to the initiation phase of the assessment process because if the species considered for importation poses a risk as a weed pest, then a "pest-initiated" pest risk assessment may be initiated. If the species to be imported passes the weediness screening, the pathway-initiated pest risk assessment continues. The results of the weediness screening for *Persea americana* did not prompt a pest-initiated risk assessment, because it is not considered a weed in the continental United States.

Table 1. Assessment of the Weed Potential of Avocado

Commodity: Fruits of *Persea americana* Mill. cv. Sharwil

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). *Persea americana* is grown in California and Florida in the continental United States (USDA NRCS, 2005).

Phase 2: Answer Yes or No to the following questions:

No	Geographic Atlas of World Weeds (Holm *et al.*, 1979)
No	World's Worst Weeds (Holm *et al.*, 1977) or World Weeds: Natural Histories and Distribution (Holm *et al.*, 1997)
No	Report of the Technical committee to Evaluate Noxious Weeds: Exotic weeds for Federal Noxious Weed Act (Gunn & Ritchie, 1982).
No	Economically Important Foreign Weeds (Reed, 1977)
No	Weed Science Society of America List (WSSA, 1989)
No	Are there any literature references indicating weediness (*e.g.*, AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "species name" combined with "weed")

Phase 3: Conclusion

Persea species are not listed as common weeds anywhere in the world. There are no other plants in this genus that are important weeds that already occur in the United States; as a result, the risk assessment proceeds (PPQ, 2000).

2.3 Previous Risk Assessment, Current Status and Pest Interceptions, and Decision History for *Persea americana* from Hawaii

Hawaiian avocado growers have long maintained a strong interest in gaining access to mainland U.S. markets. The major difficulty in this strategy has been overcoming the quarantine restrictions that require phytosanitary treatment of fruit against potential infestations by fruit flies. The fruit flies of concern are established in Hawaii but not on the mainland, and would be serious pests of significant economic consequences if they were to be introduced.

In 1985, when regulatory initiatives were initially undertaken by APHIS for shipping Sharwil to the mainland, the fruit flies of concern were the so-called "Trifly complex": the Mediterranean fruit fly (*Ceratitis capitata*), the oriental fruit fly (*Bactrocera dorsalis*), and the melon fly

(*Bactrocera curcubitae*). The Malaysian fruit fly (*Bactrocera latifrons*), with established populations in Hawaii, has not been recorded to infest avocado.

Prior to 1985, APHIS allowed the export of avocado from Hawaii to the mainland under two quarantine treatment options. The first option was fumigation with methyl bromide for fruit flies and inspection for other pests (T-101-c-1; https://manuals.cphst.org/TIndex/index.cfm). The treatment with methyl bromide gas was problematic because it caused fruit pitting and discoloration and 3-4 day reduction in shelf-life. The second option was fumigation at a lower dose combined with refrigeration for seven days (T-108-a; https://manuals.cphst.org/TIndex/index.cfm). The combined fumigation and refrigeration proved less damaging to the fruit, but resulted in significant reduction of shelf-life due to days held in refrigeration. Growers judged both treatments impractical.

ARS Research in 1983 (Armstrong *et al*., 1983) showed that Sharwil avocado was resistant to infestation by the Trifly complex when harvested, handled, packed, and shipped under specific conditions. Based on this research conclusion, APHIS proposed a program in 1985 that would allow Sharwil export to the mainland U.S. without any conventional quarantine treatment, following specific harvesting, handling, and shipping requirements. The proposal met serious criticism and negative feedback from stakeholders on the mainland, mainly due to the absence of precedent and the general lack of regulatory experience with such a program. As a result, APHIS revised the proposal to allow shipment only to Alaska (7 CFR 318 - FR Doc. 86-27875); the idea was to develop regulatory experience and to demonstrate the program's effectiveness to further justify the movement of Sharwil to the contiguous 48 States.

Shipments to Alaska began in 1987. The regulations were adjusted slightly in 1988 to reflect certain changes in procedures based on the initial experiences. After two shipping seasons and total movement of 35 metric tons of fresh fruit to Alaska, APHIS, with supporting data from ARS (Armstrong, 1991), again proposed allowing movement of Sharwil to the mainland in 1989 (7 CFR 318 - FR Doc. 89-5192).

The initiative again met strong opposition, but was ultimately finalized in September 1990 (7 CFR 318 - FR Doc. 90-22571). By February 1992, APHIS inspectors found oriental fruit fly larvae in mature green Sharwil avocados attached to the tree. Subsequent investigations revealed additional infestations in fruit that would have met the requirements specified in the regulations for interstate shipment (Liquido *et al*., 1995).
APHIS responded with an interim rule that immediately revoked the Sharwil program (7 CFR 318 - FR Doc. 93-26570), and reverted back to only allowing shipment without treatment to Alaska and requiring fumigation or fumigation with refrigeration for fruit destined to the mainland.

Currently, commercial shipments of avocado from Hawaii, including Sharwil, may be shipped to Alaska without treatment if harvested, handled, and shipped according to the conditions specified in 7 CFR 318.13-21.

Commercial shipments of avocado from Hawaii (including Sharwil) may be shipped to the contiguous 48 States, Guam, and Puerto Rico if treated by either one of the following treatment schedules in the APHIS Treatment Manual: T-101-c-1 fumigation treatment; T-108-a combined fumigation and cold treatment; and T-107-a cold treatment (https://manuals.cphst.org/TIndex/index.cfm).

Table 2. Interception on *Persea americana* from Hawaii, as reported in the AQAS Pest ID database from 1985 to August 2011 (PestID, 2011).					
Organism	Host	County	Imported As	Where Intercepted	Number of Interceptions
Acarina	*Persea americana*	Hawaii	Fruit	Baggage	1
Aleyrodidae	*Persea americana*	Hawaii	Leaf	Baggage	1
Bactrocera cucurbitae	*Persea americana*	Hawaii	Fruit	Baggage	11
Bactrocera dorsalis	*Persea americana*	Hawaii	Fruit	Baggage	221
Bactrocera dorsalis	*Persea americana*	Hawaii	Fruit	Permit Cargo	3
Bactrocera spp.	*Persea americana*	Hawaii	Fruit	Baggage	40
Bactrocera spp.	*Persea americana*	Hawaii	Plant	Mail	1
Ceratitis capitata	*Persea americana*	Hawaii	Fruit	Baggage	4
Ceratitis capitata	*Persea americana*	Hawaii	Fruit	Mail	1
Dacinae	*Persea americana*	Hawaii	Fruit	Baggage	1
Dacinae	*Persea americana*	Hawaii	Fruit	Permit Cargo	1
Diaspididae	*Persea americana*	Hawaii	Fruit	Baggage	3
Diaspididae	*Persea americana*	Hawaii	Fruit	Mail	3
Diptera	*Persea americana*	Hawaii	Fruit	Baggage	3
Margarodidae	*Persea americana*	Hawaii	Fruit	Mail	1
Sphaceloma spp.	*Persea americana*	Hawaii	Fruit	Baggage	1
Tephritidae	*Persea americana*	Hawaii	Fruit	Baggage	203
Tortricidae	*Persea americana*	Hawaii	Leaf	Baggage	1

2.4 Pest Categorization – Identification of Quarantine Pests and Quarantine Pests likely to Follow the Pathway

PPQ adheres to the accepted international definition of quarantine pest: *a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled* (IPPC, 1996; Hopper, 1996). The first step in identifying quarantine pests is to present a comprehensive pest list of potential quarantine pests known to occur in the country and region from which the commodity is to be exported. The list includes all pests in the exporting country/region known to be associated with the parent species of 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, 1996). The listed pests may or may not occur in the United States.

There are two primary components to the definition of quarantine pest (IPPC, 1996; Hopper, 1996). 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 scientific evidence, through the literature, demonstrates that an organism has an association with the plant species being assessed. Thus, all of the listed organisms are potential quarantine pests. Second, to be considered a quarantine pest, an organism must satisfy geographic and regulatory criteria, specifically, the pest must be "not yet present there or present but not widely distributed and being officially controlled" (IPPC, 1996; Hopper, 1996). A quarantine pest is "a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled" (ISPM #5; IPPC, 2009).
The information collected and provided in the risk assessment documents shows how each organism satisfies these criteria. Pertinent geographic and regulatory information, *i.e.*, with respect to the exporting country and the United States, will be provided on the comprehensive pest list. If none of the potential quarantine pests satisfy the geographic and regulatory criteria as a quarantine pest, the PRA stops. Table 3 shows the pest list for avocado, *Persea americana*, from Hawaii. This pest list identifies: (1) the presence or absence of these pests in the continental United States, (2) the generally affected plant part or parts, (3) the quarantine status of the pest with respect to the continental United States, (4) whether the pest is likely to follow the pathway to enter the continental United States on commercially exported avocado, and (5) pertinent citations for either the distribution or the biology of the pest. A pest is considered to follow the pathway if it is associated with the fruit.

Step 4b. Identify Quarantine Pest Likely to Follow the Pathway
Quarantine pests identified as likely to be associated with the potential export commodity are subject to Steps 5-7. The biology and pest potential for these pests are documented as possible. It is reasonable to assume that these quarantine pest will be present in the exporting region; be associated with the commodity at the time of harvest; and remain with the commodity in viable form during harvesting, packing, and shipping procedures.

There are some quarantine pests listed that are not expected to follow the pathway; for example, a pest may be only associated with plant parts other than the commodity or a pest may not reasonably be expected to remain with the commodity during harvest and packing.

Pests not expected to follow the pathway were not considered further. Supporting information was documented on the pest list or in the text. The decision not to further analyze a particular pest applies only to the current PRA; a pest may pose a different level of risk for the same commodity from a different country or from a different commodity from the same host plant species. Should any of the pests be intercepted in shipments of the commodity, quarantine action may be taken at the port-of-entry, and additional risk analyses may be conducted.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution**[1]	**Plant Part Affected**	**Quarantine Pest**[2]	**Follow Pathway**	**References**
Arthropods					
Acari					
Tarsonemidae					
Polyphagotarsonemus latus (Banks)	HI, US	fruit, leaf, flower, stem	No	Yes	Jeppson, *et al.* 1975; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004
Tenuipalpidae					
Brevipalpus californicus= Brevipalpus australis	HI, US	fruit, leaf, flower, stem	No	Yes	CABI, 2011; Ebeling, 1959
Brevipalpus phoenicis (Geijskes)	HI, US	fruit, leaf, flower, stem	No	Yes	Childers et al., 2003; CABI, 2011
Tetranychidae					
Eotetranychus sexmaculatus (Riley)	HI, US	leaf	No	No	Jeppson, *et al.* 1975; Bolland, *et al.* 1998; Wysoki, *et al.* 2002; UH-CTAHR 2005a
Oligonychus biharensis Hirst	HI	leaf[3]	Yes	No	Bolland, *et al.* 1998; Bishop Museum 2004

[1] [1]Distribution (specific states are listed only if distribution is limited): AL = Alabama; CA = California; FL = Florida; GA = Georgia; HI = Hawaii; LA = Louisiana; MS = Mississippi; TX = Texas; PR= Puerto Rico VI=Virgin Islands; US = continental United States.

[2] Brackets [ ] around the quarantine status designation indicate that the pest has a limited distribution in the continental United States and is either under official control or under consideration for official control.

[3] *Oligonychus biharensis:* Although no information could be found on the feeding behavior of this specific mite on avocado, it is assumed that it would be similar to mites in the genus *Oligonychus,* such as: *O. coffeae, O. punicae, O. persea,* and *O. yothersi.* Each of these mites are found on the dorsal surface of the avocado leaves, first along the midrib, then along secondary vein leaves (Crane, *et al*. 2002; Wysoki, *et al*. 2002).

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Oligonychus coffeae (Nietner)	HI, US	leaf	No	No	Bolland, *et al.* 1998; Wysoki, *et al.* 2002; Bishop Museum 2004
Oligonychus mangiferus (Rahman & Sapra)	HI, US	leaf	No	No	Bolland, *et al.* 1998; Crane, *et al.* 2002; Bishop Museum 2004
Oligonychus perseae Tuttle, Baker and Abbatiello	HI, US	leaf	No	No	SBC 1997; Muthukrishnan, *et al.* 2001; Tanako-Lee and Hoddle 2002; Wysoki, *et al.* 2002; HDOA 2005
Oligonychus yothersi (McGregor)	HI, US	leaf	No	No	Jeppson, *et al.* 1975; McMurtry 1985; Bolland, *et al.* 1998; Crane, *et al.* 2002; Wysoki, *et al.* 2002
Panonychus citri (McGregor)	HI, US	leaf	No	No	Bolland, *et al.* 1998; Bishop Museum 2004; CABI 2004
Tetranychus gloveri (Banks)	HI, US	leaf	No	No	Bolland, *et al.* 1998
Tetranychus neocaledonicus Andre	HI, US	leaf	No	No	Bolland, *et al.* 1998; Bishop Museum 2004
Tetranychus tumidus Banks	HI, US	leaf	No	No	Jeppson, *et al.* 1975; Bishop Museum 2004
Tetranychus urticae Koch	HI, US	leaf	No	No	Bolland, *et al.* 1998; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004
COLEOPTERA					
Anthribidae					
Araecerus fasciculatus (De Geer)	HI, US	fruit, root, seed, stem	No	Yes	Bishop Museum 2004; CABI 2004
Bostrichidae					

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution**[1]	**Plant Part Affected**	**Quarantine Pest**[2]	**Follow Pathway**	**References**
Sinoxylon conigerum Gerstaeker	HI	Stem, twig, branch	No[4]	No[5]	Bishop Museum 2004; CABI 2004; Halbert 1996 (in SWPM)
Cerambycidae					
Lagocheirus araneiformis (L.)	HI, US	stem	No	No	Bishop Museum 2004; CABI 2004
Chrysomelidae					
Diabrotica balteata Leconte[6]	**HI, US**	flower, leaf, root	No	No	Ebeling, 1959, HDOA, 2010
Curculionidae					
Araecerus fasciculatus (Degeer)	HI, US	fruit, root, seed, stem	No	Yes	Bishop Museum 2004; CABI 2004
Caulophilus oryzae (Gyllenhal)	HI, US	seed	No	Yes	Bishop Museum 2004; CABI 2004; HDOA 2005
Elytroteinus subtruncatus Fairmaire	HI	seed , stem	Yes	No[7]	Mau and Martin-Kessing 1992a; Bishop Museum 2004; HDOA 2005
Pantomorus cervinus (Boheman) Syn: *Asynonychus godmanni*	HI, US	leaf, root, fruit	No	Yes	CABI 2004
Nitidulidae					
Carpophilus marginellus (Motschulsky.)	HI, US	fruit	No	Yes	Hill 1983; Bishop Museum 2004
Platypodidae					

[4] Action only required for Peurto Rico and U.S. Virgin Islands (PestID, 2011).
[5] The beetle, S*inoxylon conigerum*, mainly feeds on woody trunks and branches. Although Sharwil avocados can be imported with intact stem end or pedicel, this beetle is not likely to feed on the fresh, green wood; therefore, it can reasonably be excluded from the pathway. Additionally, there has never been any instance of this insect being intercepted on avocado at any U.S. port from anywhere in the world.
[6] *Diabrotica balteata* was first detected in Hawaii in 2008 (HDOA, 2010). It is unclear whether a sustaining population still occurs in Hawaii, as there is no reported evidence that *D. balteata* no longer occurs in Hawaii, it was included on this pest list.
[7] *Elytroteinus subtruncatus*, Fijian ginger weevil, is primarily a root pest. It has been found on seeds of avocados on the ground, but it does not attack or bore into fruit (Mau and Martin-Kessing, 1992a). Thus, this species is not expected to follow the pathway.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Crossotarsus externedentatus (Fairmaire)	HI, US	leaf, twig, branch	No	No	Wood and Bright 1992; Bishop Museum 2004
Platypus cupulatus Chapuis	HI	twig, branch, wood	Yes	No	Wood and Bright 1992; Malaysia Dept. Agric. [durian trunk borer]
Scarabidae					
Adoretus sinicus	HI	leaf, flower	Yes	No	Mau and Martin-Kessing 1991a; CABI 2004; UH-CTAHR 2005a
Protaetia fusca	HI	leaf, flower	Yes	No	CABI 2004; UH-CTAHR 2005b
Scolytidae					
Coccotrypes cyperi (Beeson)	HI, US	fruit	No	Yes	Atkinson & Peck 1994; Wood and Bright 1992; Bishop Museum 2004
Coccotrypes dactyliperda (F.)	HI, US	fruit	No	yes	Wood and Bright 1992; Atkinson & Peck, 1994
Euwallacea fornicatus (Eichhoff)	HI	twig, branch,	Yes	No[8]	Hill 1983; Wood and Bright 1992; Bishop Museum 2004; CABI 2004; UH-CTAHR 2005a; UPASI 2003

[8] The beetle *Euwallacea fornicatus*, mainly feeds on woody trunks and branches. Although Sharwil avocados can be imported with intact stem end or pedicel, this beetle is not likely to feed on the fresh, green wood; therefore, it can reasonably be excluded from the pathway. Additionally, there has never been any instance of this insect being intercepted on avocado at any U.S. port from anywhere in the world.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Hypothenemus eruditus Westwood	HI, US	twig, branch, fruit	No	Yes	Wood and Bright 1992; Wood 1982 (wide range of plant parts); USDA APHIS PPQ 2005 (fruits not avocado)
Hypothenemus seriatus (Eichhoff)	HI, US	fruit, seed, twig	No	Yes	Wood and Bright 1992; Bishop Museum 2004
Xyleborinus saxeseni (Ratzeburg)	HI, US	twig, branch, stem, trunk	No	No	Wood and Bright 1992; Bishop Museum 2004; CABI 2004; Wood 1982 (damaged wood >4 mm diam.)
Xyleborus ferrugineus (F.)	HI, US	twig, branch, trunk	No	No	Bishop Museum 2004; CABI 2004; Atkinson & Peck, 1994
Xyleborus perforans (Wollaston)	HI	twig, branch, fruit	Yes	No[9]	Wood and Bright 1992; Bishop ; Museum 2004; CABI 2004; USDA APHIS PPQ 2005 (mango fruit)
Xyleborus volvulus (F.)	HI, US	twig, branch, trunk	No	No	Wood and Bright 1992; Bishop Museum 2004; CABI 2004

[9] The beetle, *Xyleborus perforans,* mainly feeds on woody trunks and branches. Although Sharwil avocados can be imported with intact stem end or pedicel, this beetle is not likely to feed on the fresh, green wood; therefore, it can reasonably be excluded from the pathway. Additionally, there has never been any instance of this insect being intercepted on avocado at any U.S. port from anywhere in the world.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Xylosandrus compactus (Eichhoff)	HI, US	twig, branch	No	No	Hill 1983; Wood and Bright 1992; Tenbrink and Hara 1994; Crane, *et al.* 2002; Bishop Museum 2004; CABI 2004; HDOA 2005; UH-CTAHR 2005a; Wood 1982
Xylosandrus crassiusculus (Motschulsky)	HI, US	fruit	No	Yes	Mau and Martin-Kessing 1991c; Wood and Bright 1992; Crane, *et al.* 2002; Bishop Museum 2004; CABI 2004; UH-CTAHR 2005a; Halbert 1996 (fruit); Wood 1982
Xylosandrus morigerus (Blandford)	HI	twig, branch	Yes	No[10]	Wood and Bright 1992; CABI 2004
DIPTERA					
Muscidae					
Atherigona orientalis Schiner	HI, US	Ebeling, 1959	No	Yes	Ebeling, 1959; CABI, 2011

[10] The beetle *Xylosandrus morigerus*, mainly feeds on woody trunks and branches. Although Sharwil avocados can be imported with intact stem end or pedicel, this beetle is not likely to feed on the fresh, green wood; therefore, it can reasonably be excluded from the pathway. Additionally, there has never been any instance of this insect being intercepted on avocado at any U.S. port from anywhere in the world.

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Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Tephritidae[11]					
Bactrocera cucurbitae Coquillett	HI	fruit	Yes	No	Allwood *et al.*, 1991 (not on host list); Armstrong *et al.*, 1983 Harris *et al.* 1986 (HI survey not found in avocado); White and Elson-Harris 1992 (secondary source, lists avocado); Bishop Museum 2004 (present in HI); CABI 2004 (secondary source, lists avocado); HDOA 2005 (present in HI)Bishop_Museum, 2004; CABI, 2004; HDOA, 2005; White and Elson-Harris, 1992; USDA APHIS PPQ, 2005 (12 of 300 int. from HI 1985-2005 on avocado)

[11] The fruit fly infestation-free quarantine procedure approved for the movement of mature green Sharwil avocado from Hawaii into the mainland United States was approved in September 1990 and suspended in February 1992, because of the discovery of oriental fruit fly, *Bactrocera dorsalis*, larval infestation in fruits on trees in certified orchards. However, the integrity of infestation-free quarantine procedure for melon fly, *Bactrocera cucurbitae*, and Mediterranean fruit fly, *Ceratitis capitata*, was supported by Liquido *et al*. (1995). Armstrong (1991) and Armstrong *et al*. (1983) concluded that mature green Sharwil avocado fruits attached on trees are resistant to infestation by oriental, melon, and Mediterranean fruit flies. Data gathered by Liquido *et al.* (1995) concurred with the findings of Armstrong (1991) and Armstrong *et al*. (1983) on melon and Mediterranean fruit flies, but disputed the latter's conclusion on oriental fruit fly. Liquido *et al.* (1995) concluded that mature green Sharwil avocado fruits are suitable hosts of oriental fruit fly, albeit, poor hosts. *Bactrocera dorsalis* follows the pathway of moving mature green Sharwil avocado from Hawaii into the mainland United States, and is analyzed in this document. *Bactrocera cucurbitae* and *Ceratitis capitata* do not follow the pathway based on Armstrong (1991), Armstrong *et al*. (1983), and Liquido *et al*. (1995).

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Bactrocera dorsalis (Hendel)	HI	fruit	Yes	Yes	Mau and Martin-Kessing 1992b; White and Elson-Harris 1992; Drew and Hancock 1994; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; HDOA 2005; UH-CTAHR 2005a; USDA APHIS PPQ, 2005
Ceratitis capitata (Wiedemann)	HI	fruit	Yes	No	Liquido, *et al.* 1991; Mau and Martin-Kessing 1992c; White and Elson-Harris 1992; Metcalf and Metcalf 1993; Liquido, *et al.* 1998; Hancock, *et al.* 2000; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; HDOA 2005; UH-CTAHR 2005a; USDA APHIS PPQ, 2005
HEMIPTERA					
Aleyrodidae					
Aleurocanthus woglumi Ashby	HI, US (FL)	leaf, stem	[Yes]	No	Hill 1983; Nguyen, Hamon *et al.* 1998; Wysoki, van den Berg *et al.* 2002; Bishop_Museum 2004; CABI 2004; HDOA 2005; USDA APHIS PPQ 2005 (on citrus, other fruit)

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution**[1]	**Plant Part Affected**	**Quarantine Pest**[2]	**Follow Pathway**	**References**
Aleurodicus dispersus Russell	HI, US	leaf, fruit	No[12]	Yes	Martin-Kessing and Mau 1993a; Bishop Museum 2004; CABI 2004; UH-CTAHR 2005a Bishop_Museum, 2004; CABI, 2004; Martin-Kessing and Mau, 1993; UH-CTAHR, 2005; USDA APHIS PPQ, 2005 (on many fruits)
Aleurodicus dugesii Cockerell	HI, US (FL, CA)	leaf, fruit	No	No	Ebeling 1959; Wysoki, *et al.* 2002; HDOA 2005; USDA APHIS PPQ 2005 (no fruit interceptions)
Aleurothrixus floccosus (Maskell)	HI, US	fruit, leaf, flower, stem	No	Yes	CABI 2004; USDA APHIS PPQ 2005 (int. on banana, citrus fruit)
Aleurotrachelus trachoides (Back)	HI, US	leafEvans, 2008Evans, 2008	No	No	Evans, 2008
Aleurothrixus floccosus (Maskell)	HI, US	Evans, 2008	No	No	Evans, 2008
Bemisia argentifolii Bellows and Perring	HI, US	fruit, leaf, stem	No	No	Mau and Lee 1992; CABI 2004; HDOA 2005; UH-CTAHR 2005a; USDA APHIS PPQ 2005 (no fruit int., only leaf)

[12] Action on required on propagative material (PestID, 2011), therefore, this pest was not examined further in this assessment as the subject of this PRA is fruit for consumption.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Bemisia tabaci (Gennadius)	HI, US	leaf	No	No	Evans, 2008; Vasquez et al., undated; CABI, 2011
Dialeurodes citri (Ashmead)	HI, US	fruit, flower, leaf, stem	No	Yes	CABI, 2011; Evans, 2008
Dialeurodes kirkaldyi (Kotinsky)	HI, US	leaf, flower, stem	No	No	Evans, 2008
Parabemisia myricae (Kuwana)	HI, US (FL, CA)	leaf, stem,	[Yes]	No	Bishop_Museum 2004; CABI 2004; USDA APHIS PPQ 2005 (no fruit int.)
Paraleyrodes persea (Quaintance)	HI, US	leaf,	No	No	UH-CTAHR 2005a; USDA APHIS PPQ 2005 (no fruit int.)
Trialeurodes abutiloneus (Haldeman)	HI, US	fruit, leaf, flower, stem	No	Yes	Evans, 2008
Trialeurodes vaporariorum (Westwood)	HI, US (FL)	fruit, leaf, flower, stem	No	Yes	Wysoki, van den Berg *et al.* 2002; Bishop_Museum 2004; CABI 2004; USDA APHIS PPQ 2005 (few fruir int., mostly leaf)
Aphididae					
Aphis craccivora Koch	HI, US	leaf, stem	No	No	Hill 1983; Blackman and Eastop 1994; Bishop_Museum 2004; CABI 2004

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Aphis gossypii	HI, US	leaf, flower, stem	No	No	Hill 1983; Martin-Kessing and Mau 1991; Blackman and Eastop 1994; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; HDOA 2005; UH-CTAHR 2005a
Aphis spiraecola Patch	HI, US	fruit, flower, leaf, stem	No	Yes	CABI, 2011; Ebeling, 1959
Myzus persicae (Sulzer)	HI, US	flower, leaf, stem, growing points	No	No	Hill 1983; Blackman and Eastop 1994; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004
Toxoptera aurantii (Fonscolombe)	HI, US	flower, leaf	No	No	Blackman and Eastop 1994; Bishop Museum 2004
Asterolecaniidae					
Asterolecanium pustulans (Cockerell)	HI, US	leaf, stem	No	No	CABI 2004; UH-CTAHR 2005aCABI, 2004; UH-CTAHR, 2005
Bambusaspis bambusae (Boisduval)	HI, US	leaf, stem	No	No	Ben-Dov et al., 2010
Eucalymnatus tessellatus (Signoret)	HI, US	leafEbeling, 1959Ebeling, 1959	No	No	Ebeling, 1959; Ben-Dov et al., 2010
Parthenolecanium persicae (Fabricius)	HI, US	leaf, stem	No	No	Ben-Dov et al., 2010; CABI, 2011
Cicidellidae					
Empoasca stevensi Young	HI, US	leaf, stem, twig (egg)	No	No	Mau and Martin-Kessing 1992d; HDOA 2005; UH-CTAHR 2005a

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Sophonia rufofascia	HI, US	leaf, stem, twig (egg)	No	No	Bishop Museum 2004; CABI 2004; Jones, *et al.* 2004; HDOA 2005; UH-CTAHR 2005a
Coccidae					
Ceroplastes ceriferus	HI, US	fruit, leaf, stem	No	Yes	Hill 1983; USDA ARS SEL, 2005
Ceroplastes cirripediformis Comstock	HI, US	fruit, leaf, stem	No	Yes	Ebeling 1959; Hill 1983; Bishop Museum 2004
Ceroplastes floridensis	HI, US	fruit, leaf, stem	No	Yes	Hill 1983; Crane, *et al.* 2002; USDA ARS SEL, 2005
Ceroplastes rubens Maskell	HI, US (FL)	fruit, leaf, stem	[Yes]	Yes	Ebeling 1959; Hill 1983; Williams and Watson 1990; Bishop Museum 2004;USDA ARS SEL, 2005; USDA APHIS PPQ, 2005 (reportable, APHIS program being considered)
Coccus hesperidum (L.)	HI, US	fruit, leaf, stem	No	Yes	Ebeling 1959; Williams and Watson 1990; Wysoki, *et al.* 2002; Bishop Museum 2004; USDA ARS SEL, 2005
Coccus longulus	HI, US	fruit, leaf, stem	No	Yes	Williams and Watson 1990; Bishop Museum 2004; USDA ARS SEL, 2005

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Coccus viridis (Green)	HI, US (FL)	fruit, leaf, stem	[Yes]	Yes	Williams and Watson 1990; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005; USDA APHIS PPQ, 2005 (reportable, APHIS program being considered)
Kilifia acuminate (Signoret) *Coccus acutissimus*	HI, US	leaf, stem, fruit	No	Yes	Williams and Watson 1990; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005
Milviscutulus mangiferae (Green)	HI, US	leaf, stem, fruit	No	Yes	Williams and Watson 1990; Bishop Museum 2004; USDA ARS SEL, 2005
Parasaissetia nigra (Nietner)	HI, US	leaf, stem, fruit	No	Yes	Williams and Watson 1990; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005
Parthenolecanium persicae ssp. *persicae* (Fabricius)	HI, US	leaf, stem, fruit	No	Yes	USDA ARS SEL, 2005
Prococcus acutissimus (Green)	HI, US	leaf, fruit	No	Yes	USDA ARS SEL, 2005
Pulvinaria mammeae *(*Maskell)	HI, US	leaf, stem, fruit	No	Yes	Mau and Martin-Kessing 1992e; HDOA 2005; UH-CTAHR 2005a

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Pulvinaria psidii (Maskell)	HI, US	fruit, leaf, flower, stem	No	Yes	Mau and Martin-Kessing 1992f; Bishop_Museum 2004; CABI 2004; UH-CTAHR 2005a; USDA ARS SEL, 2005
Saissetia coffeae (Walker)	HI, US	leaf, stem, fruit	No	Yes	Williams and Watson 1990; Metcalf and Metcalf 1993; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005
Saissetia miranda (Cockerell & Parrott)	HI, US	leaf, stem, fruit	No	Yes	Bishop Museum 2004; USDA ARS SEL, 2005
Saissetia olea (Bernard)	HI, US	leaf, stem, fruit	No	Yes	Bishop_Museum 2004; CABI 2004; USDA ARS SEL, 2005
Diaspididae					
Abgrallaspis cyanophylli (Signoret)	HI, US	fruit, leaf, stem	No	Yes	Martin-Kessing and Mau 1993b; Bishop Museum 2004; USDA ARS SEL, 2005; UH-CTAHR 2005a
Abgrallaspis palmae (Cockerell)	HI, US	fruit, leaf, stem	No	Yes	HDOA 2005
Aspidiotus destructor Signoret	HI, US	fruit, leaf, stem	No	Yes	Hill 1983; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005; HDOA 2005

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Aspidiotus nerii	HI, US	fruit, leaf, stem	No	Yes	Crane, *et al.* 2002; Bishop Museum 2004; USDA ARS SEL, 2005; HDOA 2005
Chrysomphalus aonidum (L.)	HI, US	fruit, leaf, stem	No	Yes	Metcalf and Metcalf 1993; Crane, *et al.* 2002; Bishop Museum 2004; USDA ARS SEL, 2005
Chrysomphalus bifasciculatus Ferris	HI, US	leaf	No	No	Ebeling, 1959; Ben-Dov et al., 2010
Chrysomphalus dictyospermi (Morgan)	HI, US	fruit, leaf, stem	No	Yes	Crane, *et al.* 2002; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005
Diaspidiotus perniciosus (Comstock)	HI, US	fruit, leaf, stem	No	Yes	CABI, 2011; Ben-Dov et al., 2010
Diaspis boisduvalii Signoret	HI, US	leaf	No	No	Ebeling, 1959; Ben-Dov et al., 2010
Fiorinia fioriniae (Targioni Tozzetti)	HI, US	fruit, leaf, stem	No	Yes	Wysoki, *et al.* 2002; Bishop Museum 2004; USDA ARS SEL, 2005; UH-CTAHR 2005a
Hemiberlesia lataniae (Signoret)	HI, US	fruit, leaf, stem	No	Yes	Nakahara 1982; Hill 1983; Tenbrink and Hara 1992a; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; HDOA 2005; UH-CTAHR 2005a

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Hemiberlesia palmae (Cockerell)	HI, US	leaf	No	N/A	Ebeling, 1959; Ben-Dov et al., 2010
Hemiberlesia rapax (Comstock)	HI, US	fruit, leaf, stem	No	Yes	Ebeling 1959; Nakahara 1982; Tenbrink and Hara 1992b; Wysoki, *et al.* 2002; Bishop Museum 2004; USDA ARS SEL, 2005; UH-CTAHR 2005a
Howardia biclavis (Comstock)	HI, US	fruit, leaf, stem	No	Yes	Bishop Museum 2004; USDA ARS SEL, 2005
Ischnaspis longirostris (Signoret)	HI, US	leaf, stem, fruit	No	Yes	Bishop Museum 2004; USDA ARS SEL, 2005; Tenbrink & Hara, 1992c
Morganella longispina (Morgan)	HI, US	flower, stem, fruit	No	Yes	Crane, *et al.* 2002; HDOA 2005
Lepidosaphes beckii (Newman)	HI, US	leaf, fruit	No	Yes	Ebeling, 1959; Ben-Dov et al., 2010
Lindingaspis rossi (Maskell) = *Chrysomphalus rossi*	HI, US	leaf	No	No	Ben-Dov et al., 2010; Ebeling, 1959
Lopholeucaspis cockerelli	HI, US	fruit, leaf, stem	No	Yes	Bishop_Museum 2004; USDA ARS SEL, 2005
Oceanaspidiotus spinosus (Comstock)	HI, US	leaf, bark, fruit	No	Yes	Bishop Museum 2004; USDA ARS SEL, 2005
Parlatoria proteus (Curtis)	HI, US	leaf,	No	No	Ebeling, 1959; Ben-Dov et al., 2010
Pinnaspis aspidistrae (Signoret)	HI, US	fruit, leaf, stem	No	Yes	Watson, undated; Ben-Dov et al., 2010

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Pinnaspis strachani (Cooley)	HI, US	fruit, leaf, stem	No	Yes	Tenbrink and Hara 1992d; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005; UH-CTAHR 2005a
Pseudaulacaspis cockerelli (Cooley)	HI, US	fruit, leaf, stem	No	Yes	Bishop Museum 2004; USDA ARS SEL, 2005
Pseudoparlatoria parlatorioides (Comstock)	HI, US	fruit, leaf, stem	No	Yes	Ebeling, 1959; Ben-Dov et al., 2010
Unaspis citri (Comstock)	HI, US	stem, leaf, fruit	No	Yes	Ben-Dov et al., 2010
Miridae					
Hyalopeplus pellucidus (Stal)	HI	flower, leaf, fruit	Yes	No[13]	Mau and Martin-Kessing 1992g; HDOA 2005; UH-CTAHR 2005a; Schaefer and Panizzi, 2000
Margarodidae					
Icerya purchasi Maskell	HI, US	leaf, stem	No	No	Ebeling 1959; Nakahara 1982; Bishop Museum 2004; CABI 2004
Pentatomidae					
Brochymena quadripustulata F.	HI, US	leaf, stem	No	No	Alvarz, M. *et al.* 1967; Henry and Froeschner 1988; Bishop Museum 2004

[13] *Hyalopeplus pellucidus* is in the family Miridae, which feed and insert their eggs on opening buds, leaves, flowers, and small fruit. Attacks seem to mainly affect flowers and recently set fruit, causing them to prematurely drop (Mau and Martin-Kessing 1992g). Since only mature green Sharwil avocados will be harvested, this pest is unlikely to be introduced into the United States via this pathway.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Nezara viridula (Linnaeus) (Hemiptera: Pentatomidae)	HI, US	leaf, stem, growing points, flower, fruit	No	No	Hill 1983; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; HDOA 2005
Pseudococcidae					
Dysmicoccus brevipes (Cockerell)	HI, US	leaf, stem, root, fruit	No	Yes	Hill 1983; Martin-Kessing and Mau 1992; Bishop Museum 2004; USDA ARS SEL, 2005
Dysmicoccus neobrevipes Beardsley	HI	leaf, stem, fruit	Yes	Yes	Bishop Museum 2004; CABI 2004; UH-CTAHR 2005a; USDA APHIS PPQ, 2005
Ferrisia virgata (Cockerell)	HI, US	leaf, fruit, stem, growing points	No	Yes	Hill 1983; Arnett 1985; Bishop Museum 2004; CABI 2004
Maconellicoccus hirsutus (Green)	HI, US (CA, FL)	leaf, stem, fruit, root, flower	[Yes]	Yes	USDA APHIS PPQ, 2005; Hill 1983; Persad 1995; Hoy, *et al.* 2003; Bishop Museum 2004; USDA ARS SEL, 2005 (APHIS Program pest)Ben-Dov et al., 2005a, 2005b; Bishop_Museum, 2004; Hill, 1983; Hoy et al., 2003; Persad, 1995

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Nipaecoccus nipae (Newstead)	HI, US	leaf, flower, fruit	No	Yes	Ebeling 1959; Hill 1983; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005; HDOA 2005
Nipaecoccus viridis (Newstead)	HI, US (CA)	fruit, leaf, flower, stem	[Yes]	Yes	USDA ARS SEL, 2005 (reportable, APHIS program being considered)
Paracoccus marginatus Williams & Granara de Willink	HI, US (FL)	leaf, stem, fruit	[Yes]	Yes	CABI 2004; USDA APHIS PPQ, 2005; Walker & Hoy, 2003 (reportable, APHIS program being considered)
Phenacoccus gossypii Townsend & Cockerell	HI, US	fruit, leaf, root, flower, stem	No	Yes	CABI, 2011; Ebeling, 1959
Planococcus citri (Risso)	HI, US	fruit, leaf, root, flower, stem	No	Yes	Ebeling 1959; Williams and Watson 1988; Bishop Museum 2004; CABI 2004
Planococcus minor (Maskell)	HI, US (FL)	fruit, flower, leaf, root, stem	[Yes]	Yes	Ben-Dov et al., 2010; Buss, 2006; NAPIS, 2011
Pseudococcus cryptus Hempel	HI	fruit, leaf, flower, stem	Yes	Yes	Hill 1983; Bishop Museum 2004; USDA ARS SEL, 2005
Pseudococcus jackbeardsleyi (Gimpel & Miller)	HI, US	fruit, leaf, flower, stem	No	Yes	Hill 1983; CABI 2004

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Pseudococcus longispinus (Targioni-Tozzetti)	HI, US	fruit, leaf, flower, stem	No	Yes	Ebeling 1959; Hill 1983; Tenbrink and Hara 1993; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; USDA ARS SEL, 2005; UH-CTAHR 2005a
HYMENOPTERA					
Formicidae					
Solenopsis geminata (Fabricius)	HI, US	fruit, seed, stem	No	Yes	Ebeling, 1959; CABI, 2011
LEPIDOPTERA					
Noctuidae					
Chrysodeixis eriosoma (Doubleday) [=*C. chalcites* (Esper) according to some authorities]	HI	fruit, leaf	Yes	No[14]	Zhang, 1994 (secondary source, avocado not listed); Zimmerman 1958 (primary source, avocado not listed); CABI 2004 (secondary source, avocado listed); USDA APHIS PPQ 2005 (only in fruits tomato and pepper [18 int.], mostly on leaves [260 int.] 1985-2005)
Peridroma saucia (Hübner)	HI, US	fruit flower, leaves, seed, stem	No	No[15]	CABI, 2011

[14] Although CABI (2011) lists avocados as a host of this pest, after a thorough search of the scientific literature, no corroborative information could be found regarding avocado as a host. Additionally, *Chrysodeixis eriosoma* is mainly a leaf feeder (CABI, 2011). Larvae may feed externally on fruit (CABI, 2011), and unlikely to remain on the commodity through harvest and processing.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution**[1]	**Plant Part Affected**	**Quarantine Pest**[2]	**Follow Pathway**	**References**
Spodoptera exempta (Walker)	HI, US	leaf, stem	No	No	PNKTO; CABI 2004
Pyralidae					
Cryptoblabes gnidiella (Milliere)	HI	fruit	Yes	Yes [16]	Carter 1984; Zhang 1994 (HI but avocado not listed); McQuate, *et al.* 2000; Bishop Museum 2004; CABI 2004; Wysoki 1999
Tortricidiae					
Amorbia emigratella Busck	HI, US	leaf, fruit	No	Yes	Ebeling 1959; Zhang 1994; Wysoki, *et al.* 2002; Bishop Museum 2004; HDOA 2005; UH-CTAHR 2005a

[15] *Peridroma saucia* feeds externally on fruit (CABI, 2011), and is unlikely to remain with avaocado fruit through harvest.

[16] *Cryptoblabes gnidiella* is considered a major pest of avocados in Israel (Wysoki, 1999). It is occasionally a secondary feeder and generally lays its eggs on wounds made by the feeding of other insects, such as fruit flies (Liquido, personal observation). In citrus, *Cryptoblabes gnidiella* is known to also be associated with mealybug infestation, specifically *Planococcus citri* (Silva & Mexica, 1999) which occurs in Hawaii. It is assumed that *Cryptoblables gnidiella* may follow the pathway of unmitigated fruit infested with fruit flies and/or *Planococcus citri*. Additionally, *Cryptoblabes* spp. has been intercepted on various fruit at U.S. ports of entry over 50 times, which supports their ability to follow the fruit pathway even as a secondary feeder (USDA APHIS PPQ, 2005).

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Epiphyas postvittana (Walker)	HI, US (CA)	fruit, leaf	[Yes]	Yes[17]	Ebeling 1959; Zhang 1994; Wysoki, *et al.* 2002; Bishop Museum 2004; HDOA 2005; UH-CTAHR 2005; PNKTO-INKTO; USDA APHIS PPQ 2005 (1985-2005 20 of 21 ints. in apple, peach, blueberry, blackberry, nectarine, and strawberry, but not avocado); Stevens *et al.* 1995 (major NZ avocado pest)
Platynota stultana Walsingham	HI, US	leaf, flower, fruit	No	Yes	Zhang 1994; Bishop Museum 2004; CABI 2004
ORTHOPTERA					
Gryllotalpidae					
Gryllotalpa africana	HI	root, seed, stem	Yes	No	PNKTO; CABI 2004
Tettigoniidae					
Elimaea punctifera (Walker)	HI	leaf, flower	Yes	No	Martin-Kessing and Mau 1993c; UH-CTAHR 2005a
THYSANOPTERA					
Thripidae					

[17] *Epiphya postvittana* is a major pest of avocado in Australia and New Zealand, and has been intercepted several times at U.S. Ports of entry in avocado and other fruit commodities from these countries (USDA APHIS PPQ, 2005). The light brown apple moth (LBAM), *Epiphyas postvittana* (Tortricidae), is a native pest of Australia and is now widely distributed New Zealand, the United Kingdom, Ireland, and New Caledonia. Although it was reported in Hawaii in the late 1800s, a recent LBAM detection in California is the first on the United States mainland. USDA confirmed the detection of LBAM in Alameda County, California on March 22, 2007. *Epiphyas postvittana* is currently under official control in the U.S.It has been reported to cause internal fruit damage by entering through the calyx (Meijerman & Ulenberg, 2000).

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Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Chaetanaphothrips orchidii (Moulton)	HI, US	flower, leaf	No	No	Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004
Frankliniella insularis (Franklin)	HI, US	flower, leaf	No	No	Hoddle et al., 2002; Hoddle et al., 2008
Frankliniella minuta (Moulton)	HI, US	flower	No	No	Johansen-Naime et al., 2003; Hoddle et al., 2008
Frankliniella occidentalis (Pergande)	HI, US	flower, leaf	No	No	Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004
Heliothrips haemorrhoidalis (Bouché)	HI, US	fruit, leaf	No	Yes	Ebeling 1959; Muthukrishnan, *et al.* 2001; Wysoki, *et al.* 2002; Bishop Museum 2004; CABI 2004; UH-CTAHR 2005a
Scirtothrips citri (Moulton)	HI, US	fruit, leaf	No for US Yes for HI	Yes	Zimmerman, 1948; Hoddle et al., 2008; Hoddle et al., 2002; CABI, 2007
Scirtothrips perseae Nakahara	HI, US	fruit	No	Yes	Whiley et al., 2002; CABI, 2011
Selenothrips rubrocinctus (Giard)	HI, US	fruit, flower, leaf	No	Yes	Ebeling 1959; Hill 1983; Muthukrishnan, *et al.* 2001; Crane, *et al.* 2002; Bishop Museum 2004; CABI 2004; UH-CTAHR 2005b

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Thrips hawaiiensis (Morgan)	HI, US	leaf, stem, flower	No	No	Mau and Martin-Kessing 1992h; Muthukrishnan, *et al.* 2001; CABI 2004; HDOA 2005; UH-CTAHR 2005a
Thrips palmi Karny	HI, US (CA, FL, TX)	leaf, growing point, fruit	[Yes]	No[18]	Nakahara 1982; Hill 1983; Bishop Museum 2004; CABI 2004; USDA APHIS PPQ, 2005 (reportable, APHIS considering program)
Thrips tabaci Lindeman	HI, US	flower, leaf	No	No	CABI, 2011; Peña et al., 2002
Plant Pathogens					
Bacteria					
Rhizobium radiobacter (Beijerinck & van Delden) Young *et al.* Rhizobiales: Rhizobiaceae	HI, US	root, stem	No	No	CABI, 2004
Rhizobium rhizogenes (Riker *et al.*) Young *et al.* Rhizobiales: Rhizobiaceae	HI, US	root, stem	No	No	CABI, 2004
Fungi					
Alternaria alternata (Fr.:Fr.) Keissl.	HI, US	fruit	No	Yes	CABI, 2004; USDA ARS SBML, 2005
Alternaria citri Ellis & N. Pierce in N. Pierce	HI, US	fruit, leaf	No	Yes	USDA ARS SBML, 2005; CABI, 2004

[18] If avocado fruit will be exported without leaf and peduncle and fruits are washed and sorted before the shipment then is expected that external feeders in general including thrips would be unlikely to follow the pathway with fruit. Thrips are likely to be present on the fruit surface, especially during the first stage of fruit development, producing scraping and deformities; however this insect is not likely to remain on the surface of developed fruit, because they prefer to stay under leaves (Duran *et al*., 1999). The smooth skin of this fruit without leaf and stem and does not provide opportunity for thrips to remain with the fruit.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Armillaria mellea (Vahl: Fr.) P. Kumm. Agaricales: Tricholomataceae	HI, US	root, stem (lower)	No	No	USDA ARS SBML, 2005; UCIMP, 2003
Athelia rolfsii (Curzi) C. C. Tu & Kimbr. Polyporales: Corticiaceae *Pellicularia rolfsii* *Sclerotium rolfsii*	HI, US	fruit, flower, leaf, root, seed, stem	No	Yes	USDA ARS SBML, 2005; CABI, 2003
Botryosphaeria dothidea (Moug.) Ces. & de Not. Dothideales: Botryosphaeriaceae	HI, US	fruit, leaf	No	Yes	USDA ARS SBML, 2005; Everett, 1996; CSREES, 2004
Botryosphaeria obtusa (Romagn.) Herink Dothideales: Botryosphaeriaceae *Physalospora obtusa*	HI, US	fruit, stem	No	Yes	USDA ARS SBML, 2005; CABI, 2004; Killgore, 2005; UH-CTAHR, 2005
Botryosphaeria parva Dothideales: Botryosphaeriaceae Post harvest stem end rot	HI, US	fruit	No	Yes	USDA ARS SBML, 2005; Everett, 1996
Botryosphaeria quercuum (Schwein.) Shoem. Dothideales: Botryosphaeriaceae	HI, US	wood	No	No	USDA ARS SBML, 2005
Botryosphaeria ribis Grossenb. & Duggar Dothideales: Botryosphaeriaceae	HI, US	fruit, shoot, flower, leaf, stem	No	Yes	USDA ARS SBML, 2005; CABI, 2004
Botryosphaeria ribis f. *chromogena* Dothideales: Botryosphaeriaceae	HI, US	fruit, shoot, flower, leaf, stem[19]	No	Yes	USDA ARS SBML, 2005
Botryosphaeria ribis var. *chromogena* Dothideales: Botryosphaeriaceae	HI, US	fruit, shoot, flower, leaf, stem	No	Yes	USDA ARS SBML, 2005
Botrytis cinerea Pers.:Fr. Helotiales: Sclerotiniaceae	HI, US	leaf, stem, fruit	No	Yes	USDA ARS SBML, 2005; CABI, 2004

[19] No biological information is available on *Botryosphaeria ribis* f. *chromogena* and *Botryosphaeria ribis* var. *chromogena*. Plant parts affected by *Botryosphaeria ribis* var. *chromogena* are assumed to be the same as *Botryosphaeria ribis*.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Calonectria insularis Hypocreales: Nectriaceae	HI	leaf, shoot, stem[20]	Yes	No	USDA ARS SBML, 2005
Calonectria pauciramosa Hypocreales: Nectriaceae	HI, US (FL)	leaf, shoot, stem	[Yes]	No	USDA ARS SBML, 2005; Polizzi & Catara, 2001
Ceratocystis fimbriata Ellis & Halst. Microascales: Ceratocystidaceae	HI, US	fruit, leaf, stem, root	No	Yes	USDA ARS SBML, 2005; CABI, 2004
Pseudocercospora purpurea (Cooke) Deighton Synonym: *Cercospora purpurea* Cooke	HI, US	wood, leaf, fruit, stem	No	Yes	CABI, 2004; USDA ARS SBML, 2005; Morton, 1987; Crane, *et al.*, 2001; Killgore, 2005
Cercospora spp.	HI	wood, leaf, fruit	Yes	Yes	USDA ARS SBML, 2005; UH-CTAHR, 2005
Cladosporium herbarum (Pers.:Fr.) Link	HI, US	fruit	No	Yes	USDA ARS SBML, 2005
Colletotrichum crassipes (Spegazzini) von Arx	HI, US	leaf, fruit	No	Yes	USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994a
Colletotrichum gloeosporioides (Penz.) Sacc.	HI, US	leaf, twig, fruit	No	Yes	USDA ARS SBML, 2005; UH-CTAHR, 2005; Everett, 1996; Crane, *et al.*, 2001; Killgore, 2005
Cylindrocladiella parva (P.J. Anderson) Boesewinkel	HI, US	seedling, root	No	No	USDA ARS SBML, 2005
Cylindrocladium scoparium Morg. Hypocreales: Hypocreaceae	HI, US	root, leaf, stem	No	No	USDA ARS SBML, 2005

[20] There is no published biological information on plant parts affected by *Calonectria insularis*. The closely related species *Calonectria pauciramosa*, avocado pest occurring in Hawaii, attacks leaves, shoots, and stems. It is assumed that *C. insularis* also feeds on leaves, shoot, and stems.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Cylindrocladium spp.	HI	root	Yes	No	USDA ARS SBML, 2005; Killgore, 2005; UH-CTAHR, 2005
Diplodia natalensis	HI, US	wood, fruit	No	Yes	USDA ARS SBML, 2005
Discosia spp.	HI	leaf	Yes	No	CSREES, 2004
Dothiorella spp.	HI, US	stem, fruit, branch	No	Yes	USDA ARS SBML, 2005; UH-CTAHR, 2005; Everett, 1996; Crane, *et al.*, 2001; Killgore, 2005; CSREES, 2004
Flavodon cervino-gilvus	HI	wood	Yes	No	USDA ARS SBML, 2005; CSREES. 2004; Rahgukumar & Rivonkar, 2001; Gilbertson & Adaskaveg, 1993; Gilbertson, *et al.*, 2002
Fomitopsis nivosa Polyporales: Fomitopsidaceae	HI, US (SC, FL)	wood	[Yes]	No	USDA ARS SBML, 2005; Gilbertson & Adaskaveg, 1993; Gilbertson, *et al.*, 2002
Fusarium javanicum Koord. Hypocreales *Alternaria brassicicola*	HI, US	root	No	No	Killgore, 2005; USDA ARS SBML, 2005
Fusarium solani (Mart.) Sacc. Hypocreales: Hypocreaceae	HI, US	root, stem	No	No	USDA ARS SBML, 2005
Ganoderma lucidum (Curtis:Fr.) P. Karst. Ganodermatales: Ganodermataceae	HI, US	stem	No	No	USDA ARS SBML, 2005

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Gloeosporium spp. Coelomycetes: Melanconiales	HI	leaf	Yes	No	UH-CTAHR, 2005; Gonsalves & Ferreira, 1994b
Glomerella cingulata (Stonem.) Spauld. & Schrenk Phyllachorales : Phyllachoraceae	HI, US	fruit, leaf, stem, flower	No	Yes	CABI, 2004; USDA ARS SBML, 2005; UH-CTAHR, 2005; Gonsalves & Ferreira, 1994c
Lasiodiplodia theobromae Xylariales: Hyponectriaceae *Botryodiplodia theobromae* *Botryosphaeria rhodina*	HI, US	fruit, root	No	Yes	CABI, 2004; USDA ARS SBML, 2005; Everett, 1996; CSREES, 2004
Microporus flabelliformis (Fr.) Kuntze Polyporales: Polyporaceae	HI	wood	Yes	No	USDA ARS SBML, 2005
Mycoacia kurilensis Polyporales: Meruliaceae	HI	wood	Yes	No	USDA ARS SBML, 2005; Gilbertson, *et al.*, 1976; Hjortstam & Ryvanrden, 1996; Gilbertson, *et al.*, 2002
Mycosphaerella tassiana (de Not.) Johanson Mycosphaerellales: Mycosphaerellaceae	HI, US	leaf, stem, bark, branch	No	No	CABI, 2004; USDA ARS SBML, 2005
Nectria haematococca (Wollenw.) Gerlach Hypocreales: Nectriaceae	HI, US	leaf, stem, root	No	No	CABI, 2004
Nectria pseudotrichia Berk. & M.A. Curtis Hypocreales: Nectriaceae	HI, US	bark, wood	No	No	USDA ARS SBML, 2005
Nectria rugulosa Pat. & Gaillard Hypocreales: Nectriaceae	HI	Bark, wood	Yes	No	USDA ARS SBML, 2005

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Nitschkia broomeiana (Berk.) Nannf. Sordariales: Nitschkiaceae *Fracchiaea heterogenea*	HI, US	bark, wood[21]	No	No	USDA ARS SBML, 2005; Bianchinotti, 2004
Penicillium expansum Link	HI, US	fruit	No	Yes	USDA ARS SBML, 2005; Everett, 1996
Phanerochaete australis Polyporales: Phanerochaetaceae	HI	wood	Yes	No	USDA ARS SBML, 2005; Gilbertson & Adaskaveg, 1993
Phellinus gilvus (Schwein.:Fr.) Pat. Hymenochaetales: Hymenochaetaceae	HI, US	wood	No	No	USDA ARS SBML, 2005; Martens, *et al.*, 1996; Gilbertson & Adaskaveg, 1993
Phellinus grenadensis (Murrill) Ryvarden Hymenochaetales: Hymenochaetaceae	HI, US (LA)	wood	[Yes]	No	USDA ARS SBML, 2005
Phlebia acanthocystis Polyporales: Meruliaceae	HI	wood	Yes	No	USDA ARS SBML, 2005; Gilbertson & Adaskaveg, 1993; Gilbertson, *et al.*, 2002
Phlebiella tulasnelloidea (Höhn. & Litsch.) Oberw.	HI, US	wood, bark	Yes	No	USDA ARS SBML, 2005
Phomopsis spp.	HI	stem, fruit	Yes	Yes	UH-CTAHR, 2005; Everett, 1996
Phytophthora cactorum (Lebert & Cohn) Schröter Pythiales: Pythiaceae	HI, US	fruit, leaf, stem, root	No	Yes	CABI, 2004; USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994d
Phytophthora cambivora (Petri) Buisman Pythiales: Pythiaceae	HI, US	root	No	No	USDA ARS SBML, 2005

[21] There is no published biological information on plant parts affected by *Nitschkia broomeiana*. *Nitschkia* species (*N. campylospora* and *N. pilosa*) have been collected from the bark and wood of leguminous shrub in Argentina (Bianchinotti, 2004). Most *Nitschkia* species are saprophytic on branches or decorticated wood (Bianchinotti, 2004); it is therefore assumed that *N. broomeiana* infests bark and woods.

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Phytophthora capsici Leonian Pythiales: Pythiaceae	HI, US	fruit, leaf, stem, root	No	Yes	USDA ARS SBML, 2005; CABI, 2004; Gonsalves & Ferreira, 1994d
Phytophthora cinnamomi Rands Pythiales: Pythiaceae	HI, US	root, leaf, fruit	No	Yes	CABI, 2004; USDA ARS SBML, 2005; UCIPM, 2003; UH-CTAHR, 2005; Crane, *et al.*, 2001; Killgore, 2005; Gonsalves & Ferreira, 1994d
Phytophthora citricola Sawada Pythiales: Pythiaceae	HI, US	trunk, root, bark, fruit	No	Yes	CABI, 2004; USDA ARS SBML, 2005; UCIPM, 2003; Everett, 1996
Phytophthora citrophthora (R.E. Sm. & E.H. Sm.) Leonian Pythiales: Pythiaceae	HI, US	fruit, leaf, stem, root	No	Yes	USDA ARS SBML, 2005; CABI, 2004; Gonsalves & Ferreira, 1994d
Phytophthora cryptogea Pethybr. & Laff Pythiales: Pythiaceae	HI, US	leaf, stem, root, fruit	No	Yes	CABI, 2004
Phytophthora megasperma Drechsler Pythiales: Pythiaceae	HI, US	fruit, leaf, stem, root	No	Yes	USDA ARS SBML, 2005; CABI, 2004
Phytophthora nicotianae Breda de hann var. parasitica (Dastur) Pythiales: Pythiaceae	HI, US	fruit, shoot, leaf, stem, root	No	Yes	CABI, 2004; USDA ARS SBML, 2005
Phytophthora nicotianae var. *parasitica* (Dastur) G.M. Waterhouse Pythiales: Pythiaceae *Phytophthora parasitica*	HI, US	leaf, fruit, root	No	Yes	USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994d
Phytophthora palmivora (E. J. Butler) E. J. Butler Pythiales: Pythiaceae	HI, US	fruit, shoot, flower, leaf, stem, root	No	Yes	USDA ARS SBML, 2005; CABI, 2004

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana*)					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Pythium coloratum Vaartaja Saprolegniales	HI, US	root	No	No	USDA ARS SBML, 2005; El-Tarabily, *et al.*, 1997
Pythium debaryanum Hesse Saprolegniales	HI, US	root	No	No	USDA ARS SBML, 2005; CABI, 2004; Gonsalves & Ferreira, 1994e
Pythium irregulare Buisman Saprolegniales	HI, US	root, stem	No	No	USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994e
Pythium oligandrum Drechsler Saprolegniales	HI, US	biological fungicide seedling, root	No	No	USDA ARS SBML, 2005
Pythium rostratum E.J. Butler Saprolegniales	HI, US	seedling, root	No	No	USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994e
Pythium splendens Braun Saprolegniales	HI, US	leaf, stem, root	No	No	USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994e
Pythium spp. Saprolegniales	HI, US	root	No	No	USDA ARS SBML, 2005; Killgore, 2005
Pythium torulosum Coker & Patt. Saprolegniales	HI, US	leaf, root	No	No	USDA ARS SBML, 2005
Pythium ultimum Trow Saprolegniales	HI, US	root	No	No	USDA ARS SBML, 2005; Univ. of Illinois, 2002; Gonsalves & Ferreira, 1994e
Pythium vexans de Bary Saprolegniales	HI, US	leaf, root	No	No	CABI, 2004; USDA ARS SBML, 2005; Gonsalves & Ferreira, 1994e

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Rhizoctonia solani Kuhn Ceratobasidiales: Ceratobasidiaceae *Thanatephorus cucumeris*	HI, US	leaf, stem, root, shoot, flower, fruit, seed	No	Yes	USDA ARS SBML, 2005; CABI, 2004; Gonsalves & Ferreira, 1994f
Rhizoctonia spp. Ceratobasidiales: Ceratobasidiaceae	HI	root	Yes	No	USDA ARS SBML, 2005; Killgore, 2005
Rhizopus stolonifer (Ehrenb.:Fr.) Vuill. Mucorales: Mucoraceae *Rhizopus nigricans*	HI, US	fruit	No	Yes	USDA ARS SBML, 2005; Everett, 1996
Rigidoporus microporus (Fr.) Overeem Polyporales: Meripilaceae	HI	wood, flower, leaf, stem, root	No	No	USDA ARS SBML, 2005; CABI, 2004
Rosellinia necatrix Prill. Xylariales: Xylariaceae	HI, US	root, leaf, stem	No	No	CABI, 2004; USDA ARS SBML, 2005
Sclerotinia sclerotiorum (Lib.) de Bary Helotiales: Sclerotiniaceae	HI, US	fruit, flower, leaf, stem, root, seed	No	Yes	CABI, 2004; USDA ARS SBML, 2005
Sphaeropsis tumefaciens Hedges Lecanorales: Acarosporaceae	HI, US (FL)	stem, branch, shoot	No	No	CABI, 2004; USDA ARS SBML, 2005; Strandberg, 2002
Thanatephorus cucumeris (Frank) Donk Ceratobasidiales: Ceratobasidiaceae	HI, US	fruit, shoot, flower, leaf, root, seed, stem	No	Yes	USDA ARS SBML, 2005; CABI, 2004
Trametes versicolor Hymenochaetales: Hymenochaetaceae	HI, US	(dead) wood	No	No	USDA ARS SBML, 2005
Trichoderma harzianum Rifai	HI, US	biological control of soil inhabiting fungi	No	No	USDA ARS SBML, 2005; CABI, 2004
Trichothecium roseum (Pers.:Fr.) Link	HI, US	fruit	No	Yes	CABI, 2004; USDA ARS SBML, 2005; Everett, 1996
Verticillium albo-atrum Reinke & Berthier	HI, US	leaf, branch, root, fruit	No	Yes	CABI, 2004; USDA ARS SBML, 2005; UCIMP, 2003

Table 3. Pests in Hawaii Associated with Avocado (*Persea americana)*					
Pest Scientific Name	**Geographic Distribution[1]**	**Plant Part Affected**	**Quarantine Pest[2]**	**Follow Pathway**	**References**
Verticillium dahliae Kleb.	HI, US	leaf, stem, fruit	No	Yes	CABI, 2004; USDA ARS SBML, 2005
Bacteria and Phytoplasmas					
Agrobacteriurn tumefaciens (Smith & Town.) Conn	HI, US	stem, leaf	No	No	Teliz, 2000; UGA, 2010
Erwinia carotovora subsp. c*arotovora* (Jones) Bergey *et al.* Synonym: *Pectobacterium carotovorum* subsp. *carotovorum* (Jones) Hauben et al. emend. Gardan et al.	HI, US	leaf, root, stem	No	No	Bradbury, 1986; CABI, 2011; HEAR, 2005
Erwinia herbicola (Lijhnis) Dye Synonym: *Pantoea agglomerans* (Ewing and Fife) Gavini	HI, US	fruit	No	Yes	Fucikovsky, 1987; HEAR, 2005; CABI, 2011
Pseudomonas syringae pv. *syringae* van Hall	HI, US	leaf, fruit, stem	No	Yes	HEAR, 2005; C.M.I., 1988; Bradbury, 1986
Nematodes					
Radopholus similis (Cobb) Thorne	HI, US (CA, FL, TX)	root	[Yes]	No	Ferris, 2011; NGDC, 1984

Quarantine pests that could reasonably be expected to follow the pathway, *i.e*., be included in commercial shipments of avocado were analyzed in detail (Step 5-7, PPQ, 2000). Other plant pests in this assessment, not chosen for further scrutiny, may be potentially detrimental to the agricultural production systems of the United States; however, there were a variety of reasons for not subjecting them to further analysis. For example, they were mainly associated with plant parts other than the commodity; they may be associated with the commodity, but it was not considered reasonable to expect these pests to remain with the commodity during processing; or they have been intercepted as biological contaminants of these commodities during inspection by Plant Protection and Quarantine Officers, but would not be expected to be present with every shipment. In addition, the biological hazard of organisms identified only to the genus level is not assessed due to the lack of adequate biological taxonomic information. This lack of biological information on any given insect or pathogen should not be equated with low risk. By necessity, pest assessments focus on those organisms for which biological information is available. By developing detailed assessments for known pests that inhabit a variety of niches on the parent species, *e.g*., on the surface of or within the bark/wood, on the foliage, *etc*., effective mitigation measures may be developed to eliminate the known organism and any similar unknown ones that inhabit the same niches. The organisms in this risk assessment that were identified only to genus level were *Cercospora* species, *Dothiorella* species, *Phomopsis* species, and *Pythium* species.

The quarantine pests likely to follow the pathway of the movement of Sharwil avocado (*Persea americana*) from Hawaii into the continental U. S. are further analyzed in this risk assessment and, are summarized in Table 4.

Table 4. Quarantine Pests likely to be associated with avocado imported from Hawaii
Arthropoda:
Bactrocera dorsalis (Hendel) (Diptera: Tephritidae)
Ceroplastes rubens Maskell (Homiptera: Coccidae)
Coccus viridis (Green) (Hemiptera: Coccidae)
Cryptoblabes gnidiella Millière (Lepidoptera: Pyralidae)
Dysmicoccus neobrevipes Beardsley (Hemiptera: Pseudococcidae)
Epiphyas postvittana (Walker) (Lepidoptera: Tortricidae)
Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae)
Nipaecoccus viridis (Newstead) (Hemiptera: Pseudococcidae)
Paracoccus marginatus (Hemiptera: Pseudococcidae)
Planococcus minor (Homoptera: Pseudococcidae)
Pseudococcus cryptus Hempel (Hemiptera: Pseudococcidae)

2.5. Analysis of Quarantine Pests

For the quarantine pests selected for further analysis, we assessed their likelihood of introduction into the continental United States and the undesirable consequences that may result from their introduction. We rated the pests using the criteria in the *Guidelines for Pathway-Initiated Pest Risk Assessments*, *Version 5.02* (PPQ, 2000). We calculated a cumulative risk rating, or Pest Risk Potential, for each pest by summing all risk element values. Below we summarize the values for each pest (Table 7).

The major sources of uncertainty present in this risk assessment include the use of a developing or evolving process (Orr et al., 1993; PPQ, 2000), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Kaplan, 1992; Orr et al., 1993). To address this last source of uncertainty, the lists of factors were interpreted as illustrative and not exhaustive, implying that additional biological information, even if not explicitly part of the criteria, can be used when relevant to a rating. Other sources of uncertainty include the quality of the biological information and the amount of information available on the regional flora and fauna. Inherent biological variation within a population of organisms introduces uncertainty as well (Morgan and Henrion, 1990).

2.5.1 Consequences of Introduction

For the quarantine pests listed in Table 4, we rated the potential Consequences of Introduction using five Risk Elements: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact, and Environmental Impact. These elements reflect the biology, host ranges, and climatic/geographic distributions of the pests. For each Risk Element, we assigned pests a rating of Low (1 point), Medium (2 points), or High (3 points) (PPQ, 2000). We then calculated a Cumulative Risk Rating by summing the Risk Element values. We summarized the ratings for the Consequences of Introduction for each pest below (Table 5).

Consequences of Introduction: *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction Except for adventive populations in Guam and Hawaii, *B. dorsalis* is restricted to subtropical and tropical Asia (White & Elson-Harris, 1992). It is estimated that this species could become established in the continental United States in areas corresponding to Plant Hardiness Zones 9-11 (USDA ARS, 1990).	Medium (2)
Risk Element #2: Host Range The oriental fruit fly, *B. dorsalis*, is a serious pest of a wide range of plant species (CABI, 2003). Its host species include Moraceae (*Artocarpus altilis*, *Artocarpus heterophyllus, Ficus racemosa*), Rutaceae (*Aegle marmelos, Citrus aurantiifolia, Citrus*, *Citrus maxima*, *Citrus reticulata*), Anacardiaceae (*Anacardium occidentale, Mangifera foetida, Spondias purpurea, Mangifera indica*), Arecaceae (*Areca catechu*), Rubiaceae (*Coffea Arabica*), Sapotaceae (*Chrysophyllum cainito, Mimusops elengi, Manilkara zapota*), Cucurbitaceae (*Cucumis melo, Cucumis sativus, Momordica charantia*), Sapindaceae (*Dimocarpus longan*, *Nephelium lappaceum, Litchi chinensis*), Ebenaceae (*Diospyros kaki*), Flacourtiaceae (*Flacourtia indica*), Rosaceae (*Prunus avium*, *Prunus cerasus*, *Prunus mume, Prunus persica*, *Malus pumila, Pyrus communis, Prunus armeniaca*, *Prunus domestica*), Punicaceae (*Punica granatum*), Myrtaceae (*Syzygium aromaticum*, *Syzygium cumini, Psidium guajava, Syzygium aqueum*, *Syzygium jambos*, *Syzygium malaccense*, *Syzygium samarangense*), Rhamnaceae (*Ziziphus jujuba*, *Ziziphus mauritiana*), Annonaceae (*Annona reticulata*, *Annona squamosa*), Oxalidaceae (*Averrhoa carambola*), Caricaceae (*Carica papaya*), Solanaceae (*Capsicum annuum*), Malpighiaceae (*Malpighia glabra*), Musaceae (*Musa*), Tiliaceae (*Muntingia calabura*), Lauraceae (*Persea americana*), and Combretaceae (Terminalia catappa) (CABI, 2004, White & Elson-Harris, 1992).	High (3)

Risk Element #3: Dispersal Potential The life-cycle of *B. dorsalis* varies with seasons and locations (CABI, 2003); however, the oriental fruit fly completes one generation in about 30 days (Capinera, 2001). In Hawaii, the average life-cycle takes about 16 days (Mau & Martin, 1992). Female deposits eggs under the skin of fruit in clusters of 10-50 eggs; their total fecundity per female is approximately 1200 to 1500 eggs, but can be more than 3000 eggs under optimum conditions (Mau & Martin, 1992). Eggs hatch within a day (CABI, 2003; Mau & Martin, 1992), and the larva stage typically lasts for 11-15 days in Hawaii (Mau & Martin, 1992). Pupation is in the soil for 10-12 days (CABI, 2003; Mau & Martin, 1992). Females deposit 3-30 eggs per host fruit with a total fecundity (per female) that may exceed 1000 eggs (Fletcher, 1989b). There are several generations per year. *B. dorsalis* is capable of flying distances up to 65 km (Fletcher, 1989a) and the transport of infested fruit are the major means of movement and dispersal to previously uninfested areas (CABI, 2002). Like other dacine tephritids, *B. dorsalis* exhibits high reproductive and dispersal potentials.	High (3)
Risk Element #4: Economic Impact *Bactrocera dorsalis* is a serious pest of a wide range of fruits and vegetables; it can damage up to 100% of plants when not protected (CABI, 2003). Economic losses resulting from the attack of this pest are: 1) downgrading of quality caused by oviposition "stings," which spoil the appearance of fruits, including those unfavorable for larval survival; 2) fruit spoilage caused by larval tunneling and the entry of organisms of decay; and 3) indirect damage in the form of lost markets resulting from the imposition of quarantine restrictions (Harris, 1989). In Hawaii, annual losses in major fruit crops caused by *B. dorsalis* may exceed 13% or $3 million (Culliney *et al.*, 2003).	High (3)
Risk Element #5: Environmental Impact Because of its wide host range, *B. dorsalis* has a high threat potential to threatened and endangered species. Scrub plum (*Prunus geniculata*) and Florida ziziphus (*Ziziphus celata*), which are listed as Endangered species have the potential to be attacked by *B. dorsalis* (USFWS, 2002). The oriental fruit fly is a major pest of crops of economic significance in the continental United States (*e.g.*, apple, peach, pear, citrus); its entry and establishment could stimulate the initiation of chemical or biological control programs similar to programs that have been established in Hawaii.	High (3)

Consequences of Introduction: *Ceroplastes rubens* Maskell (Hemiptera: Coccidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction *Ceroplastes rubens* is widely distributed throughout the Orient, southern Asia, Australia, India, the South Pacific, east Africa, and the West Indies. This insect has become established in Florida and Hawaii; it has potential to establish in U.S. Plant Hardiness Zones 10-11 (USDA ARS, 1990).	Medium (2)
Risk Element #2: Host Range Primary host species include citrus (*Citrus*, *Citrus deliciosa*, *Citrus limon*, *Citrus reticulata*, *Citrus sinensis*, *Citrus unshiu*) (Rutaceae) and mango (*Mangifera indica*) (Anacardiaceae) (CABI, 2003). Other host species of *C. rubens* are Moraceae (*Artocarpus*, *Ficus*, *Morus alba*, *Artocarpus altilis*), Zingiberaceae (*Alpinia purpurata*), Annonaceae (*Annona*), Asteraceae (*Artemisia*, *Chrysanthemum*, *Helianthus*), Theaceae (*Camellia sinensis*), Arecaceae (*Cocos nucifera*), Lauraceae, (*Cinnamomum*, *Cinnamomum verum*, *Laurus nobilis*, *Persea*, *Persea americana*), Rubiaceae (*Coffea*, *Eugenia*), Malvaceae (*Hibiscus*), Sapindaceae (*Litchi chinensis*), Rosaceae (*Malus*, *Prunus*, *Prunus domestica*, *Prunus mume*, *Pyrus*, *Pyrus communis*), Musaceae (*Musa*), Myristicaceae (*Myristica*, *Myristica fragrans*), Apocynaceae (*Nerium*), Oleaceae (*Olea*), Piperaceae (*Piper*), Pinaceae (*Pinus*, *Pinus thunbergii*, *Pinus caribaea*), Myrtaceae (*Pimenta dioica*, *Psidium*, *Psidium guajava*, *Syzygium*), and Zingiberaceae (*Zingiber officinale*) (CABI, 2003).	High (3)
Risk Element #3: Dispersal Potential In Australia, where *Ceroplastes rubens* was accidentally introduced, this species has two generations per year (CABI, 2003). Oviposition begins in mid-September and ends in early December; it then begins again in mid-February, lasting until June (CABI, 2003). Females, on average, lay around 300 eggs, but can lay as little as five or as much as 1178 eggs (CABI, 2003). The mortality of *C. rubens* is related to the quality of the food source rather than natural enemies (CABI, 2003). In Australian studies, the mortality rate was highest in the first 24 hours after hatching, when approximately 50% of the hatchings were lost (CABI, 2003). Primary dispersal is accomplished via infected plant parts, which is facilitated by a wide range of host species for this pest (CABI, 2003). Only first-instar Coccoidea insects are dispersed by wind, but the distances carried by wind can be several kilometers to hundreds of kilometers, although mortality rates are higher at longer distances (Gullan & Kosztarab, 1997).	Medium (2)

Risk Element #4: Economic Impact This is a serious pest of citrus species and mango. In 2002, CA, TX, and FL produced over $2250 million worth of citrus (USDA NASS, 2004b). Hawaii produced $7 million of banana and $2 million of guava in 2002 (USDA NASS, 2004a). *Ceroplastes rubens* is a widespread pest of citrus, coffee, tea, *Cinnamomum*, mango, avocado, and litchi (CABI, 2003). It is a major pest of citrus in Australia, Hawaii, Korea, China, and Japan; direct economic damage is caused through phloem feeding and indirectly through the promotion of sooty mold growth (CABI, 2003). As the species appears to be established in parts of the United States, and under no apparent official control, further introductions are unlikely to result in the loss of foreign markets for domestically produced commodities.	Medium (2)
Risk Element #5: Environmental Impact This insect is already established in Hawaii and Florida (CABI, 2003). It has limited potential to destabilize the ecosystem, reduce the biodiversity, or eliminate threatened and endangered species. Furthermore, many closely related species of *C. rubens* are pests of many agricultural crops grown in the U.S. that are managed using pest control programs that include calendar insecticide sprayings, which are also expected to be effective against *C. rubens* infestations.	Low (1)

Consequences of Introduction: *Coccus viridis* (Green) (Homoptera: Coccidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction This species is pantropical in distribution. It has been reported from India through Indo-China, Malaysia, to the Philippines, and Indonesia, throughout much of Oceania and sub-Saharan Africa (CABI, 2004). In the New World, it is present in Florida and ranges from Central America to the northern part of South America and throughout the Caribbean. It is estimated that it could become established in additional areas of the continental United States corresponding to Plant Hardiness Zones 9-11. Survival outside of these areas would be limited to greenhouse or other artificial situations.	Medium (2)
Risk Element #2: Host Range This pest is often associated with citrus species (*Citrus deliciosa*, *Citrus limon*, *Citrus reticulata*, *Citrus sinensis*) in the family Rutaceae; however, it has wide host range. Potential hosts include Moraceae (*Artocarpus*), Theaceae (*Camellia sinensis*), Rubiaceae (*Coffea*, *Coffea arabica, Ixora*), Euphorbiaceae (*Manihot esculenta*), Anacardiaceae (*Mangifera indica*), Myrtaceae (*Psidium guajava*), Sterculiaceae (*Theobroma cacao*), Zingiberaceae (*Alpinia purpurata*), Asteraceae (*Chrysanthemum*), Sapotaceae (*Manilkara zapota*), Apocynaceae (*Nerium oleander*, *Plumeria rubra* var. *acutifolia*), and Lauraceae (*Persea americana*) (CABI, 2004).	High (3)

Risk Element #3: Dispersal Potential Females can lay up to 500 eggs, which can hatch within a few hours (CABI, 2004). Life-cycle generations vary from one month to several, depending on temperatures and available food supplies (CABI, 2003). There may be several generations per year (Gullian and Kosztarab, 1997). Although it has a high reproductive rate, there is no evidence of natural long range dispersal by *C. viridis* (CABI, 2004; Tandon & Veeresh, 1988). The scale can, and has, spread quickly and widely via the transport of infested plant materials and has been intercepted numerous times by PPQ on a variety of plants from many countries (USDA APHIS PPQ, 2005).	High (3)
Risk Element #4: Economic Impact *Coccus viridis* is a major pest of coffee in Haiti (Aitken-Soux, 1985) and India (Narasimham, 1987). In Brazil, infestations of 50 scales per plant caused significant damage to coffee seedlings, reducing leaf area and plant growth rate (Silva & Parra, 1982). This insect is a major cause of yield loss in coffee in New Guinea (Williams, 1986). In India, citrus fruit quality was significantly lower on trees following *C. viridis* infestation and the sooty mold (*Capnodium citri*) contamination that accompanied it (Haleem, 1984). This scale insect is a quarantine pest for Korea, New Zealand, and Venezuela (PRF, 2004); however, as it is established in parts of the continental United States, and under no apparent official control, additional introductions of the scale are considered unlikely to result in the further loss of foreign markets.	Medium (2)
Risk Element #5: Environmental Impact The extreme polyphagy of *C. viridis* predisposes it to attack vulnerable, native plants in the continental United States (*e.g.*, *Manihot walkerae*). Additional introductions of this species could have a negative impact on the citrus industry in areas, such as Arizona and Texas, and could stimulate the initiation of chemical or biological control programs, as has occurred in Hawaii and Puerto Rico (*e.g.*, Bartlett, 1978a). *Coccus viridis* already exists in Hawaii and Florida (CABI, 2004) and appears to have limited potential to destabilize the ecosystem, reduce the biodiversity, or eliminate threatened and endangered species. Furthermore, closely related species of *C. viridis* are pests of many agricultural crops grown in the U.S. These pests are managed using pest control programs including calendar insecticide sprayings; these chemical applications are also expected to be effective against *C. viridis* infestations.	Low (1)

Consequences of Introduction: *Cryptoblabes gnidiella* Millière (Lepidoptera: Pyralidae)	Risk Value
Risk Element #1: Climate – Host Interaction *Cryptoblabes gnidiella* is a cosmopolitan species in warm climates; however, it is unable to survive winters in the cooler temperate areas it may be imported into new areas along with produce (CABI, 2003). *Cryptoblabes gnidiella* 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, 2003). Its distribution corresponds to U.S. Plant Hardiness Zones 6-11 (USDA ARS, 1990).	High (3)
Risk Element #2: Host Range *Cryptoblabes gnidiella* is polyphagous and able to use almost any plant, but it is most often encountered on commercial crops. Host species include Rutaceae (Citrus spp.), Lauraceae (Persea americana) (Wysoki 1999), Punicaceae (Punica granatum), Vitaceae (Vitis spp.), Liliaceae (Allium sativum), Annonaceae (Annona muricata), Rubiaceae (Coffea spp.), Moraceae (Ficus spp., Morus alba), Malvaceae (Gossypium spp.), Anacardiaceae (Mangifera indica, Schinus terebinthifolius), Rosaceae (Mespilus spp.), Poaceae (Oryza sativa, Saccharum officinarum, Sorghum spp., Zea mays), Oleaceae (Osmanthus spp.), Fabaceae (Phaseolus spp.), Araceae (Philodendron spp.), Euphorbiaceae (Ricinus communis), Meliaceae (Swietenia spp.), and Sapindaceae (*Nephelium lappaceum*).	High (3)
Risk Element #3: Dispersal Potential About 100 eggs per female are laid on the fruit or foliage and hatch in 4-7 days; pupation takes place on the food plant or on the ground (CABI, 2003). There are three or four generations per year in Southern Europe and up to five in North Africa (CABI, 2003). The egg stage lasts about 3-4 days; larval stage is 9-10 days; pupal stage is 4-6 days; and the adult stage is 5-6 days (van den Berg *et al.*, 2001). *Cryptoblabes gnidiella* is frequently moved between countries in fruit commerce (USDA APHIS PPQ 2005). Although there is evidence that *C. gnidiella* can infest fruits as a secondary pest associated with Homoptera, it can also be a primary pest on some fruits Mau and Martin-Kessing, 1992; McQuate et al., 2000. It is known to be moved in commerce on imported fruit (CABI, 2004). For example, it was most likely spread through Europe on transported fruit Mau and Martin-Kessing, 1992. It has also been frequently intercepted at U.S. ports on a variety of fruit, including several shipments of fruit that originated in Hawaii (USDA APHIS PPQ, 2005).	High (3)

Risk Element #4: Economic Impact *Cryptoblabes gnidiella* is an important pest of citrus, grapes, and pomegranates in the Mediterranean area (CABI, 2003). It is most noted as a major pest of avocado in Israel (Wysoki 1999); azolla, sorghum and rice in India; and sporadically of corn or other crops in warm parts of the world (CABI, 2003). Corn is one of the crops with the biggest production in the United States. Corn, sorghum, and rice combined value was more than $27 billion in 2003 (USDA NASS, 2004c). The United States also produced more than $2.2 billion of citrus and $2.5 billion of grapes in 2003 (USDA NASS, 2004a). The losses caused by this pest are not quantified in literature, although in Israel, combined losses of macadamia nuts, as a result of *C. gnidiella*, *Ectomyelois ceratoniae* [*Apomyelois ceratoniae*] and the tortricid *Cryptophlebia leucotreta,* amounted to 30% (Wysoki, 1986).	High (3)
Risk Element #5: Environmental Impact Chemical and biological control are likely to be implemented upon introduction of *Cryptoblabes gnidiella*. As a polyphagous insect, it is potentially capable of attacking threatened and endangered *Allium* species.	High (3)

Consequences of Introduction: *Dysmicoccus neobrevipes* Beardsley (Homoptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Dysmicoccus neobrevipes* occurs throughout Central America, northern South America, the Caribbean, Indo-China, the Philippines, and in parts of Oceania (Miller & Miller, 2002; USDA ARS SEL, 2005; CABI, 2004). Outside of greenhouse or other artificial situations, this species should be able to survive in the warmer, southern parts of the United States (Plant Hardiness Zones 9-11) (USDA ARS, 1990). One or more of its potential hosts occurs in these Zones USDA NRCS, 2002.	Medium (2)
Risk Element #2: Host Range *Dysmicoccus neobrevipes* is highly polyphagous. Hosts include Bromeliaceae (*Ananas comosus*), Rosaceae (*Malus domestica*) (CABI, 2003), Araceae (*Colocasia esculenta, Pritchardia* sp.), Moraceae (*Ficus* sp.), Musaceae (*Musa paradisiaca*), Cactaceae (*Opuntia ficus-indica*), Fabaceae (*Acacia koa*, *Samanea saman*), Asteraceae (*Helianthus annuus*) (Nakahara, 1981); Agavaceae (*Agave sisalana*), Cucurbitaceae (*Cucurbita maxima*), Poaceae (*Zea mays*), Heliconiaceae (*Heliconia latispatha*), Lauracea (*Persea americana*), Rutaceae (*Citrus* spp.), and Solanaceae (*Lycopersicon esculentum*) (USDA ARS SEL, 2005).	High (3)

Risk Element #3: Dispersal Potential The life span of *D. neobrevipes* varies from 59-117 days, averaging at 90 days (Martin Kessing & Mau, 1992). This mealybug is ovoviviparous, meaning the eggs hatch within the female; female produces about 350 larvae for 30 days, but some produce up to 1000 larvae (Martin Kessing & Mau, 1992). There are three instars for female and four instars for male. The total larval period for female varies from 26-52 days, averaging at 35 days, whereas the total larval period for male lasts from 22-53 days. There may be several generations per year. As in all Coccoidea (Gullan & Kosztarab, 1997), the main dispersal stage of mealybugs is the first-instar crawler, which may be transported locally by wind or other animals. Dispersal over longer distances is accomplished through the movement of infested plant materials in commerce (CABI, 2004).	High (3)
Risk Element #4: Economic Impact *Dysmicoccus neobrevipes* attacks a number of valuable commercial crops, and is a particularly serious pest of pineapple, *Ananas comosus* (Rohrbach *et al*., 1988). Like *D. brevipes*, it is a vector of the virus causing pineapple wilt disease. Feeding by large mealybug populations may cause a loss of host plant vigor. Also, honeydew deposited on leaves and fruit by mealybugs serves as a medium for the growth of black sooty molds, which interfere with photosynthesis and reduce the market value of the crop. Insecticides are often applied to control these mealybugs or the attending ants that aid in their spread and interfere with biological control (Jahn *et al*., 2003). *Dysmicoccus neobrevipes* is a quarantine pest for Korea and New Zealand.	High (3)
Risk Element #5: Environmental Impact The species is polyphagous and may infest plants listed as threatened or endangered. Further introductions of *D. neobrevipes* would likely result in the initiation of chemical or biological control programs, as has occurred in Hawaii and Puerto Rico (Bartlett, 1978). However, closely related species of *D. neobrevipes* are pests of many agricultural crops grown in the U.S. that are managed using pest control programs including calendar spraying of insecticides; these chemical applications are also expected to be effective against *D. neobrevipes* infestations.	Medium (2)

Consequences of Introduction: ***Epiphyas postvittana*** **(Walker) (Lepidoptera: Tortricidiae)**	Risk Value
Risk Element #1: Climate – Host Interaction This species is found throughout Australia, New Zealand, and is also found in Hawaii. Based on this host range it is believed that the pest would only be capable of living in the Southern and southeastern United States, a distribution that corresponds to U.S. Plant Hardiness Zones 9-11 (USDA ARS, 1990).	Medium (2)
Risk Element #2: Host Range Hosts include: Actinidiaceae (*Actinidia chinensis*), Asteraceae (*Chrysanthemum x morifolium*), Rutaceae (*Citrus*), Rosaceae (*Cotoneaster, Malus pumila, Prunus armeniaca, Prunus persica, Pyrus, Rosa, Crataegus, Rubus*), Ebenaceae (*Diospyros*), Myrtaceae (*Eucalyptus, Feijoa sellowiana*), Cannabaceae (*Humulus lupulus*), Oleaceae (*Jasminum, Ligustrum vulgare*), Sapindaceae (*Litchi chinensis*), Fabaceae (*Medicago sativa*), Lauraceae (*Persea americana*) Pinaceae (*Pinus, Pinus radiata*), Salicaceae (*Populus*), Grossulariaceae (*Ribes*), Solanaceae (*Solanum tuberosum*), Fabaceae (*Trifolium, Vicia faba*), Ericaceae (*Vaccinium*), Vitaceae (*Vitis vinifera*) (Stevens et al. 1995; CABI, 2004.	High (3)
Risk Element #3: Dispersal Potential The light brown apple moth has a relatively high biotic potiential. The number of annual generations varies with latitude within its range, but in general, there is considerable overlap between generations, with development driven by temperature and larval host plant. There is no winter resting stage, although overwintering larvae tend to develop slowly, with a lower threshold of development for all stages of 7.5°C and an upper threshold of 31°C (Danthanarayana, 1975). In Australia, the number of generations varies from three to four, with three in most areas (Wearing et al., 1991). In New Zealand, three to four overlapping generations are completed annually (CABI, 2004). Long distance dispersal is typically achieved by adults (CABI, 2004), although larval dispersal occurs over a short range. Internationally, it can be spread in fruit in commerce and has been intercepted at U.S. ports of entry on various fruits (including avocado) at least 45 times since 1985 (USDA APHIS PPQ 2005).	High (3)
Risk Element #4: Economic Impact Losses in Australia are estimated to be of the order of AU$21M per annum from a range of industries but there has been no similar estimation in other countries (CABI, 2004). The list of agricultural crops that could be damaged by this pest includes grapes, citrus, stone fruit (peaches, plums, nectarines, cherries, apricots) and many others. USDA confirmed the detection of *E.postvittana* in Alameda County, California on March 22, 2007. Intense control activities have contained *E. postvittana.*	Medium (2)

Risk Element #5: Environmental Impact Epiphyas postvittana may impact threatened and endangered species listed in Title 50, Part 17, Section 12 of the United States Code of Federal Regulations (50 CFR §17.12), such as Prunus geniculata (endangered species in FL), Ribes echinellum (threatened species in FL and SC), Solanum species, Trifolium amoenum (endangered species in CA), Trifolium stoloniferum (endangered species in AR, IL, IN, KS, KY, MO, OH, and WV), Trifolium trichocalyx (endangered species in CA), and Vicia species (USFWS, 2002).	High (3)

Consequences of Introduction: *Maconellicoccus hirsutus* (Green) (Homoptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction *Maconellicoccus hirsutus* is native to southern Asia (CABI, 2002). It is reported in northern and sub-Saharan Africa, the Middle East, south and southeast Asia, the Far East, Central America, Australia, and Oceania (CABI 2003). This pest currently has a limited distribution in the U.S., Hawaii, California, and Florida (Hoy *et al.,* 2003; Capinera, 2001). It is estimated that it could potentially become established in the United States Plant Hardiness Zones 9-11 (USDA ARS, 1990). One or more of its potential hosts occurs in these zones (USDA NRCS 2002).	Medium (2)
Risk Element #2: Host Range This species is extremely polyphagous. It has been recorded on plants in over 200 genera from 73 families, showing some preference for hosts in the Malvaceae, Fabaceae, and Moraceae (CABI, 2002). Hosts include: Acanthaceae (*Acanthus ilicifolius*, *Eranthemum pulchellum, Pachystachys lutea, Thumbergia erecta*), Amaranthaceae (*Achyranthes indica, Amaranthus* spp., *Celosia cristata*), Amaryllidaceae (*Calostemma* spp.) Anacardiaceae (*Mangifera indica, Schinus* spp., *Spondias* spp.), Annonaceae (*Annona* spp., *Canaga odorata*), Apiaceae (*Daucus carota*), Apocynaceae (*Allamanda* spp., *Carissa* spp., *Catharanthus roseus, Ervatamia coronaria, Nerium* spp., *Tabernamontana divaricata, Vinca minor*), Araceae (*Aglaonema* spp., *Alocasia cucullata, Anthurium andraeanum, Colocasia esculenta, Dieffenbachia* spp., *Philodendron* spp., *Scindapsus aureus, Syngonium podophyllum, Xanthosoma* spp.), Araliaceae (*Aralia* spp., *Brassaia actinophylla, Schefflera* spp., *Sciadophyllum pulchrum*), Basellaceae (*Basella alba*), Begoniaceae (*Begonia* spp.), Bignoniaceae (*Bignonia* spp., *Crescentia cujete, Jacaranda mimusifolia, Kigelia* spp., *Tabebuia* spp., *Tecoma* spp.,), Bombacaceae (*Ceiba pentandra*), Boraginaceae (*Cordia curssavica*), Cactaceae (*Opuntia* spp., *Pereskia bleo*), Caricaceae (*Carica papaya*), Casuarinaceae (*Casuarina* spp.), Chenopodiaceae (*Beta vulgaris, Chenopodium, album*), Combretaceae (*Quisqualis* sp., *Rhoeo* sp., *Terminalia* spp.), Compositae (*Bidens pilesa, Chrysanthemum coronarium, Cosmos* spp., *Dahlia* spp., *Emilia* sp., *Gerbera* spp., *Helicanthus annuus, Lactuca sativa, Mikania cordata, Parthenium hysterophorus, Symedrella nodifloa, Tithonia urticifolia*), Convolvulaceae (*Ipomoea* spp.), Crassulaceae (*Kalanchoe* sp.), Cucurbitaceae (*Cucumis* spp., *Cucurbita* spp.), Cyperaceae (*Cyperus* spp.), Dilleniaceae (*Tetracera* spp.), Dioscoraceae (*Dioscorea* spp.), Ebenaceae (*Diospyros kaki*), Euphorbiaceae (*Acalypha* spp., *Codiaeum* sp., *Croton* spp., *Euphorbia* spp., *Hevea* spp., *Macarangua* sp., *Manihot esculenta*., *Ohyllanthus amarus, Phyllanthus* spp., *Ricinus communis*), Fabaceae (*Acacia arabica, Albizia* spp., *Arachis hypogaea, Bauhinia* spp., *Caesalpinia* spp., *Cajanus* spp., *Calliandra* spp., *Cassia* spp., *Ceratonia siliqua, Clitoria ternatea, Crotalaria* sp., *Erythrina* spp., *Gliricidium sepium, Glycine max, Grewia* sp., *Inga* sp., *Leucaena glauca, Medicago sativa, mimosa pudica, Parkinsonia aculeate, Phaseolus mungo, Phaseolus vulgaris, Poinciana regia, Robinia pseudacacia, Samanea saman, Sena* spp., *Sesbania aegyptiaca, Tamarindus indica, Templetonia* sp., *Tephrosia* sp., *Vigna unguiculata*), Fagaceae (*Pasania* spp., *Quercus* spp.) Flacourtiaceae (*Flacourtis indica*), Gesneriaceae (*Chrysothemis pulchella*), Gramineae (*Saccharum officinarum, Zea*	High (3)

mays), Lamiaceae (*Clerodendrum aculeatum, Leonotis nepetifolia*), Lauraceae (*Persea americana*), Lecythidaceae (*Courouptia guianensis*), Liliaceae (*Asparagus* spp., *Cordyline terminalis, Dracaena* spp.), Lythraceae (*Lagerstroemia speciosa, Lawsonia* spp.), Malvaceae (*Abelmoschus esculentus, Abutilon indicum, Gossypium* spp., *Hibiscus* spp., *Holmskia sanguinea*, *Malvaviscus arboreus*, *Paritium* spp., *Pavonia* spp., *Thespesia* spp.), Melastomataceae (*Miconia cornifolia*), Meliaceae (*Azadirachta indica, Ficus* spp., *Morus* spp.), Moraceae (*Heliconia* spp., *Musda sp*), Myrtaceae (*Callistemon* spp., *Eugenia* spp., *Myrtus communis, Psidium guajava, Syzygium* spp.), Nyctaginaceae (*Bougainvillea* spp.), Oleaceae (*Jasminum* spp.), Orchidaceae (*Dendrobium* spp.), Oxalidaceae (*Averrhoa carambola*), Palmae (*Cocos nucifera, Phoenix* spp.), Passifloraceae (*Passiflora* spp.), Phytolacaceae (*Rivina humilis, Petiveria alliacea*), Piperaceae (*Peperomia pellucida, Piper tuberculatum*), Plumbaginaceae (*Plumbago auriculata*), Polygonaceae (*Cocoloba uvifera, Nephrolepis* spp.), Portulacaceae (*Portulaca* spp.), Proteaceae (*Grevillea robusta*), Rhamnaceae (*Colubrina arborescens, Ziziphus* spp.), Rosaceae (*Crataegus* spp., *Cydonia oblonga, Eriobotra japonica, Prunus* spp., *Pyrus* spp., *Rosa* sp.), Rubiaceae (*Coffea* spp., *Haldina cordifolia, Hamelia* spp., *Ixora* spp.), Rutaceae (*Aegle marmelos, Citrus* spp., *Murraya* spp., *Mussaenda* sp.), Salicaceae (*Salix* spp.), Sapindaceae (*Blighia sapida, Dodonaea viscose, Melicocca* spp.), Sapotaceae (*Manilkara zapota*), Scrophulariaceae (*Russelia equisetifolia, Scoparia dulcis*), Solnaceae (*Capsicum* spp., *Cestrum nocturnum, Datura* spp., *Lycopersicon esculentum, Solanum* spp.), Sterculiaceae (*Theobroma cacao*), Tiliaceae (*Corchorus olitorius*), Urticaceae (*Boehmeria nivea, Laportea aestuans*), Verbenaceae (*Tectona grandis*), Vitaceae (*Cissus verticillata, Vitis vinifera*), and Zigiberaceae (*Alpinia* spp.) (USDA ARS SEL, 2005).	
Risk Element #3: Dispersal Potential Each adult female can lay from 80-600 eggs over a one week period (Meyerdirk *et al,* 1996; CABI, 2004). Hatching occurs in 609 days (CABI, 2004). In warm conditions, a generation is completed in five weeks; in colder climates, the species survives cold conditions as eggs or other stages, on the host plant or in the soil. There may be as many as 15 generations per year. Local dispersal is accomplished by the first-instar crawler, most efficiently via air or water, or on animals (CABI, 2004). All stages may be dispersed over longer distances through the transport of infested plant materials.	High (3)
Risk Element #4: Economic Impact *Maconellicoccus hirsutus* attacks a wide range of (usually woody) plants, including agricultural, horticultural, and forest species (CABI, 204). Feeding on young growth causes severe stunting and distortion of leaves, thickening of stems, and a bunchy-top appearance of shoots; in severe cases the leaves may fall prematurely. Honeydew and sooty mold contamination of fruit may reduce its value. In Grenada, estimated annual losses to crops and the environment from this mealybug were $3.5 million before biological controls were implemented (CABI, 2004). Other crops seriously damaged by *M. hirsutus* include cotton in Egypt, with growth sometimes virtually halted; tree cotton in India, with reduction in yield; the fiber crop *Hibiscus sabdariffa* var. *altissima* (roselle) in India and Bangladesh, with reduction in yields of between 21 and 40%; and grapes in India, with up to 90% of bunches destroyed. It is a	High (3)

quarantine pest for Brazil, Chile, Colombia, Costa Rica, Korea, New Zealand, Panama, and Uruguay (PRF, 2004), suggesting that its widespread establishment in the United States could result in a loss of foreign markets for various commodities. This species is an actual or potential pest of a wide range of economically important plants; risk associated with its economic impact is estimated to be high. EPPO (2004c) records this as an A1 pest; thus, its establishment in the U.S. may lead to the loss of export markets. It is currently a program pest under official control.	
Risk Element #5: Environmental Impact Because of its extreme polyphagy, this pest poses a threat to plants in the continental United States listed as Threatened or Endangered, including *Cucurbita okeechobeensis* ssp. *Okeechobeensis* (FL), *Helianthus eggertii* (AL,KY, TN), *H. paradoxus (TX), H. schweinitzii (NC, SC), Manihot walkerae (TX), Opuntia treleasei (CA)*, *Rhododendron chapmanii (FL), Amaranthus pumilus (DE, MA, MD, NC, NJ, NY, RI, SC, VA), Euporbia telephiodes (FL), Prunus geniculata (FL*), and others (USFWS, 2002). It is also a potential threat to a number of crops of considerable economic value in the United States (*e.g.*, soybean, cotton, corn, citrus, grapes) (CABI, 2002). Its introduction into additional mainland states would lead to the initiation of chemical or biological control programs. This species is currently the target of an official program of biological control throughout its present range in the U.S. (Meyerdick *et al,* 1996). It has been targeted for biological control in other countries, such as Egypt and India (Bartlett, 1978b).	High (3)

Consequences of Introduction: *Nipaecoccus viridis* (Newstead) (Homoptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction This species is widespread in tropical and subtropical Asia, occurs throughout Africa and parts of Oceania, but has limited distribution in North America (CABI, 2003). It can survive in the warmer, southern parts of the United States (Plant Hardiness Zones 9-11).	Medium (2)
Risk Element #2: Host Range *Nipaecoccus viridis* has been recorded on host plants in more than 18 families (CABI, 2003). The primary host species are Rutaceae (*Citrus* spp.), Rubiaceae (*Coffea* spp.), and Malvaceae (*Gossypium* spp). However, this species is polyphagous and the following species are listed as host plants: Fabaceae (*Acacia karroo*, *Leucaena leucocephala*, *Leucaena* spp., *Albizia lebbeck*, *Glycine max*), Lamiaceae (*Clerodendrum infortunatum*), Rutaceae (*Citrus limon*, *Citrus aurantiifolia*, *Citrus aurantium*, *Citrus maxima*, *Citrus x paradisi*, *Citrus sinensis*), Apocynaceae (*Nerium oleander*), Punicaceae (*Punica granatum*), Lauraceae (*Persea* americana), Moraceae (*Artocarpus heterophyllus*, *Ficus carica*, *Morus nigra*), Tiliaceae (*Corchorus capsularis*), Malvaceae (*Alcea rosea*, *Gossypium hirsutum*, *Hibiscus manihot*), Liliaceae (*Asparagus officinalis*), Faboideae (*Cajanus* spp., *Tamarindus* spp., *Tamarindus indica*), Rubiaceae (*Coffea arabica*), Rosaceae (*Eriobotrya japonica*), Euphorbiaceae (*Euphorbia hirta*, *Phyllanthus niruri*), Proteaceae (*Grevillea robusta*), Bignoniaceae (*Jacaranda mimosifolia*, *Spathodea campanulata*), Anacardiaceae (*Mangifera indica*), Myrtaceae (*Psidium guajava*), Asteraceae (*Parthenium hysterophorus*), Solanaceae (*Solanum tuberosum*), Tamaricaceae (*Tamarix* spp.), Vitaceae (*Vitis vinifera*), and Rhamnaceae (*Ziziphus mauritiana*, *Ziziphus spina-christi*) (CABI, 2003).	High (3)
Risk Element #3: Dispersal Potential The life-cycle of *N. viridis* is about 68 days under optimum condition (Bedford *et al.*, 1998). In South Africa, there are three generations per year (CABI, 2004). A female lays 90-138 eggs, and the egg and nymphal stages last 10-13 and 31-43 days, respectively (CABI, 2004). Long distance dispersal methods are via infested plant materials (CABI, 2004).	High (3)

Risk Element #4: Economic Impact Feeding on young twigs causes bulbous outgrowths, and heavy infestations may severely stunt the growth of young trees (CABI, 2003). Citrus fruits infested with *N. viridis* may develop lumpy outgrowths or raised shoulders near the stem end. Frequently, fruits turn yellow and then partly black around the stem end, finally dropping off the tree. Late infestations on large green fruits result in congregations of young mealybugs in clumps over the face of the fruit. Copious quantities of honeydew may contaminate fruit and other plant parts, serving as a medium for the growth of sooty molds. This mealybug was responsible for losses up to 5% in vineyards in India (CABI, 2003). Losses in citrus orchards are due to fruit drop caused by large infestations of mealybugs; in South Africa, 50% or more of the navel orange crop has been lost in this way. Second, fruits with deformities caused by mealybug feeding, are culled in the packing-house, and result in the further loss of production (CABI, 2004). As this pest is already established in parts of the continental United Sates, further introductions of the mealybug are considered unlikely to result in a loss of foreign markets beyond those that may be closed at present.	Medium (2)
Risk Element #5: Environmental Impact This pest represents a potential threat to vulnerable native plants (*e.g.*, *Euphorbia, Hibiscus* spp., *Solanum* spp., and *Ziziphus celata*) (USFWS, 2002) in the United States. Its status as a citrus pest could lead to the initiation of chemical or biological control programs, if it was to become more widely established in the United States. However, closely related species of *N. viridis* are pests of many agricultural crops grown in the U.S. that are managed using pest control programs including calendar spraying of insecticides; these chemical applications are also expected to be effective against *N. viridis* infestations.	Medium (2)

Consequences of Introduction: *Paracoccus marginatus* (Hemiptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction *Paracoccus marginatus* is a native species of Mexico andCentral America (CABI, 2004; Walker & Hoy, 2003). It is distributed in Mexico, Central America, and Caribbean countries (CABI, 2004). It was first discovered in Manatee and Palm Beach counties in Florida in 1998. Its distribution corresponds to U.S. Plant Hardiness Zones 9-11 (USDA ARS, 1990).	Medium (2)
Risk Element #2: Host Range *Paracoccus marginatus* is polyphagous and attacks economically important tropical fruits and ornamentals (Walker & Hoy, 2003). Its host species includes Annonaceae (*Annona squamosa*, *Annona*), Caricaceae (*Carica papaya*), Malvaceae (*Hibiscus*, *Hibiscus rosa-sinensis*, *Hibiscus sabdariffa*, *Gossypium hirsutum*, *Malvaviscus arboreus*, *Sida*), Euphorbiaceae (*Manihot esculenta*, *Acalypha*), Lauraceae (*Persea americana*), Apocynaceae (*Plumeria*), Solanaceae (*Solanum melongena*, *Capsicum annuum*, *Lycopersicon esculentum*, *Solanum nigrum*, *Solanum torvum*, *Cestrum nocturnum*), Bromeliaceae (*Ananas comosus*), Asteraceae (*Bidens*, *Dahlia pinnata*, *Parthenium hysterophorus*), Fabaceae (*Cajanus cajan*, *Erythrina* spp., *Lablab purpureus*, *Phaseolus*, *Vigna*, *Acacia*, *Mimosa pigra*), Rutaceae (*Citrus sinensis*), Myrtaceae (*Eugenia uniflora*), Convolvulaceae (*Ipomoea*), Oleaceae (*Ligustrum*), Anacardiaceae (*Mangifera indica*), Rubiaceae (*Mussaenda*), Punicaceae (*Punica granatum*), Rosaceae (*Rosa*), Sterculiaceae (*Theobroma cacao*, *Guazuma ulmifolia*), Malpighiaceae (*Malpighia glabra*), and Acanthaceae (*Pachystachys lutea*) (CABI, 2004)	High (3)
Risk Element #3: Dispersal Potential The biology of *Paracoccus marginatus* has not been studied in detail (CABI, 2004; Walker & Hoy, 2003). It has been estimated to have as many as 15 generations per year (CABI, 2004). In general, females lay 100-600 eggs in an ovisac (Walker & Hoy, 2003). Eggs hatch in about 10 days. Females have four instars, males have five instars. The natural dispersal means of *P. marginatus* are crawling and flying. First instar crawlers are capable of crawling, and the fifth instar of the males have a winged form that is capable of flight (CABI, 2004; Walker & Hoy, 2003). It can also be dispersed with the aid of wind (CABI, 2004). Long distance dispersal is via infested plants (CABI, 2004). *Paracoccus marginatus* has been intercepted on plant materials at the port-of-entry more than 380 times since 1985 (USDA APHIS PPQ, 2005).	High (3)
Risk Element #4: Economic Impact *Paracoccus marginatus* is capable of causing significant damage to economically important plants, such as papaya, hibiscus, avocado, citrus, cotton, tomato, eggplant, peppers, beans, peas, sweet potato, mango, cherry, and pomegranate (Walker & Hoy, 2003). Walker & Hoy (2003) stated that the papaya mealybug could rapidly establish through Florida and the Gulf states to California. It is already established in parts of Florida and is not under any official control; it is unlikely that the further establishment of this pest would result in the loss of foreign markets beyond those that may be closed at present.	Medium (2)

Risk Element #5: Environmental Impact	
Paracoccus marginatus may impact threatened and endangered species listed in Title 50, Part 17, Section 12 of the United States Code of Federal Regulations (50 CFR §17.12), such as *Hibiscus* species, *Manihot walkerae* (endangered species in TX), *Solanum* species, *Bidens* species, *Vigna* species, and *Eugenia* species (USFWS, 2002). USDA APHIS and ARS initiated a classical biological control program to manage the papaya mealybug in 1999 (Walker & Hoy, 2003). Four biological control agents, *Acerophagus papayae*, *Anagyrus loecki*, *Anagyrus californicus*, and *Pseudleptomastix mexicana*, were experimentally released in Puerto Rico and the Dominican Republic (Walker & Hoy, 2003). These four parasitoids successfully reduced mealybug population by 99.7% in the Dominican Republic and 97% in Puerto Rico, with parasitism levels between 35.5% and 58.3% (Walker & Hoy, 2003). The first release of those biological agents was made in Florida in October, 2000 (Walker & Hoy, 2003). The establishment and introduction of *P. marginatus* in other parts of continental United States would stimulate biological and chemical controls.	High (3)

Consequences of Introduction: *Planococcus minor* (Homoptera: Pseudococcidae)	Risk Value

Risk Element #1: Climate-Host Interaction *Planococcus minor* is distributed in the Afrotropical, Australasian, Nearctic, Neotropical, and Oriental regions (Ben-Dov, 1994; Granara and Claps, 2003; Williams and Granara de Willink, 1992; Williams and Watson, 1988). It is reported in south Asia (Bangladesh, Brit. Indian Ocean Terr., Burma, India, Indonesia, Kalimantan, Sumatra, Malaysia, Philippines, Singapore, Taiwan, Thailand), Australia and islands of the South Pacific (American Samoa, Cook Islands, Fiji, French Polynesia, Kiribati, New Caledonia, Niue, Papua New Guinea, Solomon Islands, Tokelau, Tonga, Vanuatu, Western Samoa), Africa (Madagascar, Rodriques Island, Seychelles), tropical areas of the New World (Antigua and Barbuda, Argentina, Bermuda, Brazil, Colombia, Costa Rica, Cuba, Dominica, Galapagos Islands, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Saint Lucia, Suriname, Trinidad and Tobago, U.S. Virgin Islands, Uruguay), and tropical areas of Mexico (Ben-Dov, 1994; Ben-Dov et al., 2010; CABI, 2011). Based on this geographical distribution, we estimate this species could establish in U.S. Plant Hardiness Zones 9-11 in the continental United States (Magarey et al., 2008). Many of its potential hosts occurs in these Zones (NRCS, 2011).	Medium (2)
Risk Element #2: Host Range *Planococcus minor* (Maskell) is reported on more than 250 host plants in nearly 80 families (Ben-Dov, 1994; Cox, 1989; Venette and Davis, 2004; Williams and Granara de Willink, 1992; Williams and Watson, 1988). It shows some preference for hosts such as avocado (*Persea americana*), banana (*Musa*), beans (*Phaseolus* spp., *P. vulgaris*, *P. lunatus*), cabbage (*Brassica oleracea*), cantaloupe (*Cucumis melo*), citrus (*Citrus* spp.), cocoa (*Theobroma cacao*), coffee (*Coffea*), corn (*Zea mays*), cotton (*Gossypium hirsutum*), grapes (*Vitis* spp.), potato (*Solanum tuberosum*), rice (*Oryza sativa*), soybean (*Glycine max*), and tomato (*Solanum lycopersicum*). Most of these species are widely cultivated in the United States (CABI, 2011; NRCS, 2011; Venette and Davis, 2004). *Planococcus minor* attacks multiple species among multiple plant families.	High (3)
Risk Element #3: Dispersal Potential *Planococcus minor* completes ten generations in a year and fecundity ranges from 200 to over 400 eggs per female, depending on the host plant and between 65-425 eggs under laboratory conditions (Martínez and Surís, 1998; Sahoo et al., 1999 Venette and Davis, 2004). Preoviposition period ranged from 8-12 days, incubation period lasted approximately 3 days. The time to complete 1 generation ranged from 31-50 days (Venette and Davis, 2004). *Planococcus minor* is likely introduced to the Neotropics by trade (Cox, 1989). The insect can be transported long distances in fruit shipments (Sugimoto, 1994). Ants may also play a role in mealybug dispersal. Mealybug populations closely associated with ants tend to be larger than non-tended populations of the same species (Venette and Davis, 2004).	High (3)

Risk Element #4: Economic Impact *Planococcus minor* is a common pest species of many economically important plants, particularly cocoa, throughout its geographical range (Ben-Dov, 1994; Cox, 1989). *Planococcus minor* is a phloem feeder, and, in general, this may cause reduced yield, reduced plant or fruit quality, stunting, discoloration, and defoliation. Indirect or secondary damage is caused by sooty mold growth on honeydew produced by the mealybug (Venette and Davis, 2004). *Planococcus minor* is a quarantine pest that could cause the loss of foreign or domestic markets	High (3)
Risk Element #5: Environmental Impact Based on the broad *P. minor* host range (see above), it may negatively impact Federal Threatened and Endangered plants species in the continental United States, particularly congeners of current hosts: *Amaranthus pumilus* (DE, MA, MD, NC, NJ, NY, RI, SC, VA), *Cucurbita okeechobeensis* ssp. *okeechobeensis* (FL), *Euphorbia telephioides* (FL), *Helianthus paradoxus* (NM, TX), *H. schweinitzii* (NC, SC), *Manihot walkerae* (TX), *Rhus michauxii* (GA, NC, SC, VA), and *Verbena californica* (CA) (USFWS, 2011). The control strategies used for *P. minor* include chemical and biological control (CABI, 2011; Cunningham and Harden, 1999; Paul and Ghosh, 2004; Shukla and Tandon, 1984; Williams and Watson, 1988). The introduction of *P. minor* into the continental United States would likely stimulate chemical and biological control programs.	High (3)

Consequences of Introduction: *Pseudococcus cryptus* Hempel (Hemiptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction *Pseudococcus cryptus* is widely distributed in southeast Asia, tropical Africa, the mideastern Mediterranean and South America (USDA ARS SEL, 2005). Its distribution corresponds to U.S. Plant Hardiness Zones 9-11 (USDA ARS, 1990).	Medium (2)
Risk Element #2: Host Range Host species of *P. cryptus* include Anacardiaceae (*Mangifera indica*), Apocynaceae (*Plumeria* spp.), Compositae (*Dahlia* spp.), Dilleniaceae (*Dillenia indica*), Euphorbiaceae (*Hevea brasiliensis*), Guttiferae (*Calophyllum inophyllum*), Heliconiaceae (*Heliconia* spp.), Lauraceae (*Ocotea pedalifolia*, *Persea americana*), Leguminosae (*Erythrina* spp.), Liliaceae (*Crinum asiaticum*), Moraceae (*Artocarpus altilis*, *Artocarpus incisa*, *Artocarpus odoratissimus*), Musaceae (*Musa* spp.), Myrtaceae (*Osbornia ocdonta*, *Psidium guajava*), Palmae (*Cocos nucifera*, *Elaeis guineensis*), Pandanaceae (*Pandanus* spp., *Pandanus upoluensis*), Passifloraceae (*Passiflora foetida*), Piperaceae (*Piper methysticum*), Rubiaceae (*Coffea arabica*, *Coffea liberica*, *Gardenia* spp., *Ixora* spp.), Rutaceae (*Citrus* spp., *Citrus aurantifolia*, *Citrus aurantium*, *Citrus grandis*, *Citrus limon*, *Citrus paradisi*, *Citrus reticulata*, *Citrus sinensis*), Selaginellaceae (*Selaginella* spp.) (USDA ARS SEL, 2004).	High (3)
Risk Element #3: Dispersal Potential The number of eggs produced by females vary with the seasons; the greatest number in summer and the smallest number in winter. Female typically lay groups of 30-50 eggs, a total of 200-500 eggs (Avidov & Harpaz, 1969). This mealybug is able to have six generations per year (Avidov & Harpaz, 1969). The insect is only capable of limited dispersal under its own power. Long distance dispersal could be accomplished via the movement of infected plant materials.	High (3)
Risk Element #4: Economic Impact *Pseudococcus cryptus* is considered a major pest of citrus (Hill, 1983). The insect produces copious quantities of honeydew, on which sooty molds develop, sometimes reaching a thickness of 5-8 mm (Avidov & Harpaz, 1969). In heavy infestations, entire trees may be contaminated, and leaves and fruit prematurely shed. High population densities on coconut palm may cause the drying of inflorescence and button shedding (Moore, 2001). In Israel, both biological and chemical controls have succeeded in maintaining populations below economically damaging densities (Avidov & Harpaz, 1969; Blumberg *et al*., 2001). Citrus are commercially produced in AZ, CA, FL, and TX in the continental United States, and are worth more than $2.3 billion (USDA NASS, 2004b). This mealybug may have a high potential to damage the citrus industry in the continental United States.	High (3)

Risk Element #5: Environmental Impact	
Pseudococcus cryptus has the potential to damage threatened and endangered species that are listed in Title 50, Part 17, Section 12 of the United States Code of Federal Regulations (50 CFR §17.12), such as *Gardenis* species (USFWS, 2002). In Israel, where *P. cryptus* was introduced, it was successfully controlled by its natural enemy, *Clausenia purpurea* (USDA ARS SEL, 2005). Chemical treatment is used to control *P. cryptus* in Israel. The introduction and establishment would stimulate biological and chemical controls in the continental United States. However, closely related species of *P. cryptus* are pests of many agricultural crops grown in the U.S. that are managed using pest control programs including calendar spraying of insecticides; these chemical applications are also expected to be effective against *P. cryptus* infestations.	Medium (2)

For each pest, the sum of the five Risk Elements gives a Cumulative Risk Rating. This Cumulative Risk Rating is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts. The summary of risk rating for Consequences of Introduction is shown in Table 5.

Low: 5 – 8 points
Medium: 9 – 12 points
High: 13 – 15 points

Table 5. Risk Rating for Consequences of Introduction (*Persea americana* cv. Sharwil) from Hawaii

Pest	Risk Element 1 Climate/ Host Interaction	Risk Element 2 Host Range	Risk Element 3 Dispersal Potential	Risk Element 4 Economic Impact	Risk Element 5 Environ-mental Impact	Cumulative Risk Rating
Bactrocera dorsalis	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Ceroplastes rubens	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (10)
Coccus viridis	Medium (2)	High (3)	High (3)	Medium (2)	Low (1)	Medium (11)
Cryptoblabes gnidiella	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Dysmicoccus neobrevipes	Medium (2)	High (3)	High (3)	High (3)	Medium (2)	High (13)
Epiphyas postvittana	Medium (2)	High (3)	High (3)	Medium (2)	High (3)	High (13)
Maconellicocc us hirsutus	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (1)
Nipaecoccus viridis	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	High (12)
Paracoccus marginatus	Medium (2)	High (3)	High (3)	Medium (2)	High (3)	High (13)
Planococcus minor	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Pseudococcus cryptus	Medium (2)	High (3)	High (3)	High (3)	Medium (2)	High (13)

2.6 Introduction Potential

We based this section on 1) an estimate of the amount of commodity likely to be imported (sub-element#1), and 2) pest opportunity estimated using five biological features (sub-elements #2).

Details of the rating criteria are explained in the *Guidelines for Pathway-Initiated Pest RiskAssessments*, *Version 5.02* (PPQ, 2000). These sub-element ratings, along with the values for theLikelihood of Introduction, are summarized below (Table 6).

Risk Element #1: Quantity of commodity imported annually

The likelihood that an exotic pest will be introduced depends on the amount of potentially infested commodity that is 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 terms of 40-foot shipping containers.

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

The anticipated volume of avocado to be moved from Hawaii into the Continental United States is unknown. Given current production leveles, it is very likely that <10 containers of Sharwil would be exported in most years; thus the quantity of avocado imported annually is estimated to be Low (1). Should Hawaii wish to send more than 10 containers/year, this risk element will need to be re-evaluated.[22]

Risk Element #2: Pest Opportunity (Survival and Access to Suitable Habitat and Hosts)

1. Survive post-harvest treatment:

The industry accepted post-harvest treatments for mature green Sharwil avocados include culling, inspection, and packing within 12 hours of harvest. Fruit with skin damage, oviposition marks, and morphological aberrations associated with fruit fly infestation would be culled. However, tephritid fruit flies being internal feeders are ranked High risk.

Sharwil avocado has smooth skin without any crevice for external feeding insects to hide; the short woody pedicel offers a limited but not preferred space of refuge. Thus, all hemipterous quarantine pests are ranked Medium risk.

C. gnidiella has not been observed infesting mature green avocado fruit in Hawaii. Based on its feeding behavior, if early instars are found feeding on hard mature green fruit, they would be on the fruit surface, and would be culled during postharvest inspection. Full grown larvae are typical of pyralids—large, excrete noticeable frass, make evident circular entry hole into the fruit. Thus, larvae of *C. gnidiella* are detectable with ease during postharvest culling and inspection; this pest is ranked Low (1) risk.

E. postvittana has neither been observed infesting avocados in Hawaii nor detected in traps in avocado orchards. The general feeding behavior of this pest on hard mature green fruit would be by scraping the surface, thus, allowing detection during postharvest culling and inspection. It is

[22] The total avocado production in Hawaii (all varieties) in the growing season of 2003 to 2004 was 380 tons (USDA NASS, 2005b). Sea shipping containers, which are 40-foot in length, hold approximately 40,000 pounds (20 U.S. tons). Thus, 380 tons of avocados would be 19 containers per year.

unlikely that this pest will bore through the woody tissue of the pedicel of mature green Sharwil avocado. *E. postvittana* is ranked Low (1) risk.

2. Survive shipment:

Depending on the variety, avocados are shipped at temperatures ranging from 4ºC (40ºF) to 13ºC (55ºF) and humidity between 85% and 95% (McGregor, 1999). Fruits can be safely held for at least two weeks under these conditions (Morton, 1987). Avocados are subject to chilling injury in refrigerated storage; the degree of susceptibility to this injury varies with the cultivar and the stage at which harvesting took place and the length of time in storage (Morton, 1987). It is expected that most of the quarantine pests analyzed in the risk assessment would be able to survive shipment if the commodity is shipped under optimal conditions.

Additionally, all specieshave been intercepted at ports-of-entry (USDA APHIS PPQ, 2005). This evidence suggests that all species are capable of surviving shipment; all species were ranked High (3) in this sub-element.

3. Not be detected at the port-of-entry:

Bactrocera dorsalis is rated High (3) risk because its eggs and larvae have the potential of escaping detection at the port-of-entry.

Coccus viridis, *Dysmicoccus neobrevipes*, *Maconellicoccus hirsutus*, *Nipaecoccus viridis*, *Paracoccus marginatus*, *Planococcus minor*, and *Pseudococcus cryptus* are external feeders and visible with the naked eye. Sharwil avocado has smooth skin without any crevice for external feeding insects to hide; the short woody pedicel offers a limited but not preferred area of refuge. Thus, all hemipterous quarantine pests are ranked Medium (2) risk.

If Cryptoblabes gnidiella is found feeding on mature green fruit, it would be on the fruit surface, and would be detected during inspection at the port-of-entry. Similarly, internal feeding larvae, unlikely occurrence in mature green Sharwil avocado, leave indices of infestation that are evident and higly detectable. Furthermore, feeding larvae are gregarious and move in and out of the fruit (Liquido, personal observation on the feeding behavior of *C. gnidiella* in lychee). This pest is ranked Low (1) risk.

If Epiphyas postvittana is found feeding on hard mature green avocado fruit, it would be on the fruit surface, thus, allowing detection during inspection. It is unlikely that this pest will bore through the woody tissue of the pedicel of mature green Sharwil avocado. *E. postvittana* is ranked Low (1) risk.

4. Imported or move subsequently to an area with an environment suitable for survival:
Consider the geographic location of likely markets and the proportion of the commodity that is likely to move to locations suitable for pest survival. Even if infested commodities enter the country, not all final destinations will have suitable climatic conditions for pest survival.

Bactrocera dorsalis, *Ceroplastes rubens*, *Coccus viridis*, *Dysmicoccus neobrevipes*, *Maconellicoccus hirsutus*, *Nipaecoccus viridis*, *Paracoccus marginatus*, *Planococcus minor,* *Pseudococcus cryptus*, and *Epiphyas postvittana* occur in tropical and subtropical regions. In the continental United States, tropical and subtropical climate zones are limited to the South and the West Coast, which comprise an estimated 10-12% of the total land area of the continental United States. This PRA is for the limited movement of mature green Sharwil avocado from Hawaii to northern-tier states during winter months; thus, these pests are rated Low (1) risk.

Cryptoblabes gnidiella has a potential to move and survive in a wide range of climate zones; however, it has been reported to have the poor ability to survive winters of cooler temperate areas. The proposed limited movement of mature green Sharwil avocado from Hawaii to northern-tier states during winter months would constitute low volume shipments; thus this pest is rated Medium (2) risk for the likelihood to move to suitable habitat.

5. Come into contact with host material suitable for reproduction:

Bactrocera dorsalis has a wide range of recognized host species that inhabit tropical, subtropical, tropical and temperate zones. The proposed low volume movement of Sharwil avocado during winter months to northern-tier states warrant Medium risk rating.

Scales and mealybugs (*Ceroplastes rubens*, *Coccus viridis*, *Dysmicoccus neobrevipes*, *Maconellicoccus hirsutus*, *Nipaecoccus viridis*, *Paracoccus marginatus*, *Planococcus minor,* and *Pseudococcus cryptus*) have limited powers of natural dispersal due to lack of wings or other means to achieve flight (Gullan & Kosztarab, 1997). For these insects, successful establishment in a new environment is contingent on the likelihood of at least two necessary conditions occurring: close proximity of susceptible hosts and presence on the imported fruit of crawlers (or other mobile forms) to transfer to new hosts (Miller, 1985; Blank *et al.*, 1993), circumstances that are highly unlikely to occur. Several aleyrodid, scale and mealybug species have become permanently or sporadically established in the continental United States, including *Ceroplastes rubens* (Florida), *Coccus viridis* (Florida), *Dysmicoccus neobrevipes* (Florida), *Maconellicoccus hirsutus* (California and Florida), *Nipaecoccus viridis* (California), *Planococcus minor* (Florida), and *Paracoccus marginatus* (Florida). The proposed low volume movement of Sharwil avocado during winter months to northern-tier states significantly reduced the likelihood of coming into contact with host material. All these pests are Low (1).

Pseudococcus cryptus has not been found in the continental United States. Like other scales and mealybugs, *P. cryptus* has a wide range of host species and has been intercepted several times at the port-of-entry since 1985 (USDA APHIS PPQ, 2005). There is no record of *P. cryptus* establishment in the continental United States, which suggests that this species has a low probability of coming into contact with host material suitable for reproduction. *Pseudococcus cryptus* is rated Low (1).

Cryptoblabes gnidiella and *Epiphyas postvittana* have a wide range of host species that occur in tropical to temperate zones in the continental United States. Few host plants may be grown year-round, but not necessarily fruiting or fruiting in abundance during winter months in the northern-tier states. These two pests are rated Medium risk.

Summary of the ratings for Likelihood of Introduction is depicted in Table 6.

Low: 6 – 9 points
Medium: 10 – 14 points
High: 15 – 18 points

Table 6. Risk Rating for Likelihood of Introduction

Pest	Quantity Imported Annually	Survive Post-harvest Treatment	Survive Shipment	Not Detected at Port-of Entry	Move to Suitable Habitat	Contact with Host Material	Cumulative Risk Rating
Bactrocera dorsalis	Low (1)	High (3)	High (3)	High (3)	Low (1)	Medium (2)	Medium (13)
Ceroplastes rubens	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)
Coccus viridis	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)
Cryptoblabes gnidiella	Low (1)	Low (1)	High (3)	Low (1)	Medium (2)	Medium (2)	Medium (10)
Dysmicoccus neobrevipes	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medum (10)
Epiphyas postvittana	Low (1)	Low (1)	High (3)	Low (1)	Low (1)	Medium (2)	Low (9)
Maconellicoccus hirsutus	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)
Nipaecoccus viridis	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)
Paracoccus marginatus	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)
Planococcus minor	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)
Pseudococcus cryptus	Low (1)	Medium (2)	High (3)	Medium (2)	Low (1)	Low (1)	Medium (10)

2.7 Conclusion – Pest Risk Potential and Pests Requiring Phytosanitary Measures

To estimate the Pest Risk Potential for each pest, the Cumulative Risk Rating for the Consequences of Introduction and the Cumulative Risk Rating for the Likelihood of Introduction are summed in Table 7. The Pest Potential rating is as follows:

Low: 11 – 18 points
Medium: 19 – 26 points
High: 27 – 33 points

Table 7. Pest Risk Potential

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential	Risk Rating
Bactrocera dorsalis	High (14)	Medium (13)	27	High
Ceroplastes rubens	Medium (10)	Medium (10)	20	Medium
Coccus viridis	Medium (11)	Medium (10)	21	Medium
Cryptoblabes gnidiella	High (15)	Medium (10)	25	Medium
Dysmicoccus neobrevipes	High (13)	Medium (10)	23	Medium
Epiphyas postvittana	High (13)	Low (9)	22	Medium
Maconellicoccus hirsutus	High (14)	Medium (10)	24	Medium
Nipaecoccus viridis	Medium (12)	Medium (10)	22	Medium
Paracoccus marginatus	High (13)	Medium (10)	23	Medium
Planococcus minor	High (14)	Medium (10)	24	Medium
Pseudococcus cryptus	High (13)	Medium (10)	23	Medium

Following the assignment of the Pest Risk Potential for each pest, the risk assessor may briefly comment on risk management options associated with the requested commodity importations. 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 mitigation measures; the port of entry inspection to which all imported commodities are subjected can be expected to provide sufficient phytosanitary security.
Medium: Specific phytosanitary measure 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 pest with particular Pest Risk Potential ratings is undertaken as part of the risk management phase and is not discussed in this document. The appropriate risk management strategy for a particular pest depends on the risk posed by that pest. APHIS risk management programs are risk-based and dependent on the availability of appropriate mitigation methods. Details of APHIS risk management programs are published, primarily, in the Federal Register as quarantine notices.

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