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Importation of mango (*Mangifera indica* L.) fruit from Colombia into the continental United States, Hawaii, Puerto Rico, the US Virgin Islands and all US territories

A Qualitative, Pathway-Initiated Pest Risk Assessment

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Executive Summary

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) prepared this risk assessment to examine plant pest risks associated with importing commercially-produced fresh fruit of mango, *Mangifera indica* L. (Anacardiaceae) for consumption from Colombia into the United States and Territories. Based on the market access request submitted by Colombia, we considered the pathway to include the following processes and conditions: washing. The risk ratings in this risk assessment are contingent upon the application of all components of the pathway as described in this document. Fruit produced under different conditions was not evaluated in this PRA and may have a different pest risk.

Based on the scientific literature, port-of-entry pest interception data, and information from the government of Colombia, we developed a list of all potential pests with actionable regulatory status for the United States that are known to occur in Colombia (on any host) and to be associated with the commodity plant species (anywhere in the world). Of these, we found 13 organisms that have a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing and thus are potentially able to follow the pathway.

We analyzed the pest risk potential of these organisms and determined that the following six are not candidates for risk management because they received a Negligible overall risk rating for likelihood of introduction (i.e., entry plus establishment) into the endangered area via the import pathway: *Ceroplastes rubens*, (Hemiptera: Coccidae), *Crypticerya multicicatrices*, (Hemiptera: Monophlebidae), *Dysmicoccus neobrevipes*, *Maconellicoccus hirsutus*, *Pseudococcus elisae*, and *Planococcus lilacinus* (all Hemiptera: Pseudococcidae).

The remaining seven organisms met the threshold for unacceptable consequences of introduction and had a non-negligible likelihood of introduction. We therefore consider these pests to be candidates for risk management:

Pest type	Taxonomy	Scientific name	Likelihood of Introduction overall rating
Arthropods	Diptera: Lonchaeidae	*Neosilba glaberrima*	Medium
	Diptera: Tephritidae	*Anastrepha fraterculus*	High
		Anastrepha obliqua	High
		Anastrepha serpentina	Medium
		Anastrepha sororcula	High
		Anastrepha striata	High
		Ceratitis capitata	High

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

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1. Introduction

1.1. Background

This document was prepared by the Plant Epidemiology and Risk Analysis Laboratory of the Center for Plant Health Science and Technology, USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), to evaluate the pest risk associated with the importation of commercially-produced fresh fruit of mango (*Mangifera indica* L.) for consumption from Colombia into the United States and Territories.

This is a qualitative risk assessment, meaning that the likelihood and consequences of pest introduction are expressed as qualitative ratings rather than in numerical terms. Methodology and rating criteria used are detailed in the *Guidelines for Plant Pest Risk Assessment of Imported Fruit and Vegetable Commodities, Version 6.0* (PPQ, 2012). This methodology is consistent with guidelines provided by the International Plant Protection Convention (IPPC) in the International Standard for Phytosanitary Measures (ISPM) No. 11, "Pest Risk Analysis for Quarantine Pests" (IPPC, 2017a). The use of biological and phytosanitary terms is consistent with ISPM No. 5, "Glossary of Phytosanitary Terms" (IPPC, 2017b).

As defined in ISPM No. 11, this document comprises Stage 1 (Initiation) and Stage 2 (Risk Assessment) of risk analysis. Stage 3 (Risk Management) will be covered in a separate document.

1.2. Initiating event

The importation of fruits and vegetables for consumption into the United States is regulated under Title 7 of the Code of Federal Regulations, Part 319.56-3 (7 CFR §319.56-3, 2012). Under this regulation, the entry of fresh mangoes from Colombia into the United States is not currently authorized. This commodity risk assessment was initiated due to a request by the Colombian Agriculture and Livestock Institute (Instituto Colombiano Agropecuario) to change the Federal regulation to allow entry (ICA, 2014).

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

In some cases, an imported commodity could become invasive in the pest risk analysis (PRA) area. If warranted, the pest risk posed by the commodity itself is evaluated in a weed risk assessment, conducted separately from the commodity risk assessment.

Weed risk assessments are unnecessary for plant species that are widely established (native or naturalized) or cultivated in the United States, for commodities that are already enterable into the United States from other countries, or for plant parts that cannot easily propagate on their own or be propagated. We determined that a weed risk assessment is not needed for mango because it is cultivated commercially in the United States.

1.4. Description of the pathway

A pathway is "any means that allows the entry or spread of a pest" (IPPC, 2017b). In the context of this risk assessment, the pathway is the commodity to be imported, together with all the processes the commodity undergoes from production through importation and distribution that may have an impact on pest risk.

In this risk assessment, the specific pathway of concern is the importation of fresh fruit of mango (*Mangifera indica* L.) for consumption from Colombia into the United States. The movement of this commodity provides a potential pathway for the introduction or spread of plant pests.

The following description of this pathway focuses on the conditions that may affect plant pest risk, including morphological and physiological characteristics of the commodity, as well as processes that the commodity will undergo from production in Colombia through importation and distribution in the United States. These conditions provided the basis for creating the pest list and assessing the likelihood of introduction of the pests selected for further analysis. Hence, the risk ratings in this risk assessment are contingent upon the application of all components of the pathway as described below.

1.4.1. Description of the commodity

Mango is a major fruit crop in the tropics and subtropics, particularly in Asia (Mukherjee and Litz, 2009). The mango tree is native to southern Asia and can range in height from 10 to 40 m (Morton, 1987; Mukherjee and Litz, 2009). The fruit is a large, fleshy drupe, with great variation in form, size (2.5 to over 30 cm in length), and color, depending on the cultivar (Morton, 1987; Mukherjee and Litz, 2009). For this risk assessment, we considered only importation of the fruit of mango (i.e., no other plant parts would be imported).

1.4.2. Production and harvest procedures in the exporting area

Production and harvesting procedures in the exporting area are not being considered as part of the assessment.

1.4.3. Post-harvest procedures in the exporting area

The only post-harvest procedure in the exporting area that is being considered as part of the assessment is washing. Post-harvest processing of commercial export-quality mango fruit always involves washing (by hand or machine) of the fruit to remove sap (Johnson and Hofman, 2009; Nakasone and Paull, 1998), because sap causes lesions and rotting (Morton, 1987; Nakasone and Paull, 1998), which degrade the fruit.

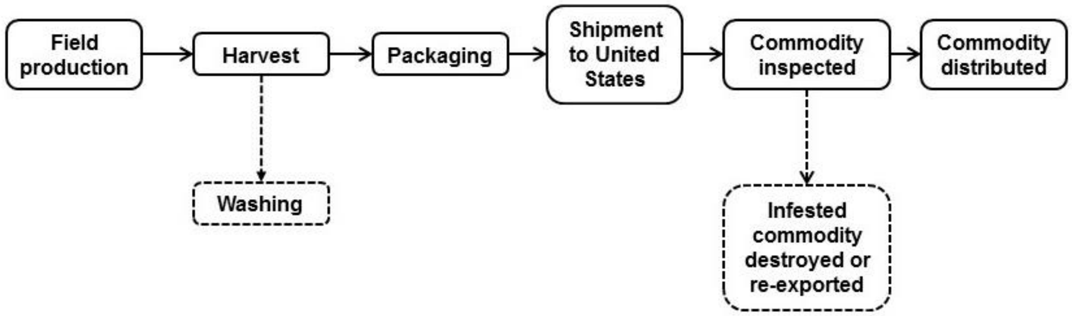
1.4.4. Shipping and storage conditions

Shipping and storage conditions are not being considered as part of the assessment.

1.4.5. Summary of the pathway

Figure 1 summarizes the pathway of concern: the importation of fresh fruit of *Mangifera indica* L. for consumption from Colombia into the United States.

Figure 1. Pathway diagram for imports of mango fruit from Colombia into the United States.



2. Pest List and Pest Categorization

The pest list (Table 1) is a compilation of all plant pests with actionable regulatory status for the United States that are present in Colombia (on any host) and associated with *Mangifera indica* (anywhere in the world). Species on the pest list with a reasonable likelihood of being present on mango fruit at the time of harvest could follow the pathway into the United States and are therefore analyzed in more detail to determine their pest risk potential. Pests are considered to be of regulatory significance if they are actionable at U.S. ports of entry. Actionable pests include quarantine pests, regulated non-quarantine pests, pests under official control or considered for official control, and pests that require evaluation for regulatory action.

2.1. Pests considered but not included on the pest list

2.1.1. Pests with weak evidence for association with the commodity or for presence in Colombia

Anastrepha antunesi Lima (Diptera: Tephritidae)
Martínez-Alava (2007) reported *A. antunesi* from Colombia and listed its hosts throughout its geographical range. The only reference citing mango as a host for *A. antunesi* was a report from Central America in 1967 (McGuire and Crandall, 1967), which listed the fly as a low concern for mango. Korytkowski and Ojeda (1968) and White and Elson-Harris (1994) did not list mango as a host of *A. antunesi*. It appears the fly is chiefly a pest of guava. Therefore, we did not include it on the pest list.

Anastrepha ludens (Loew) (Diptera: Tephritidae)
Anastrepha ludens (Loew) was reported from Colombia (Yepes and Velez, 1989), but later studies revealed that to be an error in taxonomy, in which *A. manizaliensis* was mistaken for *A. ludens* (Norrbom et al., 2005). *Anastrepha ludens* is not present in Colombia (Norrbom et al., 2005; Orduz and Norbom, 2004). Therefore, we did not include it on the pest list.

Oiketicus kirbyi Guilding (Lepidoptera: Psychidae)
Figueroa (1977) and Martínez and Plata-Rueda (2013) both reported *Oiketicus kirbyi* from Colombia; however, the only reference citing mango as a host for *O. kirbyi* was CABI (2018), and we did not find any direct evidence that this bagworm occurs on mango. Therefore, we did not include it on the pest list.

2.1.2. Organisms with non-actionable regulatory status

We found evidence of some organisms being associated with mango and being present in Colombia; however, because these organisms have non-actionable regulatory status for the

United States, we did not include them in Table 1 of this risk assessment. These organisms are listed in Appendix A.

2.1.3. Organisms identified only to the genus level

In commodity import risk assessments, the taxonomic unit for pests selected for evaluation beyond the pest categorization stage is usually the species (IPPC, 2017a), as we focus assessments on organisms for which biological information is available. Therefore, we generally do not assess risk for organisms identified only to the genus level, particularly if the genus in question is reported in the import area. Many genera contain multiple species, and we cannot know if the unidentified species occurs in the import area and, consequently, whether it has actionable regulatory status for the import area. On the other hand, if the genus in question is absent from the import area, any unidentified organisms in the genus can have actionable status; however, because such an organism has not been fully identified, we cannot properly assess the likelihood and consequences of its introduction.

In light of these issues, we usually do not include organisms identified only to the genus level in the main pest list. Instead, we address them separately in this sub-section. The information here can be used by risk managers to determine if measures beyond those intended to mitigate fully-identified pests are warranted. Often, mitigation measures developed for identified pests will be effective against the pests for which we have little information, but only risk managers can make this judgment.

For this risk assessment, we identified the following organisms identified only to the genus level that are reported on *Mangifera indica* L. in Colombia:

ARTHROPODS: *Eriophyes* sp. (Acari: Eriophyidae) and *Euryscopa* sp. near *cingulata* Latreille (Coleoptera: Chrysomelidae), both reported on mango leaves in Colombia (Posada, 1989). *Isonychus* sp. (Coleoptera: Melolonthidae), reported on mango flowers in Colombia (Posada, 1989). *Lonchaea* sp. and *Silba* n. sp. (Diptera: Lonchaeidae), reported on mango fruit in Colombia (Posada, 1989). *Ceroplastes* sp. near *dugesii* Lichtenstein (Hemiptera: Coccidae) and *Diaspis* sp. (Hemiptera: Diaspididae), both reported on mango leaves in Colombia (Posada, 1989). *Aconophora* sp. (Hemiptera: Membracidae), reported on mango flowers in Colombia (Posada, 1989). *Crypticerya* sp. (Hemiptera: Margarodidae), reported on mango in Colombia (Gallego and Vélez, 1992). *Icerya* sp. (Hemiptera: Margarodidae), reported on mango leaves in Colombia (Posada, 1989). *Heterotermes* sp. (Isoptera: Rhinotermitidae), reported as a trunk borer on mango in Colombia (Posada, 1989). *Atta* sp. (Hymenoptera: Formicidae) and *Sibine* sp. (Lepidoptera: Limacodidae), both reported on mango in Colombia (Gallego and Vélez, 1992). *Tiquadra* sp. (Lepidoptera: Tineidae), reported on mango leaves in Colombia (Posada, 1989). *Sparganothis* sp. (Lepidoptera: Tortricidae), reported on mango in Colombia (Figueroa, 1977).

2.2. Pest list

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

Table 1. Actionable pests associated with *Mangifera indica* (in any country) and present in Colombia (on any host).

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
ARTHROPODS					
Acari: Tetranychidae					
Allonychus braziliensis (McGregor)	Flechtmann, 1982;	Paschoal, 1970	Leaf (Bellotti et al., 1986)	No	Post-harvest washing would remove any mites incidental on the fruit.
Oligonychus mangiferus (Rahman and Sapra) syn.: *Paratetranychus mangiferus* Rahman and Sapra	Posada, 1989	Ochoa et al., 1991; Lin, 2013; Prichard and Baker, 1955; Rahman and Sapra, 1940	Leaf (Sadana and Chander, 1978; Rahman and Sapra, 1940)	No	This species is present in Hawaii (Goff, 1986). Post-harvest washing would remove any mites incidental on the fruit.
Coleoptera: Dryophthoridae					

[1] If warranted, the host type (i.e., Type 1, Type 2, or Type 4 host) may be indicated for a pest. Host types are explained in *Guidelines for Plant Pest Risk Assessment of Imported Fruit and Vegetable Commodities, Version 6.0* (PPQ, 2012).

[2] The plant parts listed are those for the plant species under analysis. If the information has been extrapolated, such as from plant part association on other plant species, we note that.

[3] "Yes" indicates simply that the pest has a reasonable likelihood of being associated with the harvested commodity; the level of pest prevalence on the harvested commodity (Low, Medium, or High) is qualitatively assessed in Risk Element A1 as part of the Likelihood of Introduction assessment (Section 3).

Pest name	**Evidence of presence in Colombia**	**Association with *Mangifera indica*[1]**	**Plant part(s) association[2]**	**On harvested plant part(s)?[3]**	**Remarks**
Metamasius hemipterus (L.)	Vaurie, 1966	Woodruff and Baranowski, 1985	Rotting fruit (Martorell, 1976; Woodruff and Baranowski, 1985)	No	This species is present in Florida (Woodruff and Baranowski, 1985 Giblin-Davis et al., 1996) and Puerto Rico (Martorell, 1976). Actionable only to Hawaii (PestID, 2018).
Coleoptera: Lymexylidae					
Atractocerus brasiliensis Lepeletier and Audinet-Serville	Gallego and Vélez, 1992	Gallego and Vélez, 1992	Stem (Gallego and Vélez, 1992)	No	
Coleoptera: Scarabaeidae					
Macraspis lucida (Olivier)	Figueroa, 1977; Posada, 1989	Jirón, 1995; Posada, 1989	Flower (Figueroa, 1977; Posada, 1989)	No	
Macrodactylus tenuilineatus Guerin-Meneville	Figueroa, 1977; Muñoz et al., 2017	Figueroa, 1977	Flowers, roots (Larvae feed on avocado roots; adults feed on the pollen and nectar.) (Muñoz et al., 2017)	No	
Coleoptera: Tenebrionidae					
Epitragus aurulentus (Kirsch)	Posada, 1989	Cabrera-Asencio et al., 2003; Posada, 1989	Flower, leaf (Cabrera-Asencio et al., 2003; Posada, 1989)	No	This species is present in Puerto Rico (Cabrera-Asencio et al., 2003).
Diptera: Bibionidae					
Plecia plagiata Wiedemann	Figueroa, 1977	Figueroa, 1977	Flowers (genus listed as a pollinator of avocado) (Muñoz et al., 2017)	No	
Diptera: Lonchaeidae					

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Neosilba glaberrima (Wiedemann)	Galeano-Olaya and Canal, 2012; McAlpine and Steyskal, 1982; Yepes and Vélez, 1989	Korytkowski and Ojeda 1971; McAlpine and Steyskal, 1982	Fruit, leaf, stem (McAlpine and Steyskal, 1982). See Notes.	Yes	
Diptera: Tephritidae					
Anastrepha distincta Greene	Castañeda et al., 2010; Carrejo and González, 1994; Korytkowski, 1968	Questionable (Enkerlin et al, 1989; Norrbom and Kim, 1988; Stone, 1942)	Fruit (Aluja, 1984; Posada, 1989)	Yes	Strong preference for *Yuca* and *Inga* species (Norrbom and Kim, 1988). Jirón et al. did not find mango infested with *A. distincta* in surveys in Costa Rica where the fly is present (Jirón and Hedsstrom1988).
Anastrepha fraterculus (Wiedemann)	Castañeda et al., 2010; ICA, 2014; Posada, 1989	Gallego and Vélez, 1992; ICA, 2014; Núñez, 1981; Raga et al., 2011	Fruit (Uramoto et al., 2004)	Yes	
Anastrepha obliqua (Macquart)	Castañeda et al., 2010; Figueroa, 1977; ICA, 2014; Posada, 1989; Yepes and Vélez, 1989	Gallego and Vélez, 1992; ICA, 2014; Núñez, 1981; Posada, 1989; Raga et al., 2011	Fruit (Uchôa-Fernandes et al., 2002; Posada, 1989; Vayssières et al., 2013)	Yes	Present in Puerto Rico and the U.S. Virgin Islands (CABI, 2018).
Anastrepha serpentina (Wiedemann)	Castañeda et al., 2010	Aluja, 1984; Hernández-Ortiz, 1992; Korytkowski and Ojeda, 1968	Fruit (Aluja et al. 1987; Hernández-Ortiz et al., 2006)	Yes	
Anastrepha sororcula Zucchi	Canal, 2010; Castañeda et al., 2010	Raga et al, 2011	Fruit (Raga et al., 2011)	Yes	
Anastrepha striata Schiner	Castañeda et al., 2010; Gallo-Franco et al., 2017; ICA, 2014	ICA, 2014; Núñez, 1981; Vayssières et al., 2013	Fruit (Hernández-Ortiz, 2007; Montoya et al., 2016)	Yes	

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Ceratitis capitata (Wiedemann)	Núñez, 1981; Posada, 1989	Eskafi and Cunningham, 1987; Liquido et al., 1990;	Fruit (Liquido et al., 1991)	Yes	This fruit fly has been recorded intermittently in California, Florida, and Texas and subsequently eradicated (CABI, 2018). It is considered established in Hawaii (CABI, 2018).
Hexachaeta amabilis Loew	Posada, 1989	Posada, 1989	Fruit (Posada, 1989)	No	Adult flies feed on mango fruit (Aluja et al., 2000) and would not remain with harvested fruit. Larvae of this genus develop in fruits of the family Moraceae (Aluja et al., 2000).
Hemiptera: Aetalionidae					
Aetalion reticulatum L.	Posada, 1989	Espina, 1974; Posada, 1989	Flower, stem (Espina, 1974), leaf (Posada, 1989)	No	
Hemiptera: Aleyrodidae					
Aleurocanthus woglumi Ashby	Agudelo and Falcon, 1977; CABI, 2018	CABI, 2018; Dietz and Zetek, 1920	Leaf (CABI, 2018; Hart et al., 1978)	No	Present in Hawaii (Heu and Nagamine, 2001), Florida (Hart et al., 1978), Puerto Rico, Solomon Islands, (CABI, 2018) and Texas (Meagher and French, 2004).
Hemiptera: Aphididae					
Aphis rumicis Linnaeus	Bustillo and Sánchez, 1977; Figueroa, 1977; Posada, 1989	Figueroa, 1977	Leaf (*Malus* sp., Posada, 1989)	No	We found no evidence of this species feeding on mango fruit.
Hemiptera: Coccidae					
Ceroplastes martinae Mosquera	ICA, 2014; Kondo, 2009; Mosquera, 1979	ICA, 2014; Kondo, 2009; Mosquera, 1979	Leaf (Mosquera, 1979)	No	

Pest name	**Evidence of presence in Colombia**	**Association with *Mangifera indica*[1]**	**Plant part(s) association[2]**	**On harvested plant part(s)?[3]**	**Remarks**
Ceroplastes rubens Maskell	ICA, 2014; Kondo, 2008a; 2009	De Lotto, 1965; ICA, 2014; Kondo, 2009	Fruit, leaf, stem (Peña et al., 2002)	Yes	Present in Florida, Guam, Hawaii (Nakahara, 1981), Northern Mariana Islands, Puerto Rico (Nakahara and Miller, 1981), American Samoa, and Solomon Islands (CABI, 2018).
Ceroplastes stellifer (Westwood) syn.: *Vinsonia stellifera* (Westwood)	ICA, 2014; Kondo, 2001; 2009; Posada, 1989	ICA, 2014; Gallego and Vélez, 1992; Patil, 2015; Posada, 1989	Leaf (Patil, 2015; Posada, 1989)	No	Present in Alabama, Florida, Georgia, Puerto Rico, and U.S. Virgin Islands (Ben-Dov, 1993). Actionable only to Guam and American Samoa (PestID, 2018).
Ceroplastes trochezi Mosquera	ICA, 2014; Kondo 2001; 2009; Mosquera, 1979a	ICA, 2014; Kondo, 2009; Mosquera, 1979	Stem (Mosquera, 1979)	No	
Philephedra broadwayi (Newstead)	Figueroa, 1977; Kondo, 2001; Nakahara and Gill, 1985	Ben-Dov, 1993; Figueroa, 1977; Nakahara and Gill, 1985	Fruit, leaf (Nakahara and Gill, 1985)	Yes	Nakahara and Gill (1985) examined a single slide-mounted specimen collected from mango fruit. See Section 2.3 for further details.
Protopulvinaria longivalvata Green	ICA, 2014; Kondo, 2001; Posada, 1989	ICA, 2014; Posada, 1989	Leaf, stem (Posada, 1989)	No	Present in Puerto Rico (Ben-Dov, 1993; Nakahara and Miller, 1981) and U.S. Virgin Islands (Ben-Dov, 1993).
Hemiptera: Diaspididae					
Aulacaspis tubercularis Newstead	ICA, 2014; Kondo, 2009; Kondo and Velazco, 2009; Posada, 1989	ICA, 2014; Kondo, 2009; Posada, 1989	Leaf, fruit (Kondo and Unruh, 2009)	Yes	Present in Florida (Miller, 2005) and Puerto Rico (Martorell, 1976; Miller, 2005). Diaspidid scales may enter on commercial fruit but are unlikely to establish via this pathway (Miller et al., 1985; PERAL, 2007).

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Hemiberlesia cyanophylli (Signoret) syn.: *Abgrallaspis cyanophylli* (Signoret)	Posada, 1989	Claps and Dos Santos Wolff, 2003	Leaf (Normark et al., 2014)	No	Present in Florida, Georgia, Louisiana, Mississippi, Texas (Miller, 2005), Hawaii (Nakahara, 1981) and Puerto Rico (Nakahara and Miller, 1981).
Parlatoria cinerea (Hadden in Doane & Hadden)	Mosquera París, 1979; Posada, 1989	Butani, 1993	Bark, branch, fruit, leaf, stem (Watson, 2017)	Yes	Present in Puerto Rico (Miller, 2005). Diaspidid scales may enter on commercial fruit but are unlikely to establish via this pathway (Miller et al., 1985; PERAL, 2007).
Pseudischnaspis acephala Ferris	ICA, 2014; Kondo, 2009; Posada, 1989	ICA, 2014; Kondo, 2009; Maes, 2004; Posada, 1989	Leaf (Posada, 1989)	No	
Hemiptera: Membracidae					
Campylenchia hastata (F.)	Posada, 1989	Posada, 1989	Flower (Posada, 1989)	No	
Horiola picta (Coquebert)	CABI, 2018; Figueroa, 1977	CABI, 2018; Figueroa, 1977	Fruit (of *Bombax aqualicum*; Van Dinther, 1960)	No	Membracids are conspicuous jumping insects that feed externally on stems and fruits (Van Dinther, 1960). Any insects resting or feeding on the fruit would jump or fly off at harvest.
Hemiptera: Monophlebidae					
Crypticerya multicicatrices Kondo & Unruh	Kondo et al., 2012; Kondo and Unruh, 2009	Kondo et al., 2012; Pinchao et al., 2015	Leaf, stem, fruit (Kondo et al., 2012)	Yes	

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Icerya seychellarum (Westwood)	CABI, 2018; Kondo et al, 2016	Salman and Bakry, 2012	Fruit, leaf, stem (Salman and Bakry, 2012)	Yes	Weeks et al. (2012) state that *Icerya seychellarum* primarily infests stems and undersides of older leaves but is occasionally found on fruit, and Salman and Bakry (2012) also mention fruit. Neither publication, however, provides direct evidence for infestation of fruit.
Hemiptera: Ortheziidae					
Praelongorthezia praelonga (Douglas) syn.: *Orthezia praelonga* Douglas	Kondo, 2009	Kondo, 2009	Flower, leaf, trunk, twig (Kondo et al., 2013)	No	This species is present in Puerto Rico and is found primarily on the undersides of leaves (Martorell, 1976).
Hemiptera: Pentatomidae					
Antiteuchus pallescens Stal	Posada, 1989	Posada, 1989	Leaf (Posada, 1989)	No	
Antiteuchus tripterus (Fabricius)	Figueroa, 1977; Posada, 1989	Figueroa, 1977; Posada, 1989	Branch, trunk (Eberhard, 1975)	No	
Macropygium reticulave (Fabricius)	Posada, 1989	Posada, 1989	Flower (Posada, 1989)	No	
Hemiptera: Pseudococcidae					
Dysmicoccus neobrevipes Beardsley	CABI, 2018; Kondo et al., 2008	CABI, 2018; Williams, 2004	Fruit, leaf, root, stem (CABI, 2018)	Yes	Present in Hawaii (Nakahara, 1981), American Samoa, Florida, Guam, Northern Mariana Islands, Puerto Rico, and U.S. Virgin Islands (CABI, 2018). Actionable only to PR (DEEP 09/15/2016) (PestID, 2018).
Geococcus coffeae Green	Williams and Granara de Willink, 1992	Hara et al., 2001	Root (Williams and Granara de Willink, 1992)	No	This species is present in Hawaii (Beardsley, 1966; Hara et al., 2001; Nakahara, 1981) and Puerto Rico (Martorell, 1976).

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Maconellicoccus hirsutus (Green) syn.: *Phenacoccus hirsutus* Green	Kondo et al., 2008	González-Gaona et al., 2010; Rosas-Garcia and Parra-Bracamonte, 2011	Young shoots, flowers, fruit (Kairo et al., 2000); terminal bud, fruit (Rosas-Garcia and Parra-Bracamonte, 2011)	Yes	Present in California, Florida, Guam, Hawaii, Northern Mariana Islands, Puerto Rico, and U.S. Virgin Islands and reported but unconfirmed in several other states (CABI, 2018). Not actionable to St. Thomas (PestID, 2018).
Planococcus lilacinus (Cockerell) syn.: *Pseudococcus lilacinus* Cockerell	Kondo, 2001	Butani, 1993; Williams and Granara de Willink, 1992	Fruit, shoots, stem (Doan et al., 2016)	Yes	Present in Guam (CABI, 2018) and Northern Mariana Islands (Ben-Dov, 1994).
Pseudococcus elisae Borchsenius	Gimpel and Miller, 1996; Williams and Granara de Willink, 1992	Beardsley, 1986a; Williams and Granara de Willink, 1992	Fruit and leaves (CABI, 2018) [banana fruit (Beardsley, 1986a)]	Yes	This species is present in Hawaii (Beardsley, 1986a; Nakahara, 1981), Puerto Rico (Nakahara and Miller, 1981; Williams and Granara de Willink, 1992), and Florida (Miller et al., 2005).
Hymenoptera: Formicidae					
Atta cephalotes (Linnaeus)	Lores Medina and Pinzón-Florián, 2011; Posada, 1989	CABI, 2018; Van Dinther, 1960	Leaf, stem, flower (CABI, 2018; Van Dinther, 1960)	No	The genus *Atta* is listed as actionable in PestID (2018).
Atta sexdens (Linnaeus)	Posada, 1989; AntWeb, 2018	CABI, 2018; Jirón, 1995; Van Dinther, 1960	Leaf, stem, flower (CABI, 2018; Espina, 1974; Jirón, 1995; Van Dinther, 1960)	No	The genus *Atta* is listed as actionable in PestID (2018).
Camponotus blandus (F. Smith)	Posada, 1989	Posada, 1989	Leaf (Posada, 1989)	No	
Isoptera: Rhinotermitidae					
Heterotermes convexinotatus (Snyder)	Figueroa, 1977	Figueroa, 1977	Root, stem (of passion fruit) (Dominguez-Gil and McPheron, 1992)	No	Action required to Hawaii and southern states. No action to Puerto Rico or U.S. Virgin Islands (PestID, 2018).
Lepidoptera: Erebidae					

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Gonodonta bidens Geyer	Figueroa, 1977	Figueroa, 1977	Leaf, fruit (*Annona* sp.; Silva et al., 2017)	Yes	Larvae feed on leaves. Adults are fruit-piercing moths (Silva et al., 2017) and would fly away during the harvesting process.
Lepidoptera: Limacodidae					
Phobetron hipparchia Cramer	Figueroa, 1977; Gallego and Vélez, 1992; Martínez and Plata-Rueda, 2013	Figueroa, 1977	Leaf (Villegas García, 2005)	No	
Lepidoptera: Megalopygidae					
Megalopyge lanata (Stoll)	Figueroa, 1977; Posada, 1989	Espina, 1974; Posada, 1989	Leaf (Espina, 1974; Posada, 1989)	No	
Megalopyge ornata (Druce)	Gallego and Vélez, 1992	Gallego and Vélez, 1992	Leaf (Gallego and Vélez, 1992)	No	
Megalopyge orsilochus (Cramer)	Figueroa, 1977; Posada, 1989	Posada, 1989	Leaf (Posada, 1989)	No	
Lepidoptera: Nymphalidae					
Hamadryas feronia L. syn.: *Ageronia feronia* L.	Posada, 1989	Posada, 1989	Fruit (Posada, 1989)	No	Adult moths pierce fruit to feed (Posada, 1989) and would fly away during the harvesting process.
Lepidoptera: Saturniidae					
Automeris illustris Walker	Figueroa, 1977	Figueroa, 1977	Leaf (Specht et al., 2006)	No	
Orthoptera: Acrididae					
Tropidacris cristata cristata (L.) syn: *Eutropidacris cristata* L.	Posada, 1989	Posada, 1989	Leaf (Posada, 1989)	No	
Orthoptera: Proscopiidae					
Prosarthria teretrirostris Brunner von Wattenwyl	Posada, 1989	Posada, 1989; Lores Medina and Pinzón-Florián, 2011	Leaf (Posada, 1989)	No	
Thysanoptera: Thripidae					

Pest name	Evidence of presence in Colombia	Association with *Mangifera indica*[1]	Plant part(s) association[2]	On harvested plant part(s)?[3]	Remarks
Thrips palmi Karny	Aristizábal et al., 2013; CABI, 2018	Aliakbarpour and Rawi, 2012; CABI, 2018	Flower (Aliakbarpour and Rawi, 2012)	No	Present in Florida since 1990 (Castineiras et al., 1997; Seal and Baranowski, 1993), Hawaii since 1982 (Johnson, 1986; Nakahara et al., 1984), Guam since 1986 (Beardsley, 1986b; Nakahara, 1984) and Puerto Rico since 1986 (Pantoja et al., 1988). We found no evidence this species occurs on mango fruit. Furthermore, thrips are not firmly attached to plants and have no place to hide on a mango (no calyx on fruit). Therefore, any thrips incidental on the harvested fruit would be removed by washing.
FUNGI					
Ascomycetes					
Scolecostigmina mangiferae (Koord.) U. Braun & Mouch. syn.: *Cercospora mangiferae* Koord.	CABI, 2018; Farr and Rossman, 2018; ICA, 2014	Farr and Rossman, 2018; ICA, 2014	Leaf (Farr and Rossman, 2018; ICA, 2014; Stevenson, 1975)	No	Present in Puerto Rico (Stevenson, 1975), American Samoa, and the Solomon Islands (Hyde et al., 1992).

2.3. Notes on pests identified in the pest list

Anastrepha distincta has a strong preference for *Inga* species (Norrbom and Kim, 1988). Based on a few isolated records, mango can serve as a host for *A. distincta*, but it is apparently a very rare host. Stone (1942) listed mango as a host plant of *A. distincta* based on fruit collected from markets and fields, although he did not note how many samples were taken. Since that time, Korytkowski and Ojeda (1968) recorded mango as a host in Peru, based on pheromone trap catches. In another paper, the same authors stated that *A. distincta* was caught only in orchards where mango trees were mixed abundantly with *Inga* spp., the preferred host of *A. distincta*. (Korytkowski. and Ojeda P., 1969). Host association studies in Mexico (Aluja et al., 1987) and Brazil (Jesus-Barros et al., 2012; Raga et al., 2011) found no association with mango. Likewise, Jirón and Hedstrom (1988) did not find mango infested by *A. distincta* in surveys in Costa Rica where the fly is present. The authors only found the fly infesting *Inga* spp. Other authors citing mango as a host of *A. distincta*, such as White and Elson-Harris (1994), are probably citing Stone (1942) or Korytkowski and Ojeda (1968). For these reasons, we predict that the fly will be highly unlikely to be present with harvested commercial fruit.

Philephedra broadwayi (Newstead) has been reported from Colombia (Figueroa, 1977; Kondo, 2001; Nakahara and Gill, 1985), and mango has been reported as a host (Ben-Dov, 1993; Figueroa, 1977; Nakahara and Gill, 1985). We found only one report, however, of *P. broadwayi* being associated with mango fruit, and the authors were reporting on their examination of a single slide-mounted specimen labeled as having been collected on mango fruit (Nakahara and Gill, 1985), rather than on a direct field collection or observation of *P. broadwayi* by the authors. Although we acknowledge that *P. broadwayi* may occur on mango fruit, the lack of reports suggests this is a rare occurrence. For this reason, we predict that this scale will be highly unlikely to be present with harvested commercial fruit.

2.4. Pests selected for further analysis

We identified 14 pests for further analysis (Table 2). All of these organisms are actionable pests for the United States and have a reasonable likelihood of being associated with mango (*Mangifera indica*) fruit at the time of harvest and remaining with the commodity, in viable form, throughout the harvesting process.

Table 2. Pests selected for further analysis.

Pest type	Taxonomy	Scientific name
Arthropod	Diptera: Lonchaeidae	*Neosilba glaberrima*
	Diptera: Tephritidae	*Anastrepha fraterculus*
		Anastrepha ludens
		Anastrepha obliqua
		Anastrepha serpentina
		Anastrepha sororcula
		Anastrepha striata
		Ceratitis capitata
	Hemiptera: Coccidae	*Ceroplastes rubens*
	Hemiptera: Monophlebidae	*Crypticerya multicicatrices*
	Hemiptera: Pseudococcidae	*Dysmicoccus neobrevipes*
		Maconellicoccus hirsutus
		Planococcus lilacinus
		Pseudococcus elisae

3. Assessing Pest Risk Potential

3.1. Introduction

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

The likelihood and consequences of introduction are assessed using different approaches. For the consequences of introduction, we determine if the pest meets the threshold (Yes/No) of being likely to cause unacceptable losses. We base that determination on the physical damage the pest is likely to cause or the proportion of exports likely to be disrupted, rather than on an absolute value or amount of monetary loss.

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

High: Pest introduction is highly likely to occur.

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

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

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

3.2. Assessment results

3.2.1. *Anastrepha fraterculus* (Diptera: Tephritidae)

We determined the overall likelihood of introduction to be High and that establishment of *A. fraterculus* in the continental United States is likely to cause unacceptable impacts. We present the results of this assessment in the following tables.

Determination of the portion of the United States endangered by *Anastrepha fraterculus*

Climatic suitability	*Anastrepha fraterculus* occurs in North, Central, and South America and the Caribbean, ranging from the southern United States to Argentina (CABI, 2018; Foote et al., 1993; PPQ, 2002). More specifically, it occurs in the United States (Rio Grande Valley of southern Texas), Mexico (restricted distribution), Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Trinidad and Tobago,

	Argentina (restricted distribution), Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela (CABI, 2018; PPQ, 2002). This distribution covers a temperature range corresponding to global Plant Hardiness Zones 8-13 (Magarey et al., 2008; Saha et al., 2010).
Potential hosts at risk in PRA Area	*Anastrepha fraterculus* feeds on multiple genera in multiple plant families, including *Actinidia* spp. (Actinidiaceae); *Mangifera* spp. (mango) and *Spondias* spp. (mombin) (Anacardiaceae); *Annona* spp. (Annonaceae); Combretaceae *Terminalia* spp. (tropical almond) (Combretaceae); Ebenaceae *Diospyros* spp. (persimmon) (Ebenaceae); *Juglans* spp. (walnut) (Juglandaceae); *Persea* spp. (bay, avocado) (Lauraceae); *Ficus* spp. (fig) (Moraceae); *Eugenia* spp., *Psidium* spp. (guava), and *Syzygium* spp. (Myrtaceae); Oleaceae *Olea* spp. (olive) (Oleaceae); *Punica* spp. (pomegranate) (Punicaceae); *Cydonia* spp. (quince), *Eriobotrya* spp. (loquat), *Fragaria* spp. (strawberry), *Malus* spp. (apple), *Prunus* spp. (plum, peach, cherry), *Pyrus* spp. (pear), and *Rubus* spp. (blackberry, raspberry) (Rosaceae); Rutaceae *Citrus* spp. and *Fortunella* spp. (kumquat) (Rutaceae); *Manilkara* spp. and *Pouteria* spp. (Sapotaceae); *Solanum* spp. (tomato, potato, eggplant) (Solanaceae); and *Vitis* spp. (grape) (Vitaceae) (CABI, 2018; White and Elson-Harris, 1992).
Economically important hosts at risk	The *A. fraterculus* species complex may infest such important crops as apple, citrus, and grape (CABI, 2018; NASS, 2014, 2017b).
Pest potential on economically important hosts at risk[a]	The *A. fraterculus* species complex damages economically important plants (Simões Dias and Lucky, 2017). In Argentina, *A. fraterculus* is considered the most important pest of citrus (PPQ, 2002). The oviposition punctures ("stings") alone may render fruit unmarketable (Gould and Raga, 2002). In Brazil, it causes severe yield losses in apple due to fruit malformation and fruit drop and results in significant restrictions on fresh fruit exports to countries with quarantine barriers (Sugayama et al., 1997). The introduction of *A. fraterculus* into new areas of the continental United States would likely stimulate control programs (CABI, 2018; Guillen and Sanchez, 2007; Vera et al., 2007), thereby increasing crop production costs.
Defined Endangered Area	The area endangered by *A. fraterculus* comprises global Plant Hardiness Zones 8-13, as this area is both climatically suitable and contains economically important hosts.

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Anastrepha fraterculus* into the endangered area via the importation of the mangoes from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	High	MC	In this analysis we did not consider any field practices that would reduce the prevalence of this species in the field. Furthermore, this species has a high level of fecundity. Females can lay up to 50 eggs in a single fruit, depending on maturity and variety of the host fruit (PPQ, 2002).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	High	MC	Apart from routine washing, no postharvest processing was considered in this analysis. Fruits infested with fruit flies are highly likely to escape detection during culling (White and Elson-Harris, 1992).
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	High	MU	Transport and storage conditions were not considered; therefore, we did not change the previous rating. Live *Anastrepha* spp. larvae, however, have been intercepted at U.S. ports of entry over 1,000 times in permit cargo, mostly in fruit (PestID, 2018), indicating that the larvae in this genus can survive normal shipping conditions.
Risk Element A: Overall risk rating for likelihood of entry	High	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	C	*Anastrepha fraterculus* feeds on multiple genera in multiple plant families (CABI, 2018; White and Elson-Harris, 1992). Suitable hosts are widely distributed throughout the entire endangered area (NRCS, 2018).
Risk Element B2: Likelihood of arriving in the endangered area	High	C	More than 25 percent of the U.S. population lives in the endangered area (PERAL, 2015).

Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	High	N/A	

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

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

Criteria	**Meets criteria? (Y/N)**	**Uncertainty Rating[a]**	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	MC	As mentioned in the discussion of the endangered area, this species has significant damage potential.
Risk Element C2: Spread potential	Yes	C	In mark-release-recapture experiments in Brazil, adults of *A. fraterculus* were captured up to 800 meters from their release point (Kovaleski et al., 1999). *Anastrepha fraterculus* also moves in trade via infested fruit (CABI, 2018, PestID, 2018).
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	N/A	N/A	
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A	N/A	
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

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

3.2.2. ***Anastrepha obliqua*** (Diptera: Tephritidae)

We determined the overall likelihood of introduction of *A. obliqua* to be High and that establishment of *A. obliqua* in the United States is likely to cause unacceptable impacts. We present the results of this assessment in the following tables.

Determination of the portion of the United States endangered by *Anastrepha obliqua*

Climatic suitability	*Anastrepha obliqua* is present in Central and South America and the Caribbean (CABI, 2018; White and Elson-Harris, 1992), corresponding to global Plant Hardiness Zones 10-13 within the United States and Territories (Magarey et al., 2008; Saha et al., 2010).
Potential hosts at risk in PRA Area	The main hosts of *A. obliqua* are *Spondias* species (Anacardiaceae), which are usually only of local interest in the tropical parts of the United States and Territories. *Mangifera indica* (mango) (Anacardiaceae) is a significant host, and occasional hosts include *Citrus* spp. (Rutaceae) and *Psidium guajava* (guava) (Myrtaceae). *Anastrepha obliqua* has also been reported on a range of other tropical and temperate fruits including *Anacardium occidentale* (cashew) (Anacardiaceae), *Averrhoa carambola* (starfruit) (Oxalidaceae), *Coffea arabica* (coffee) (Rubiaceae), *Eriobotrya japonica* (loquat) (Rosaceae) and *Prunus dulcis* (almond) (Rosaceae) (CABI, 2018; Norrbom and Kim, 1988; White and Elson-Harris, 1992).
Economically important hosts at risk[a]	Mango, citrus, coffee, and *Prunus* spp. are at risk (CABI, 2018; NASS, 2014, 2015, 2017a; Norrbom and Kim, 1988; White and Elson-Harris, 1992)
Pest potential on economically important hosts at risk	*Anastrepha obliqua* larvae could infest mango and citrus fruit, making them unmarketable or requiring additional control programs to limit the impact of the fly.
Defined Endangered Area	The endangered area consists of global Plant Hardiness Zones 10-13 in the continental United States, Hawaii and the U.S. Territories. The fly is already present in Puerto Rico (Segarra-Carmona et al., 1990) and the U.S. Virgin Islands (CABI, 2018).

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Anastrepha obliqua* into the endangered area via the importation of the mangoes from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			

Risk Element	**Risk Rating**	**Uncertainty Rating**[a]	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	High	MC	*Anastrepha obliqua* is a common pest of mango, feeding internally on the fruit in the larval stage (Camargo et al., 1996).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	High	C	Apart from routine washing, no postharvest processing was considered in this analysis. Washing would have no effect on internal feeders; therefore, the risk rating from A1 is unchanged.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	High	MC	Transport and storage conditions were not considered; therefore, we did not change the previous rating in A2. Live *Anastrepha* spp. larvae, however, have been intercepted at U.S. ports of entry over 1,000 times in permit cargo, mostly in fruit (PestID, 2018), indicating that the larvae in this genus can survive normal shipping conditions.
Risk Element A: Overall risk rating for likelihood of entry	High	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	MU	Commercial and non-commercial hosts are regularly distributed throughout the endangered area (NRCS, 2017). The larvae can develop in discarded fruit, and adult insects can fly to find new hosts (White and Elson-Harris, 1992).
Risk Element B2: Likelihood of arriving in the endangered area	Medium	MC	Approximately thirteen percent of the U.S. population occurs in Plant Hardiness Zones 10-13, where the environmental conditions and potential hosts make it likely that *A. obliqua* could survive (PERAL, 2015).
Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Combined likelihoods of entry and establishment	High	N/A	

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

Assessment of the consequences of introduction of *Anastrepha obliqua* into the United States

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	MC	*Anastrepha obliqua* infests mango and citrus. U. S. citrus production alone was valued at almost two billion dollars in 2016/2017 (NASS, 2017a). Larvae of *Anastrepha obliqua* feed internally in fruit, making the fruit unmarketable (Jiron and Hedstrom, 1988).
Risk Element C2: Spread potential	Yes	MU	*Anastrepha obliqua* is a flying insect with many potential hosts in the endangered area (Norrbom and Kim, 1988). Besides a preference for Anacardiaceae (Jiron and Hedstrom, 1988), no apparent mechanisms would limit its spread within the endangered area.
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	N/A	N/A	
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A	N/A	
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Conclusion			
Is the pest likely to cause unacceptable consequences in the United States?	Yes	N/A	

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

3.2.3. *Anastrepha serpentina* (Diptera: Tephritidae)

We determined the overall likelihood of introduction of *A. serpentina* to be Medium and that establishment of *A. serpentina* in the United States and Territories is likely to cause unacceptable impacts. We present the results of this assessment in the following tables.

Determination of the portion of the continental United States endangered by *Anastrepha serpentina*

Climatic suitability	*Anastrepha serpentina* has been reported from North America [the United States (Rio Grande Valley of Texas) and Mexico], Central America (Costa Rica, Guatemala, and Panama), and South America (Argentina, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, Trinidad, and Venezuela) (CABI, 2018; Weems, 2015). We estimate that *A. serpentina* could establish in areas of the United States and Territories corresponding to global Plant Hardiness Zones 9-13 (Magarey et al., 2008; Saha et al., 2010).
Potential hosts at risk in PRA Area	*Anastrepha serpentina* has been reported from *Annona glabra* (Annonaceae); *Citrus* spp., including *C. sinensis* (Rutaceae); *Ficus* sp. (Moraceae); *Mangifera indica* (Anacardiaceae); *Manilkara zapota* (Sapotaceae); *Persea americana* (Lauraceae); *Cydonia oblonga*, *Malus domestica*, *Pouteria* spp., *Prunus* spp., and *Pyrus communis* (Rosaceae); and *Psidium guajava* (Myrtaceae) (Weems, 2015).
Economically important hosts at risk	*Anastrepha serpentina* is an important pest in the American tropics and subtropics, especially of sapotaceous fruits (Hernández-Ortiz, 1992). It has also been reported to infest mango, apple, peach, and quince (Norrbom and Kim, 1988), although these do not appear to be primary hosts of this fruit fly.
Pest potential on economically important hosts at risk[a]	The establishment of *A. serpentina* is likely to affect market access to the countries where this pest is of quarantine importance. The establishment of *A. serpentina* in Florida could seriously affect tropical fruit production there (Weems, 2015).
Defined Endangered Area	The area endangered by *Anastrepha serpentina* comprises global Plant Hardiness Zones 9-13, as this area is both climatically suitable and contains economically important hosts.

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Anastrepha serpentina* into the endangered area via the importation of mango fruit from Colombia

Risk Element	**Risk Rating**	**Uncertainty Rating**[a]	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Low	MU	*Mangifera* spp. is a marginal host for *A. serpentina* (Aluja et al., 1989). Although adults have been observed feeding on overripe fallen fruits (Soto-Manitiu and Jirón, 1989), larvae are unlikely to be present within the harvested commodity.
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Low	C	Fruits infested with fruit flies are highly likely to escape detection during culling (White and Elson-Harris, 1992).
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	Low	C	Transport and storage conditions were not considered; therefore, we did not change the previous rating. Live *Anastrepha* spp. larvae, however, have been intercepted at U.S. ports of entry over 1,000 times in permit cargo, mostly in fruit (PestID, 2018), indicating that the larvae in this genus can survive normal shipping conditions.
Risk Element A: Overall risk rating for likelihood of entry	Low	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	MC	*Anastrepha serpentina* has a large potential host range (see discussion of endangered area). Suitable hosts are widely distributed throughout the entire endangered area (NRCS, 2018).
Risk Element B2: Likelihood of arriving in the endangered area	High	MC	More than 25 percent of the U.S. population lives in the endangered area (PERAL, 2015).
Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Medium	N/A	

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

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

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	MU	*Anastrepha serpentina* is an important pest of sapote (*Pouteria* spp.), sapodilla (*Manilkara zapota*), canistel (*Lucuma salicifolia*), and other fruits including avocado (*Persea americana*) (Weems, 2015). Infestations have been documented to cause 80 percent losses to mamey sapote in Mexico (Ariza-Flores et al., 2009; Hernández-Ortiz, 1992). Infestations in tree-ripened fruit are frequently said to be so severe that growers are forced to harvest early and ripen fruit artificially, which lowers its quality (Weems, 2015). Mamey sapote is grown on a small scale in southern Florida and in Puerto Rico (Crane et al., 2016), where the fly could cause major damage.
Risk Element C2: Spread potential	Yes	M	*Anastrepha serpentina* expanded its host range and geographical distribution in conjunction with the spread of commercial fruit cultivation (Celedonio-Hurtado et al., 1988)
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	N/A	N/A	
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A	N/A	

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

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

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

3.2.4. *Anastrepha sorocula* (Diptera: Tephritidae)

We determined the overall likelihood of introduction to be High and that establishment of *Anastrepha sororcula* in the United States and Territories is likely to cause unacceptable impacts. We present the results of this assessment in the following tables.

Determination of the portion of the continental United States endangered by *Anastrepha sororcula*

Climatic suitability	*Anastrepha sororcula* is present in South America in Brazil, Colombia, and Venezuela (CABI, 2018; Canal, 2010). A comparison of this distribution with the global Plant Hardiness Zones (Magarey et al., 2008; Saha et al., 2010) indicates that establishment may occur in global Plant Hardiness Zones 10-13. Canal (2010) noted that the distribution in Colombia included low, middle, and high altitudes, suggesting with a high level of uncertainty that this species could also establish in Zone 9.
Potential hosts at risk in PRA Area	The hosts of *Anastrepha sororcula* include *Averrhoa carambola* (starfruit) (Oxalidaceae) (Bomfin et al., 2007), *Chrysobalanus icaco* (coco plum) (Chrysobalanaceae) [native to the United States (Florida)] (Zucchi et al., 2011), *Coffea arabica* (coffee) (Rubiaceae) (Aguiar-Menezes et al., 2007), *Mangifera indica* (mango) (Anacardiaceae) (Raga et al, 2011), *Prunus persica* (peach) (Rosaceae) (Zucchi and Moraes, 2008), *Psidium guajava* (guava) (Myrtaceae) (Bomfin et al., 2007), *Psidium guineense* (Guinea guava) (Myrtaceae) (Bomfin et al., 2007), *Spondias mombin* (yellow mombin) (Anacardiaceae) (Zucchi et al., 2011), and *Spondias purpurea* (red mombin) (Anacardiaceae) (Bomfin et al., 2007; Zucchi and Moraes, 2008; Zucchi et al., 2011). To date, this species is only known from the tropics, and the reported hosts are primarily tropical species. One or more of these hosts occur within Zones 9-13 in the United States and Territories (NRCS, 2017).

Economically important hosts at risk[a]	Coffee, mango, and peach are economically important hosts of *A. sororcula* in the United States (NASS, 2014, 2015, 2017a).
Pest potential on economically important hosts at risk	*Anastrepha sororcula* is one of the four *Anastrepha* species considered to be serious pests in Brazil (Aguiar-Menezes et al., 2001); however, the main damage reported is premature fruit drop in coffee and significantly reduced quality of the beverage (Souza et al., 2005). In general, *Anastrepha* species are considered to be the most serious fruit fly pests in Central and South America (CABI, 2018); therefore, we consider it likely that *A. sororcula* would have significant economic impacts on potential host species in the United States and Territories.
Defined Endangered Area	The endangered area encompasses areas of the United States and Territories where coffee, mango, and peach are grown in Plant Hardiness Zones 9-13.

[a] As defined by ISPM No. 11, supplement 2, "economically" important hosts refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Anastrepha sororcula* into the endangered area via the importation of mango fruit from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Medium	U	Aguiar-Menezes et al. (2001) and Zucchi et al. (2011) reported mango as a host; however, we found no specific information on the rate or intensity of mango infestation in the literature. Joachim-Bravo et al. (2003) collected infested guava from the

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
			field and documented that, like other fruit flies, *A. sororcula* lays its eggs within fruit, and larvae feed internally during development. In the laboratory, *A sororcula* produced significantly fewer eggs than *A. obliqua* or *A. fraterculus* (Joachim-Bravo et al., 2003), suggesting that its rate of infestation may be lower than for some other species of *Anastrepha*.
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Medium	MC	Fruits infested with fruit flies are highly likely to escape detection during culling (White and Elson-Harris, 1992). The risk rating remains unchanged.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	Medium	MU	Transport and storage conditions were not considered; therefore, we did not change the previous rating in A2. Live larvae of *Anastrepha* species, however, have been intercepted at U.S. ports of entry over 1,000 times in permit cargo, mostly in fruit (PestID, 2018), indicating that the larvae in this genus can survive normal shipping conditions.
Risk Element A: Overall risk rating for likelihood of entry	Medium	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	MC	*Anastrepha sororcula* is reported from at least five economically important genera in Brazil (Souza Filho et al., 2003; Zucchi et al., 2011) but may have a much wider host range including multiple plant genera (Zucchi and Moreas, 2008) that occur in the United States and Territories as either native or cultivated plants (NRCS, 2018). Many of these plants are primarily distributed in the southern United

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
			States and Territories; however, at least one cultivated host, *Prunus persica* (peach), is widespread throughout the continental United States (NRCS, 2018).
Risk Element B2: Likelihood of arriving in the endangered area	High	C	More than 25 percent of the U.S. population lives in the endangered area.
Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	High	N/A	

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

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

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	MU	*Anastrepha sororcula* is considered a pest species in South America (Aguiar-Menezes et al., 2001). Fruit drop in coffee berries is the only economic damage we found reported in the literature; however, we found little information about this species, especially outside its native range. Coffee, mango, and peach are economically important hosts (NASS, 2014, 2015). We estimate that there is potential for significant damage to occur in the endangered area, but with a moderate level of uncertainty.

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Risk Element C2: Spread potential	Yes	MU	We did not find evidence of any biological factors that may reduce the spread potential of *A. sororcula* in the United States. As with other *Anastrepha* species, the primary mode of spread is likely through the movement of infested fruit (Botha et al., 2004; CABI, 2018).
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	N/A	N/A	
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A	N/A	
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

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

3.2.4. *Anastrepha striata* (Diptera: Tephritidae)

We determined the overall likelihood of introduction to be High and that establishment of *Anastrepha striata* in the United States and its territories is likely to cause unacceptable impacts. We present the results of this assessment in the following tables.

Determination of the portion of the continental United States endangered by *Anastrepha striata*

Climatic suitability	*Anastrepha striata* is present in southern Mexico; most of Central America; and Peru, Bolivia, and Brazil in South America (CABI, 2018; Hernández-Ortiz, 1992; Weems and Fasulo, 2015). A comparison with the global Plant Hardiness Zones (Magarey et al., 2008; Saha et al., 2010) indicates that establishment may occur in Plant Hardiness Zones 9-13.

Potential hosts at risk in PRA Area	The primary host of *Anastrepha striata* is guava (*Psidium guajava*) (Hernández-Ortiz, 1992), although it may also infest fruits of other *Psidium* species (Zucchi and Moraes, 2008; Zucchi et al., 2011), key lime (*Citrus aurantifolia*), orange (*Citrus sinensis*) (Condor, 1973), and red mombin (*Spondias purpurea*), all of which may be found in Plant Hardiness Zones 9-13 (NRCS, 2018).
Economically important hosts at risk[a]	Oranges and other citrus fruits are economically important hosts of *A. striata* in the United States (NASS, 2014).
Pest potential on economically important hosts at risk	*Anastrepha striata* is considered to be an important agricultural pest in guava, lime, and orange (Aluja et al., 1987; Condor, 1973; Weems and Fasulo, 2015). In general, *A. striata* does not appear to be considered a pest of primary economic importance (Weems and Fasulo, 2015), although significant damage may occur in dooryard plantings or other plants in the environment. *Anastrepha* species are considered to be the most serious fruit fly pests in Central and South America (CABI, 2018); therefore, we consider it likely that *A. striata* would have significant economic impacts on potential host species in the United States and Territories.
Defined Endangered Area	The endangered area encompasses areas where guava and citrus are grown in Plant Hardiness Zones 9-13.

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Anastrepha striata* into the endangered area via the importation of mango fruit from Colombia

Risk Element	**Risk Rating**	**Uncertainty Rating[a]**	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Medium	MC	The primary host of *Anastrepha striata* is guava (Jirón and Hedström, 1991), but mango has been mentioned as an occasional host. Eggs are laid within fruit, and larvae feed internally during development (Aguiar-Menezes et al., 2002).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Medium	MC	Fruits infested with fruit flies are highly likely to escape detection during culling (White and Elson-Harris, 1992). Risk rating remains unchanged.
Risk Element A3: Likelihood of surviving transport and	Medium	MU	Transport and storage conditions were not considered; therefore, we

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
storage conditions of the consignment			did not change the previous rating in A2. Live *Anastrepha* spp. larvae, however, have been intercepted at U.S. ports of entry over 1,000 times in permit cargo, mostly in fruit (PestID, 2018), indicating that the larvae in this genus can survive normal shipping conditions.
Risk Element A: Overall risk rating for likelihood of entry	Medium	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	MC	*Anastrepha striata* feeds on multiple genera in multiple plant families (CABI, 2018; Weems and Fasulo, 2015). Suitable hosts are widely distributed throughout the entire endangered area.
Risk Element B2: Likelihood of arriving in the endangered area	High	C	More than 25 percent of the U.S. population lives in the endangered area.
Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	High	N/A	

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

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

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	MU	*Anastrepha striata* is considered a pest species in South America (Aguiar-Menezes et al., 2002; CABI, 2018). We estimate that there is potential for significant damage to occur in the endangered area, but with moderate levels of uncertainty.

Criteria	Meets criteria? (Y/N)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Risk Element C2: Spread potential	Yes	MU	We did not find evidence of any biological factors that may reduce the spread potential of *A. striata* in the United States. As with other *Anastrepha* species, the primary mode of spread is likely through the movement of infested fruit (Botha et al., 2004; CABI, 2018).
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Trade Impacts			
Risk Element D1: Export markets at risk	N/A	N/A	
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A	N/A	
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

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

3.2.5. *Ceratitis capitata* (Diptera: Tephritidae)

We determined the overall likelihood of introduction of *C. capitata* (Medfly) to be High and that establishment of *C. capitata* in the continental United States and Territories is likely to cause unacceptable impacts. We present the results of this assessment in the following tables.

Determination of the portion of the United States endangered by *Ceratitis capitata*

Climatic suitability	*Ceratitis capitata* is widely distributed in the Mediterranean region (including Israel), South and Central America, the Pacific (Hawaii), western Asia, Australia, and Africa (CABI, 2018). Based on its current distribution, we estimate that Medfly could establish in global Plant Hardiness Zones 8-13 (Magarey et al., 2008; Saha et al., 2010) of the continental United States.

Potential hosts at risk in PRA area	*Ceratitis capitata* infests over 400 different wild and cultivated species across a wide variety of plant families. Some of those that are at risk in the PRA area include *Mangifera indica* (mango) (Anacardiaceae); *Annona cherimola* (cherimoya) (Annonaceae); *Opuntia* spp. (pricklypear) (Cactaceae); *Carica papaya* (papaya) (Caricaceae); *Diospyros* spp. (persimmon) (Ebenaceae); *Ficus carica* (fig) (Moraceae); *Psidium guajava* (guava) (Myrtaceae); *Olea europaea* (olive) (Oleaceae); *Zizphus* spp. (jujube) (Rhamnaceae); Rosaceae: *Cydonia oblonga* (quince), *Malus* spp. (apple), *Prunus* spp. (peach, plum, cherry), *Pyrus* spp. (pear), and *Rubus* spp. (blackberry, raspberry) (Rosaceae); *Citrus* spp. (Rutaceae); *Capsicum annuum* (pepper), *C. frutescens* (tabasco pepper), *Solanum lycopersicum* (tomato), *Solanum* spp. (potato, eggplant) (Solanaceae); and *Vitis vinifera* (grape) (Vitaceae) (CABI, 2018).
Economically important hosts at risk[a]	Mango, fig, apple, peach, pear, raspberry, citrus, and solanaceous crops are economically important hosts in the PRA area (CABI, 2018; NASS, 2014, 2017a, 2017b).
Pest potential on economically important hosts at risk	Fruit flies are major pests where they are established, and they cause trade restrictions or phytosanitary measures to be applied (CABI, 2018; White and Elson-Harris, 1992). Medfly is one of the world's most destructive fruit pests (Thomas et al., 2010). Because of its wide distribution, ability to tolerate colder climates than most other fruit flies, and wide host range, it is ranked as the most economically important fruit fly (CABI, 2018; Cayol et al., 2002; Thomas et al., 2010). It is a major pest of citrus but is often an even more serious pest of deciduous fruits, such as peach, pear, and apple (CABI, 2018; Thomas et al., 2010). In Mediterranean countries, it is damaging to citrus and peach crops (CABI, 2018).
Defined Endangered Area	Suitable hosts for *C. capitata* occur in Plant Hardiness Zones 8-13 of the United States. The endangered area accounts for 27.7 percent of the PRA area and 47.5 percent of the U.S. population (PERAL, 2015). The demand for host material (fruit) within this area increases the likelihood of introduction.

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Ceratitis capitata* into the endangered area via the importation of mango fruit from Colombia.

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	High	C	Mango is a host, and larvae feed inside fruit (See Table 1 for references).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	High	C	Internally-feeding arthropods are highly likely to survive minimal post-harvest treatment, such as washing. Infested fruits are also highly likely to escape detection during culling (White and Elson-Harris, 1992). Therefore we did not change the previous rating in A1.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	High	MU	Transport and storage conditions were not considered; therefore, we did not change the previous rating in A2. Officers at U.S. ports of entry, however, have intercepted live *C. capitata* in fruit from a number of countries over 3,000 times, including 114 times in permit cargo (PestID, 2018), indicating that *C. capitata* larvae are generally able to survive standard shipping conditions.
Risk Element A: Overall risk rating for likelihood of entry	High	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	High	C	*Ceratitis capitata* has an expansive host range consisting of at least 167 commercial hosts (CABI, 2018; De Meyer et al., 2002). Suitable hosts such as apple, peach, and pear are widely distributed throughout the entire endangered area (De Meyer et al., 2002).
Risk Element B2: Likelihood of arriving in the endangered area	High	C	More than 25 percent of the U.S. population lives in the endangered area (PERAL, 2015). Transport of infested fruit remains the major means of introduction to new areas (CABI, 2018).

Risk Element	**Risk Rating**	**Uncertainty Rating[a]**	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Risk Element B: Combined likelihood of establishment	High	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	High	N/A	

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

Assessment of the consequences of introduction of *Ceratitis capitata* into the continental United States and her territories

Criteria	**Meets criteria? (Y/N)**	**Uncertainty Rating[a]**	**Justification for rating and explanation of uncertainty (and other notes as necessary)**
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	C	*Ceratitis capitata* is a serious pest of numerous hosts, including many *Citrus* spp., *Ficus carica*, and species of *Prunus*, *Pyrus*, and *Malus* (CABI, 2018; White and Elson-Harris, 1992), with damage to stone fruit crops approaching 100 percent (Thomas et al., 2010).
Risk Element C2: Spread potential	Yes	C	*Ceratitis capitata* is a strong flier with adults found to disperse over 1.6 km. Weather can also aid in dispersal, blowing flies over 14 km from release sites (Christenson and Foote, 1960).
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

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

3.2.6 *Ceroplastes rubens* (Hemiptera: Coccidae)

We determined the overall likelihood of introduction to be Negligible. We present the results of this assessment in the following table. Because the likelihood of introduction is Negligible, we did not determine the endangered area or the consequences of introduction.

Assessment of the likelihood of introduction of *Ceroplastes rubens* into the endangered area via the importation of mangoes from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Medium	MU	Field practices that may reduce the prevalence of *C. rubens* were not considered. Most nymphs settle on twigs, rarely on leaves or fruit (Itioka and Inoue, 1989, 1991).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Medium	MU	We found no evidence that washing would reduce pest numbers. Therefore we did not change the previous rating in A1.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	Medium	MC	Transport and storage conditions were not considered; therefore, we did not change the previous rating.
Risk Element A: Overall risk rating for likelihood of entry	Medium	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	Negligible	MC	*Ceroplastes rubens* has extremely limited dispersal ability because the insects are only able to move during the first several hours after hatching. After settling they are unable to move again, in contrast to several other scale insects which can relocate repeatedly (Itioka and Inoue, 1991).
Risk Element B2: Likelihood of arriving in the endangered area	N/A	N/A	
Risk Element B: Combined likelihood of establishment	Negligible	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Negligible	N/A	

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

3.2.7. *Crypticerya multicicatrices* (Hemiptera: Monophlebidae)

We determined the overall likelihood of introduction of *C. multicicatrices* to be Negligible. We present the results of this assessment in the following table. Because the likelihood of introduction is Negligible, we did not determine the endangered area or the consequences of introduction.

Assessment of the likelihood of introduction of *Crypticerya multicicatrices* into the endangered area via the importation of mangoes from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Low	MC	*Crypticerya multicicatrices* outbreaks have only occurred on San Andres island and in the city of Cali, not in the mango-producing areas of Colombia (Kondo et al, 2016). The coccinelid beetle *Anovia* spp. keeps mainland populations of *C. multicicatrices* low, and it completely controlled the outbreak in San Andres once it became established there (Kondo et al., 2014). *Crypticerya multicicatrices* normally occurs on twigs and leaves and only occurs on fruit when populations are very high (Kondo et al, 2016).
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Low	MC	We found no evidence that post-harvest washing would decrease scale numbers on the fruit. Therefore the risk rating remains unchanged.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	Low	MC	Transport and storage conditions were not considered; therefore, we did not change the previous rating.
Risk Element A: Overall risk rating for likelihood of entry	Low	N/A	

Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	Negligible	MC	Live crawlers emerge from an ovisac inside of the adult female and are the only mobile stage of *C. multicicatrices*. Mortality is 50 percent or more. The crawlers tend to migrate upwards, possibly to allow for wind dispersal. Once crawlers settle on a particular plant part, they do not leave it during the remainder of their development (Sotelo and Kondo, 2017)..
Risk Element B2: Likelihood of arriving in the endangered area	N/A	N/A	
Risk Element B: Combined likelihood of establishment	Negligible	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Negligible	N/A	

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

3.2.8. Mealybugs (Hemiptera: Pseudococcidae)

We assessed the likelihood that the mealybug species *Dysmicoccus neobrevipes*, *Maconellicoccus hirsutus*, *Pseudococcus elisae*, and *Planococcus lilacinus* would be introduced into the United States via imported mangoes from Colombia by assessing the likelihood of entry and establishment and then combining these two likelihoods to give an overall combined rating. Based on our analysis, specifically Element A2 under Likelihood of Entry, we determined the overall likelihood of introduction to be Negligible. We present the results of this assessment in the following table. Because the likelihood of entry is Negligible, we did not determine the endangered area, nor did we assess the likelihood of establishment or the consequences of introduction.

Assessment of the likelihood of introduction of mealybug species (Hemiptera: Pseudococcidae) via the importation of mango from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			

Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	High	C	Mango is a host, and fruit is a feeding site for these pests (see Table 1 for specific references). Mealybugs are fairly obvious visually (see photos in CABI, 2018), and heavy infestations would be culled at harvest.
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Negligible	C	Mealybugs are not firmly attached to the fruit and have no place to hide on a mango (no calyx on fruit) during harvest. The skin of the fruit is smooth (Morton, 1987), and any mealybugs present are likely to be removed during the post-harvest fruit washing process (see section 1.4). Therefore, these insects are highly unlikely to remain associated with the fruit.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	N/A	N/A	Because A2 is Negligible, assessment of Risk Element A3 is not needed.
Risk Element A: Overall risk rating for likelihood of entry	Negligible	N/A	The overall rating for the likelihood of entry is equal to the rating for A2.
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	N/A	N/A	
Risk Element B2: Likelihood of arriving in the endangered area	N/A	N/A	
Risk Element B: Combined likelihood of establishment	N/A	N/A	Because the likelihood of entry, Risk Element A, is Negligible, assessment of Risk Element B is not needed.
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Negligible	N/A	Because the likelihood of entry, Risk Element A, is Negligible, the overall likelihood of introduction is Negligible.

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

3.2.9. *Neosilba glaberrima* (Diptera: Lonchaeidae)

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

We determined that the establishment of *Neosilba glaberrima* in the United States and Territories is likely to cause unacceptable impacts. We present the results of this assessment in the following table.

Determination of the portion of the United States endangered by *Neosilba glaberrima* (Wiedemann)

Climatic suitability	*Neosilba glaberrima* occurs in many Caribbean Islands and in the Americas from Mexico through northern Chile and southern Brazil (Gonzalez, 1989; McAlpine and Steyskal, 1982). Specifically, the pest occurs in Chile, Colombia, Costa Rica, Brazil, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Peru, Trinidad and Tobago, the United States (St. Croix in the U.S. Virgin Islands), and the West Indies (Galeano-Olaya and Canal, 2012; Gonzalez, 1989; Korytkowski and Ojeda, 1971; Uchôa and Nicácio, 2010; McAlpine and Steyskal, 1982). A comparison of global Plant Hardiness Zones (Magarey et al., 2008; Saha et al., 2010) indicates that potential establishment in the United States and Territories could occur in Plant Hardiness Zones 9-13, and possibly Zone 8 as well. These zones cover much of the west coast and all of the southern states as well as Hawaii and the U.S. Territories.
Potential hosts at risk in PRA Area	*Neosilba glaberrima* has been reared from numerous fruits and vegetables (McAlpine and Steyskal, 1982). Hosts that occur in Plant Hardiness Zones 8-13 in the United States and Territories (NRCS, 2018) include *Mangifera indica* (mango) (Anacardiaceae) (Korytkowski and Ojeda 1971; McAlpine and Steyskal, 1982); *Annona* spp. (Annonaceae) (Maes, 2018); *Carica papaya* (papaya) (Caricaceae) (Yepes and Velez, 1989); *Manihot* spp. (cassava) (Euphorbiaceae) (Maes, 2015); *Ficus indica* (banyan tree) (Moraceae) (Gonzalez, 1989); *Psidium guajava* (guava) (Myrtaceae) (Souza-Filho et al., 2009); *Zea* spp. (corn) (Poaceae) (Maes, 2015); *Prunus persica* (peach) (Rosaceae) (Souza-Filho et al., 2009); *Coffea arabica* (coffee) (Rubiaceae) (Souza et al., 2005); *Citrus* spp. (Maes, 2015) and *C. reticulata* (tangerine) (Lopes et al., 2008) (Rutaceae); and *Capsicum annuum* (pepper) (Solanaceae) (Gonzalez, 1989; McAlpine and Steyskal, 1982).
Economically important hosts at risk[a]	Economically important hosts infested by *Neosilba glaberrima* include citrus, mango, peach, and pepper (NASS, 2018).
Pest potential on economically important hosts at risk[a]	*Neosilba glaberrima* is usually found in damaged fruit that is already infested with *Anastrepha* spp. (Lopes et al., 2008). More specifically, *N. glaberrima* either infests fallen fruit, which is not economically important, or infests fruit through the oviposition stings of other Tephritidae (McAlpine and Steyskal, 1982), although Souza et al.

	(2005) reported that *Neosilba* species caused damage to coffee plantations.
Defined Endangered Area	The area endangered by *Neosilba glaberrima* comprises coffee, citrus, mango, and papaya growing areas in the United States and Territories within Zones 9-13.

[a] As defined by ISPM No. 11, supplement 2, "economically important hosts" refers to both commercial and non-market (environmental) plants (IPPC, 2017a).

Assessment of the likelihood of introduction of *Neosilba glaberrima* into the endangered area via the importation of mango fruit from Colombia

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Likelihood of Entry			
Risk Element A1: Pest prevalence on the harvested commodity (= the baseline rating for entry)	Medium	MU	*Neosilba* spp., including *N. glaberrima*, are typically considered secondary invaders that take advantage of oviposition sites created by tephritid fruit flies (Korytkowski and Ojeda, 1971; McAlpine and Steyskal, 1982). For this analysis, we considered *N. glaberrima* to be an occasional secondary pest of mango following initial infestation by other pests, and we did not consider any field practices that would reduce the prevalence of tephritids or *N. glaberrima* in the field. Because mango is only reported as a host in two publications (Korytkowski and Ojeda, 1971; McAlpine and Steyskal, 1982), we had moderate uncertainty for the prevalence of this insect on the harvested commodity.
Risk Element A2: Likelihood of surviving post-harvest processing before shipment	Medium	MC	The larvae feed inside of the fruit of their hosts (Korytkowski and Ojeda, 1971; McAlpine and Steyskal, 1982) and would therefore be unaffected by post-harvest processing and highly likely to escape detection during culling. Therefore, we did not change the previous rating.
Risk Element A3: Likelihood of surviving transport and storage conditions of the consignment	Medium	MU	Transport and storage conditions were not considered; therefore, we did not change the previous rating.

Risk Element	Risk Rating	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Risk Element A: Overall risk rating for likelihood of entry	Medium	N/A	
Likelihood of Establishment			
Risk Element B1: Likelihood of coming into contact with host material in the endangered area	Medium	U	In general, the biology of *Neosilba* spp. has been poorly studied. *Neosilba* spp. can fly (Uchoa-Fernandes et al., 2003), but the distance they can travel is unknown. Suitable hosts of *Neosilba* spp. occur throughout the endangered area (NRCS, 2018). Research indicates that *Neosilba* flies could be primary invaders in some crops (Souza et al., 2005), which increases the likelihood of successful infestation of host material in new areas.
Risk Element B2: Likelihood of arriving in the endangered area	High	C	More than 25 percent of the U.S. population lives within the endangered area (PERAL, 2015).
Risk Element B: Combined likelihood of establishment	Medium	N/A	
Overall Likelihood of Introduction			
Combined likelihoods of entry and establishment	Medium	N/A	

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

Assessment of the consequences of introduction of *Neosilba glaberrima* into the United States

Criteria	Meets criteria? (Yes/No)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Direct Impacts			
Risk Element C1: Damage potential in the endangered area	Yes	MU	*Neosilba glaberrima* has been reported in coffee berries, associated with other *Neosilba* species causing berries to drop (Souza et al., 2005)
Risk Element C2: Spread potential	Yes	MU	The flies have several hosts in the endangered area (see endangered area discussion).
Risk Element C: Pest introduction is likely to cause unacceptable direct impacts	Yes	N/A	

Criteria	Meets criteria? (Yes/No)	Uncertainty Rating[a]	Justification for rating and explanation of uncertainty (and other notes as necessary)
Trade Impacts			
Risk Element D1: Export markets at risk	N/A		
Risk Element D2: Likelihood of trading partners imposing additional phytosanitary requirements	N/A		
Risk Element D: Pest is likely to cause significant trade impacts	N/A	N/A	
Conclusion			
Is the pest likely to cause unacceptable consequences in the PRA area?	Yes	N/A	

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

4. Summary and Conclusions of Risk Assessment

Of the organisms associated with mango worldwide and present in Colombia, we identified organisms that are actionable pests for the United States and have a reasonable likelihood of being associated with the commodity following harvesting from the field and prior to any post-harvest processing. If warranted, we further evaluated these organisms for their likelihood of introduction (i.e., entry plus establishment) and their potential consequences of introduction. Pests that are likely to cause unacceptable consequences of introduction with an overall likelihood of introduction risk rating above Negligible are candidates for risk management. These results represent a baseline estimate of the risks associated with the import commodity pathway described in section 1.4, fresh mangoes from Colombia with no specified postharvest procedures except washing.

Of the pests selected for further analysis, we determined that those identified in Table 3 are not candidates for risk management because they received a Negligible risk rating for likelihood of introduction into the endangered area via the import pathway. We summarize the results for each pest in Table 3.

All the other pests selected for further analysis are candidates for risk management because they are likely to cause unacceptable consequences of introduction, and they received a likelihood of introduction risk rating above Negligible. We summarize the results for each pest in Table 4.

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

Table 3. Summary for pests selected for further evaluation and determined not to be candidates for risk management.

Pest	Reason the pest is *not* a candidate for risk management	Uncertainty statement (optional)[a]
Ceroplastes rubens	Negligible likelihood of coming into contact with host plants	
Crypticerya multicicatrices	Negligible likelihood of coming into contact with host plants	
Dysmicoccus neobrevipes	Negligible likelihood of entry	
Maconellicoccus hirsutus	Negligible likelihood of entry	
Pseudococcus elisae	Negligible likelihood of entry	
Planococcus lilacinus	Negligible likelihood of entry	

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

Table 4. Summary for pests selected for further evaluation and determined to be candidates for risk management. All of these pests meet the threshold for unacceptable consequences of introduction.

Pest	Pest Likelihood of Introduction overall rating	Uncertainty statement (optional)[a]
Neosilba glaberrima	Medium	
Anastrepha fraterculus	High	
Anastrepha obliqua	High	
Anastrepha serpentina	Medium	
Anastrepha sororcula	High	
Anastrepha striata	High	
Ceratitis capitata	High	

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

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7. Appendices

Appendix Pests with non-actionable regulatory status

We found some evidence of the listed organisms being associated with mango and being present in Colombia. Because these organisms have non-actionable regulatory status for the United States, however, we did not list them in Table 1 of this risk assessment, and we did not evaluate the strength of the evidence for their association with mango or their presence in Colombia. Because we did not evaluate the strength of the evidence, we consider the following pests to have only "potential" association with the commodity and presence in Colombia.

We list these organisms along with the references supporting their potential association with mango, their potential presence in Colombia, their presence in the United States (if applicable), and their regulatory status for the United States. For organisms not present in the United States, we also provide justification for their non-actionable status.

Organism	Evidence and/or other notes
ARTHROPODS	
Acari: Tarsonemidae	
Polyphagotarsonemus latus (Banks)	CO: CABI, 2018; ICA, 2014; Posada, 1989; mango: Ochoa et al., 1991; Posada, 1989; non-actionable: PestID, 2018
Acari: Tenuipalpidae	
Brevipalpus phoenicis (Geijskes)	CO: CABI, 2018; ICA, 2014; mango: Ochoa et al., 1991; non-actionable: PestID, 2018
Acari: Tetranychidae	
Oligonychus yothersi (McGregor)	CO: ICA, 2014; Posada, 1989; Pritchard and Baker, 1955; mango: Posada, 1989; Pritchard and Baker, 1955; non-actionable: PestID, 2018
Diptera: Lonchaeidae	
Neosilba batesi (Curran)	CO: McAlpine and Steyskal, 1982; Yepes and Vélez, 1989; mango: McAlpine and Steyskal, 1982; Yepes and Vélez, 1989; non-actionable: PestID, 2018
Diptera: Muscidae	
Atherigona orientalis Schiner	CO: CABI, 2018; mango: CABI, 2018 non-actionable: PestID, 2018
Hemiptera: Aleyrodidae	
Aleurodicus dispersus Russell	CO: CABI, 2018; mango: Russell, 1965; non-actionable (PestID, 2018)
Aleurothrixus floccosus Maskell	CO: CABI, 2018; mango: Evans, 2007; non-actionable: PestID, 2017
Hemiptera: Aphididae	
Aphis gossypii Glover	CO: Bustillo and Sánchez, 1977; CABI, 2018; mango: Bustillo and Sánchez, 1977; CABI, 2018; non-actionable: PestID, 2018
Toxoptera aurantii (Fonscolombe)	CO: León, 2001; CABI, 2018; Posada, 1989; mango: Posada, 1989; non-actionable: PestID, 2018
Hemiptera: Coccidae	
Ceroplastes cirripediformis Comstock	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018

Ceroplastes floridensis Comstock	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Coccus hesperidum (L.)	CO: Figueroa, 1977; García-Morales et al., 2017; mango: Butani, 1993; Figueroa, 1977; non-actionable: PestID, 2018
Coccus longulus (Douglas)	CO: Kondo, 2001; mango: Nakahara, 1981; non-actionable: PestID, 2018
Coccus viridis (Green)	CO: CABI, 2018; ICA, 2014; Kondo, 2009; mango: CABI, 2018; ICA 2014; Kondo, 2009; non-actionable: PestID, 2018
Kilifia acuminata (Signoret)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Milviscutulus mangiferae (Green) syn.: *Coccus mangiferae* Fernald	CO: ICA, 2014; Figueroa, 1977; Kondo, 2009; mango: ICA, 2014; Figueroa, 1977; Kondo, 2009; non-actionable: PestID, 2018
Parasaissetia nigra (Nietner)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Pulvinaria psidii Maskell	CO: ICA, 2014; Posada, 1989; mango: ICA, 2014; Posada, 1989; non-actionable: PestID, 2018
Saissetia coffeae (Walker)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Hemiptera: Diaspididae	
Andaspis hawaiiensis (Maskell)	CO: Kondo, 2009; mango: Kondo, 2009; non-actionable: PestID, 2018
Aonidiella orientalis (Newstead)	CO: Kondo, 2001; mango: Ofek et al., 1997; non-actionable: PestID, 2018
Aonidomytilus albus (Cockerell)	CO: Kondo, 2001; mango CABI, 2018; non-actionable: PestID, 2018
Aspidiotus destructor Signoret	CO: CABI, 2018; ICA, 2014; Posada, 1989; mango: Posada, 1989; non-actionable: PestID, 2018
Aspidiotus nerii Bouche	CO: CABI, 2018; mango: Butani, 1993; non-actionable: PestID, 2018
Aspidiotus spinosus Comstock	CO: Gallego and Vélez, 1992; Posada, 1989; mango: Gallego and Vélez, 1992; Posada, 1989; non-actionable: PestID, 2018
Chrysomphalus aonidum (L.)	CO: Kondo, 2009; mango: Kondo, 2009; non-actionable: PestID, 2018
Chrysomphalus dictyospermi (Morgan)	CO: ICA, 2014; Kondo, 2009; Posada, 1989; mango: ICA, 2014; Kondo, 2009; Posada, 1989; non-actionable: PestID, 2018
Hemiberlesia lataniae (Signoret)	CO: ICA, 2014; Kondo, 2009; Posada, 1989; mango: ICA, 2014; Kondo, 2009; Posada, 1989; non-actionable: PestID, 2018
Hemiberlesia palmae (Cockerell)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Ischnaspis longirostris (Signoret)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Lepidosaphes beckii (Newman)	CO: CABI, 2018; mango: CABI, 2018 non-actionable: PestID, 2018
Mycetaspis personata (Comstock)	CO: Kondo, 2009; mango: Kondo, 2009; non-actionable: PestID, 2018
Oceanaspidiotus spinosus (Comstock)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Pinnaspis strachani (Cooley) syn.: *Pinnaspis aspidistrae* Hall	CO: Mosquera Paris, 1973; mango: Mosquera Paris, 1973; non-actionable: PestID, 2018
Pseudaonidia trilobitiformis (Green)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018

Pseudaulacaspis pentagona (Targoni-Tozzetti)	CO: CABI,2018 mango: CABI, 2018; non-actionable: PestID, 2018
Pseudischnaspis bowreyi Cockerell	CO: Kondo, 2009; Posada, 1989; mango: Kondo, 2009; Posada, 1989; non-actionable: PestID, 2018
Selenaspidus articulatus (Morgan)	CO: ICA, 2014; Kondo, 2009; mango: ICA, 2014; Kondo, 2009; non-actionable: PestID, 2018
Unaspis citri (Comstock)	CO: Kondo, 2009; mango: [Rarely found on mango (Kondo, 2009)]; non-actionable: PestID, 2018
Hemiptera: Pseudococcidae	
Dysmicoccus brevipes (Cockerell)	CO: Kondo et al., 2008; Williams and Granara de Willink, 1992; mango: Williams and Granara de Willink, 1992; non-actionable: PestID, 2018
Ferrisia virgata (Cockerell)	CO: ICA, 2014; Kondo, 2009; Williams and Granara de Willink, 1992; mango: Kondo, 2009; Williams and Granara de Willink, 1992; non-actionable: PestID, 2018
Nipaecoccus nipae (Maskell)	CO: CABI, 2018; Kondo et al., 2008; mango: Williams and Granara de Willink, 1992; non-actionable: PestID, 2018
Phenacoccus madeirensis Green	CO: Ben-Dov, 1994; Williams and Granara de Willink, 1992; mango: Ben-Dov, 1994; non-actionable: PestID, 2018
Phenacoccus solenopsis Tinsley	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Planococcus citri (Risso)	CO: Kondo et al., 2008; Williams and Granara de Willink, 1992; mango: Butani, 1993; Williams and Granara de Willink, 1992; non-actionable: PestID, 2018
Pseudococcus comstocki (Kuwana)	CO: Figueroa, 1977; mango Figueroa, 1977; non-actionable on fruit PestID, 2018
Pseudococcus longispinus (Targioni-Tozzetti) syn.: *Pseudococcus adonidum* (Targioni Tozzetti)	CO: Figueroa, 1977; Kondo et al., 2008; ICA, 2014; Williams and Granara de Willink, 1992; mango: Figueroa, 1977; ICA, 2014; Kondo, 2009; Williams and Granara de Willink, 1992; non-actionable: PestID, 2018
Hymenoptera: Apidae	
Trigona trinidadensis (Provancher)	CO: Posada, 1989; mango Posada, 1989; genus non-actionable PestID, 2018
Lepidoptera: Pyralidae	
Cadra cautella (Walker)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Thysanoptera: Thripidae	
Frankliniella cephalica (Crawford)	CO: Goldarazena et al., 2012; mango: Goldarazena et al., 2012; non-actionable: PestID, 2018
Heliothrips haemorrhoidalis (Bouche)	CO: León, 2001; CABI, 2018; Posada, 1989; mango: Posada, 1989; non-actionable: PestID, 2018
Selenothrips rubrocinctus (Giard)	CO: CABI, 2018; Posada, 1989 mango: Posada, 1989 non-actionable: PestID, 2018
Thrips tabaci Lindeman	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
FUNGI and CHROMISTANS	
Albonectria rigidiuscula (Berk. & Broome) Rossman & Samuels	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Alternaria alternata [(Fr.) Keissl.]	CO: CABI, 2018; ICA, 2014; mango: CABI, 2018; ICA, 2014; non-actionable: PestID, 2018

Athelia rolfsii [(Curzi) C.C. Tu & Kimbr.]	CO CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Ceratocystis fimbriata (Ellis & Halst.)	CO: CABI, 2018; ICA, 2014; mango: CABI, 2018; ICA, 2014; non-actionable: PestID, 2018
Ceratocystis paradoxa [(Dade) C. Moreau]	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc.	CO: ICA, 2014; mango: ICA, 2014; non-actionable: PestID, 2018
Colletotrichum tropicale (E.I. Rojas, S.A. Rehner & Samuels) syn.: *Colletotrichum alienum* (B.S. Weir & P.R. Johnst.)	CO: Álvarez et al., 2014; mango: Lima et al., 2013; non-actionable: PestID, 2018
Elsinoë mangiferae (Bitanc. & Jenkins)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Erysiphe quercicola S. Takam. & U. Braun; syn.: *Oidium anacardii* F. Noack	CO: ICA, 2014; mango: ICA, 2014; non-actionable: PestID, 2018
Erythricium salmonicolor [(Berk. & Broome) Burds.] syn.: *Corticium salmonicolor* Berk & Broome	CO: CABI, 2018; ICA, 2014; mango: ICA, 2014; Farr and Rossman, 2018; US: [FL, PR, USVI, HI (Farr and Rossman, 2018)]
Fusarium moniliforme (J. Sheld.)	CO: ICA, 2014; mango: ICA, 2014; non-actionable: PestID, 2018
Fusarium oxysporum (sensu Smith & Swingle)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Gibberella zeae ((Schwein.) Petch)	CO: CABI, 2018; mango: CABI, 2017; US: CABI, 2018; non-actionable: PestID, 2018
Globisporangium splendens [(Hans Braun) Uzuhashi, Tojo & Kakish.] syn.: *Pythium splendens* Hans Braun	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Golovinomyces cichoracearum (Ehrenb.) Heluta; syn.: *Erysiphe cichoracearum* DC.	CO: ICA, 2014; mango: ICA, 2014; non-actionable: PestID, 2018
Lasiodiplodia theobromae [(Pat.) Griffon & Maubl.]	CO: CABI, 2018; ICA, 2014; mango: CABI, 2018; ICA, 2014; non-actionable: PestID, 2018
Macrophomina phaseolina [(Tassi) Goid.]	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Meliola mangiferae Earle	CO: CABI, 2018; mango: CABI, 2018; genus non-actionable: PestID, 2018
Oidium mangiferae (Berthet)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Phytophthora cinnamomi (Rands)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Rhizoctonia solani J. G. Kuhn	CO: ICA, 2014; mango: ICA, 2014; non-actionable: PestID, 2018

Rosellinia necatrix (Berl. ex Prill.)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018
Verticillium dahlia (Kleb.)	CO: CABI, 2018; mango: CABI, 2018; non-actionable: PestID, 2018