Expansion of the Importation of Fresh Unshu Orange Fruit (*Citrus reticulata* Blanco var. *unshu* Swingle) from the Republic of Korea into Citrus Producing States of the Continental United States

A Pathway-Initiated Pest Risk Assessment

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Executive Summary

This risk assessment was prepared in response to the 1995 request by The National Plant Quarantine Service, Ministry of Agriculture and Forestry of the Republic of Korea to expand the distribution of imported Unshu orange fruit (*Citrus reticulata* Blanco var. *unshu* Swingle) from Cheju Island into all States of the continental United States.

A list of pests attacking Unshu oranges in Korea was developed based on documents submitted by the Republic of Korea, PPQ records of intercepted pests and the scientific literature. The quarantine pests and the quarantine pests that are likely to follow the pathway were identified based on this list. A pathway is any means that allows the entry or spread of a pest. From this list of quarantine pests, the assessment identified two scale insects, *Parlatoria ziziphi* Lucas (Homoptera: Diaspididae) and *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae), one mealybug, *Planococcus kraunhiae* Kuwana (Homoptera: Pseudococcidae) and the bacterium, *Xanthomonas axonopodis* pv. *citri* Vauterin *et al*. (Pseudomonadaceae), causal organism of citrus canker, as quarantine pests of concern.

The Baseline Pest Risk Potential was High for *P. kraunhiae* and *U. yanonensis,* and Medium for *P. ziziphi* and *X. axonopodis* pv. *citri*. The Baseline Pest Risk Potential is the summation of the ratings for the Consequences of Introduction and Likelihood of Introduction. The Consequences of Introduction value was estimated by assessing the Climate/Host Interaction, the Host Range, the Dispersal Potential, the Economic Impact, and the Environmental Impact which are based on the biology of the pests. The Likelihood of Introduction value was estimated by evaluating the proposed Quantity Imported Annually in combination with the Pest Survival Potential. The Pest Survival Potential evaluates the likelihood that the pests survive postharvest treatments, survive shipment, avoid detection at the port of arrival, are moved to a suitable habitat and come into contact with suitable host material.

The risk management section considers the efficacy of combined risk mitigation measures in decreasing the Pest Survival Potential by removing the pests from the pathway. The currently approved export program is a Systems Approach (7 CFR § 319.28). The proposed Systems Approach combines the mitigation measures in the current system with additional safeguards such as increased inspections and grove testing for bacterial citrus canker.

The risk mitigation measures comprising the proposed Systems Approach are: (1) a grove certification program, (2) the presence of a buffer zone around each export production grove, (3) grove and buffer zone pest surveys (including citrus canker testing), (4) a field pest control program, (5) cultural practices, (6) packing house safeguards (including a bleach dip to reduce bacterial populations on the fruit), (8) preclearance inspections (including inspection of culled fruit), (9) shipment safeguards and (10) port of arrival inspection.

The applications of these two Systems Approaches assume that: (1) all measures are applied to every approved export grove within a given growing season at the appropriate stage of production, harvest, or shipment, (2) all measures are maximally effective, (3) survey results are followed by appropriate action to reduce pests or eliminate orchards from the export production program, (4) packing house procedures do not allow hitchhiker organisms to remain with the fruit or allow them to contaminate fruit at the packing house and (5) the integrity of shipments is not breached before inspection at the port of arrival.

The overall effectiveness of the combined mitigation measures in the current Systems Approach is indicated by the lack of interceptions of the quarantine pests of concern. It is not reasonable to expect this outcome to change with the implementation of the proposed Systems Approach, because this proposed Systems Approach requires more stringent inspections. An increase in the

import volume of the Unshu fruit and a wider market distribution in the United States will increase the risks associated with the pest proximity to suitable habitats and host plants. Increased detection requirements in Korea, however, are expected to offset this increased Pest Survival Potential because the pests will continue to be effectively removed from the pathway. These combined mitigation measures are designed to ensure that pests do not travel with shipments of the fruit, so there is no reason to restrict the destination of the fruit.

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I. Introduction

This risk assessment was conducted by the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Plant Epidemiology and Risk Analysis Laboratory (USDA, APHIS, PPQ, CPHST, PERAL) to examine the risks associated with the expanded importation of fresh Unshu orange fruit (*Citrus reticulata* Blanco var. *unshu* Swingle) from the Republic of Korea into the entire continental United States. Authority for APHIS to regulate the importation of citrus fruit is derived from the Plant Protection Act (2000) and Title 7 of the Code of Federal Regulations (CFR.) Part 319, Subparts 28 and 56. Currently, Unshu orange fruit from Korea is permitted entry into the United States excluding American Samoa, Arizona, California, Florida, Louisiana, the Northern Mariana Islands, Puerto Rico, Texas, and the Virgin Islands (7 CFR. § 319.28(b)).

International plant protection organizations, such as the North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) administered by the Food and Agriculture Organization (FAO) of the United Nations, provide guidance for conducting pest risk analyses and the use of phytosanitary terms (FAO, 1996, 2001, 2002). The methods used to initiate, conduct and report this analysis and the phytosanitary terms utilized are consistent with these guidelines.

Pest risk analysis encompasses risk assessment plus risk management (FAO, 2002). Pest risk analysis is the overall process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated, and the strength of any phytosanitary measures that should be taken against that pest (FAO, 2002). Pest risk assessment evaluates the probability of the introduction and spread of a pest and the associated potential economic consequences (FAO, 2002). Pest risk management involves the process of reducing the risk of introduction of a quarantine pest (FAO, 2002) and leads to a decision to import the commodity, and the conditions governing the import, or to continued prohibition. In this document, the estimates of risk are expressed qualitatively (high, medium or low), and based on the criteria in the document: Pathway-Initiated Pest Risk Assessment: Guidelines for Qualitative Assessments, Version 5.02 (PPQ, 2000).

Citrus Production

Unshu orange, *Citrus reticulata* var. *unshu*, includes mandarin oranges, satsumas and tangerines (Floridata, 2000). In the continental United States, species of *Citrus*, including grapefruit, K-early citrus, lemons, lime, oranges, tangerine, tangelo, and temple oranges are grown for the fresh fruit market or processing, and commercially produced in Arizona, California, Florida, Louisiana and Texas, (NASS, 1997).

II. Risk Assessment

A. Initiating Event: Proposed Action

This commodity-based, pathway-initiated risk assessment evaluates the plant pest risks associated with the expanded commercial importation of fresh Unshu orange fruit from the Republic of Korea into the continental United States. In 1994, PPQ assessed the risks posed by the proposed importation of fresh Unshu orange fruit from the Cheju Island production area of the Republic of Korea. After that review, the USDA approved the entry of Unshu orange fruit from Cheju Island that met the requirements of 7 CFR § 319.28. Commercial shipments began in 1995. In that year, the government of the Republic of Korea requested that the distribution area be expanded to include the five citrus producing States of Arizona, California, Florida, Louisiana and Texas (Cho, 1995). This risk assessment is prepared in response to that request. The Unshu oranges are to continue to originate from Cheju Island.

B. Assessment of Weediness Potential

If the citrus species considered for import poses a risk as a weed pest, then the pathway-initiated assessment is terminated and a pest-initiated assessment is conducted. The results of the weediness screening for *Citrus* spp. did not prompt a pest-initiated risk assessment (Appendix A).

C. Pest Interceptions, Prior Risk Assessments, and Current Status of Imports Pest Interceptions

The pest interceptions on *Citrus* spp. from the Republic of Korea from 1985 to 2001 are listed in Appendix B. Between January 1985 and October 2001 there were 298 interceptions of quarantine pests on *Citrus* spp. from the Republic of Korea. These include: 128 interceptions of *Xanthomonas axonopodis* pv. *citri* Vauterin *et al*. (= *X. campestris* pv. *citri* (Hasse) Dye) (Pseudomonadaceae); 53 interceptions of *Guignardia citricarpa* Kiely (Fungi Imperfecti: Coelomycetes; 53 interceptions of *Parlatoria ziziphi* Lucas (Homoptera: Pseudococcidae); and 29 interceptions of *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae). The interceptions of these pests were from passenger baggage, ship stores, mail, or dried fruit, and not from the commercial fruit produced under the current export program. Although multiple interceptions indicate a potential pathway for the entrance of quarantine pests into the United States, none of the intercepted material can be directly linked to fruit produced on Cheju Island. The lack of pest interceptions on the permit cargo from the currently approved export program is indicates the efficacy of the mitigation program
(7 CFR § 319.28).

Prior Risk Assessments

In 1994, USDA approved entry of unshu oranges from Korea, subject to the safeguards outlined in 7 CFR §319.28(b), into any area of the United States except: Arizona, California, Florida, Louisiana, Texas, American Samoa, Puerto Rico, Northern Mariana Islands and the United States Virgin Islands. The risk assessment conducted in support of this decision identified the following pests of quarantine significance: *U. yanonensis* Kuwana, *Conogethes punctiferalis* (Guenee), *Adoxophyes orana* Fischer von Roeslerstamm, *P. kraunhiae* Kuwana, *Frankliniella intonosa* Trybom, *Helicobasidium mompa* Tanaka, *Phyllosticta beltranii* Penz., *X. campestris* pv. *citri* Dye [this is the older synonym of *X. axonopodis* pv. *citri*], *Guignardia citricarpa* Kiely, *Haplothrips chinensis* Priesner, *Scirtothrips dorsalis* Hood, *Aculops pelekassi* (Keifer) and *Megalurothrips distalis* Karney. The 1994 assessment stated, Permit entry of clean fruit subject to preclearance inspection and the safeguards . . . A work plan spelling out the specific responsibilities needs to be developed and approved prior to any preclearance activities.

Subsequent site visits by PPQ officials did not detect *G. citricarpa* on Cheju Island.

Current Status

Commercial shipment of Unshu oranges from the Republic of Korea began in 1995. The following shipment volumes were reported (Thomas, 2001):

Year	Volume of Shipments (metric tons)
1995	50
1996	220
1997	1190
1998	40
1999	380
2000	240

The quarantine security measures required in the currently approved export program are known collectively as a Systems Approach (7 CFR §319.28(b)) and consider the Cheju Island export production areas to be free of bacterial citrus canker. A trip report filed by PPQ personnel in 1992 described the finding of citrus canker on fruit at a citrus vending stand on Cheju Island in late May to early June, but it is not known if that particular piece of fruit originated in Korea (Redlin, 2002).

D. Pests associated with *Citrus* spp. in the Republic of Korea

Appendix C lists the pests associated with *Citrus* spp. in Korea. The list identifies: (1) the presence or absence of these pests in the United States, (2) the affected plant part or parts, (3) the quarantine status of the pests in the United States, (4) the likelihood of the pests following the import pathway and entering the United States and (5) pertinent citations for distributions and biologies of the pests. Based on the biological and geographic information, many organisms are eliminated from consideration as sources of phytosanitary risk on Korean Unshu oranges because they do not satisfy the geographic and regulatory criteria of a quarantine pest.

A quarantine pest is defined as, A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2002). Reports of harmful organisms associated with the commodity plant species indicate the organism is a pest of potential economic importance. A pest is likely to be transported on the Unshu oranges if it is present in Korea, is associated with Unshu oranges at the time of harvest, and remains with the oranges throughout the harvesting, packing and shipping procedures. Quarantine pests likely to follow the pathway may be capable of establishment and spread within the United States if suitable ecological and climatic conditions and vectors exist (this includes protected areas such as greenhouses).

The current list of 236 citrus pests includes 193 arthropods, three bacteria, 29 fungi, seven nematodes and three viruses. Of the total number of pests, 45 were identified as likely to follow the pathway.

E. Quarantine Pests Likely to Follow the Pathway

The quarantine pests selected for further analysis are summarized in Table 1. Other quarantine pests, not included in this summary (Appendix C), have the potential to be detrimental to U.S. agriculture, but are not likely to follow the import pathway. However, there were a variety of reasons for not subjecting them to further analysis, *e.g.*, the primary association of the pest may be with plant parts other than the fruit; the pests may not be associated with the fruit during transport or processing because of their inherent mobility; sexually immature insect stages can be transported in a shipment but are unable to establish viable populations; the pests may be associated with the fruit as incidental biological contaminants and are not expected to be present in every shipment.

The biological hazard of organisms identified only to the order, family or the generic level is not often assessed because of the lack of biological information. Lack of species identification may indicate the limits of taxonomic or life-stage knowledge or the quality of the specimen submitted for identification. In this assessment, this applies to: *Cladosporium* sp., *Elsinoë* sp., *Longitarsus* sp., *Microsphaeropsis* sp., and *Tarsonemus* sp. (Appendix B). By necessity, pest risk assessments focus on the organisms for which biological information is available. The lack of biological information on any given pest insect, mite or pathogen of a major crop suggests that this pest is of minor economic importance or does not present a high pest risk. Lack of information, however, cannot be taken as proof of this supposition. The lack of identification at the specific level does not rule out the possibility that a dangerous pest or virulent pathogen was intercepted or that it was not a quarantine pest. Development of detailed assessments for known pests that inhabit a variety of ecological niches, such as internal fruit feeders or foliage pests, allow effective mitigation measures to be crafted that will eliminate the known organisms as well as similar, but incompletely identified organisms, that inhabit the same niche.

Certain Noctuidae (Lepidoptera), known as fruit piercing moths, attack fruit as adults (Banzinger, 1982). The following taxa of fruit piercing m moths are not likely to follow the import pathway: *Anomis mesogona*, *Arcte coerulea*, *Artena dotata*, *Calyptera thalictri*, *Dysgonia arctotaenia*, *D. maturata*, *Eudocima tyrannus amurensis, Ophiusa tirhaca*, *Oraesia emarginata*, *O. excavata* and *Thyas juno*. A trip report (Redlin, 2002) stated that it was a standard practice to keep the packing house doors closed, and no packing at night because the lights attract moths and other insects.

In addition, *Vespa mandarina*, (Hymenoptera: Vespidae), *Acanthocoris striicomis*, (Heteroptera: Coreidae) and *Glaucias subpunctatus, Halyomorpha halys* and *Plautia stali* (Heteroptera: Pentatomidae) will not remain with the fruit during harvest or packing and *Drosicha corpulenta* (Homoptera: Pseudococcidae) and *Helicoverpa assulta assulta* (Lepidoptera: Noctuidae) mainly attack parts other than the fruit.

There are no references to *C. reticulata* as a host for the yellow peach moth, *Conogethes punctiferalis,* (Lepidoptera: Pyralidae), however, *C. nobilis* is a secondary host (CPC, 2001; INKTO #19, 1957). The larvae of this moth are internal feeders in host fruit (CPC, 2001; INKTO #19, 1957; Sekiguchi, 1974) and have never been intercepted on *Citrus* spp. (PIN309, 2001). Other hosts include: *Averrhoa carambola, Carica papaya*, *Gossypium*, *Helianthus annuus, Macadamia ternifolia*, *Morus alba*, *Nephelium lappaceum*, *Prunus persica*, *Psidium guajava*, *Sorghum bicolor*, and *Zea mays* (CPC, 2001; INKTO #19, 1957). Based on the reported host range and the lack of interceptions on citrus, PPQ believes that it is unlikely that *C. punctiferalis* will follow the import pathway.

In 1995, one adult *Nezara antennata* (Heteroptera: Pentatomidae) was intercepted during a preclearance inspection (PIN309, 2001). The closely related *N. viridis* is, controlled on fruit by normal packinghouse procedures (Dixon, 1995). So it is likely that *N. antennata* would be controlled in a similar manner.

In the last 20 years, *Thrips palmi* (Thysanoptera: Thripidae) has spread from tropical to temperate Asia and has been introduced into the southern coastal areas of Korea (including Cheju Island), Australia, the Caribbean, and the United States (Florida and Hawaii) (Cho *et al*., 2000; Layland *et* *al*., 1994; Nakahara, 1984; Tsai *et al*., 1995; Kajita *et al*., 1996; Banks *et al*., 1996; FAO, 1990). This pest affects ornamentals and vegetables, and hosts include asters, chrysanthemums, cucurbits, ficus, cotton, orchids, members of the Solanaceae and some weeds (EPPO, 1997; Kawai, 1990; Martin and Mau, 1992; Vierbergen, 1995). It is listed as a citrus pest on fruit and leaves in Florida, but is controlled on fruit by normal packinghouse procedures (Dixon, 1995). Interestingly, this pest is not listed in the Florida Citrus Pest Management Guide (Childers and Knapp, 2001). There were no interceptions on any fruit commodities from Korea (PIN309, 2001), despite being identified as a citrus pest in Korea (NPQS, 1998; Thaw, 1997). Additionally, this pest was not observed during a three-year survey (1996-98) on Cheju Island (NPQS, 1998). Based on the preceding evidence, *T. palmi* is unlikely to follow the pathway on imported Unshu oranges produced on Cheju Island.

Sooty mold fungi generally are considered minor leaf pathogens that grow superficially on plant tissue (Agrios, 1997). The four sooty molds identified as citrus pests in Korea are quarantine pests because they are not present in the United States: *Antenella citrina* (synonym: *Scorias citrina*), *Capnodium tanakae*, *Limacinia japonica* and *Phaeopeltis japonica*. It is unlikely that any of these fungi will follow the pathway because fruit is surface disinfested as part of the bacterial canker control measures, and these fungi are likely to be washed off during these packing house procedures.

The inclusion of *Ascochyta citri* and *E. australis* (Appendix C) are based on single interceptions of these fungi on citrus fruit in passenger baggage from the Republic of Korea (Appendix B). Additional interceptions are expected if these fungi are prevalent. Neither fungus is further analyzed because these lone interceptions are considered anomalies.

Guignardia citricarpa, the causal agent of citrus black spot disease, is a quarantine pest (Sutton and Waterston, 1966). But the mere report of *G. citricarpa* does not mean that citrus black spot disease and its causal fungus are present (Timmer *et al*., 2000) because *Guignardia* sp. is a species morphologically similar to, but physiologically and pathogenically different from *G. citricarpa* (McOnie, 1964). The endophyte *Guignardia* sp. causes symptomless infections in many plant species (McOnie, 1964). The presence of *Guignardia* sp. in citrus producing regions where citrus black spot disease does not occur led to confusion in the literature regarding the true distribution of *G. citricarpa*. The pest risk assessment conducted by PPQ in 1994 noted that Korean officials were unable to detect citrus black spot disease during several years of survey in the citrus growing areas on Cheju Island.

A list of *Citrus* pests submitted by the Republic of Korea (Anon., 1990) included *Phoma citricarpa* McAlpine var. *mikan* Hara as a causal agent of storage rot of citrus. *Phoma citricarpa* McAlpine is an anamorph of *G. citricarpa* (EPPO, 1997). The same situation was described in Japan, where a low percentage of stored Unshu fruit developed a decay caused by *G. citricarpa* var. *mikan* (anamorph: *P. citricarpa* var. *mikan*) (McOnie, 1967, personal communication). McOnie (1964, personal communication) concluded that *G. citricarpa* var. *mikan* was actually the nonpathogenic strain of *G. citricarpa* (*Guignardia* sp.), that small irregular markings on fruit originally thought to be caused by *G. citricarpa* were due to mechanical or insect injury, and that the *G. citricarpa* isolated from those fruit was the nonpathogenic *Guignardia* sp. Based on this information, PPQ believes that the *Guignardia* present in the Republic of Korea is the nonpathogenic *Guignardia* sp. This concurs with reports of *G. citricarpa* in the Republic of Korea as being either doubtful or reports of the non-pathogenic *Guignardia* sp. (CPC, 2001; CMI, 1990). The non-pathogenic *Guignardia* was reported in Florida (Alfieri *et al*., 1994) and Texas (Okamura and Davis, 1987) and is not considered a quarantine pest.

Table 1. Quarantine pests selected for further analysis.

Arthropods	*Parlatoria ziziphi* Lucas (Homoptera: Pseudococcidae) *Planococcus kraunhiae* Kuwana (Homoptera: Pseudococcidae) *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae)
Pathogen	*Xanthomonas axonopodis* pv. *citri* Vauterin *et al*. (Pseudomonadaceae)

F. Consequences of Introduction

This portion of the analysis considers negative outcomes that may occur when the quarantine pests identified as following the pathway of Unshu oranges from Korea are introduced into the entire continental United States. The potential consequences were evaluated using the following five Risk Elements: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact, and Environmental Impact. These risk elements reflect the biology, host range and climatic and geographic distribution of each pest. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points), or High (3 points) based on the criteria as stated in the Guidelines (PPQ, 2000). A cumulative risk value is then calculated by summation of each Risk Element (Table 3).

The major sources of uncertainty in this document are similar to those in other risk assessments. They include the use of a developing or evolving process (PPQ, 2000), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), the quality of the biological information (Gallegos and Bonano, 1993), the inherent biological variation within a population of organisms (Morgan and Henrion, 1990) and the evaluation of risk by comparisons to lists of factors within the guidelines (Kaplan, 1992). To address this last source of uncertainty, the lists of factors were interpreted as illustrative and not exhaustive. This implies that additional biological information, even if not explicitly part of the criteria, can be used when it applies to a rating.

Risk Element #1: Climate-Host Interaction
This risk element considers ecological zonation and the interactions of quarantine pests with their biotic and abiotic environments. When introduced into new areas, pests are expected to behave as they do in their native areas if the potential host plants are present and the climates are similar. Broad availability of suitable climates and a wide distribution of suitable hosts are assumed to increase the impact of a pest introduction. The ratings for this risk element are based on the relative number of United States Plant Hardiness Zones (ARS, 1990) where the pest could establish. The primary host for these pests, *C. reticulata*, is grown in three Plant Hardiness Zones, while other potential hosts occur throughout the United States (NASS, 1997; NRCS, 2001).

Parlatoria ziziphi
This scale insect is found mainly in the tropics, but also extends into temperate regions and is a major pest of citrus in Asia (PNKTO #44, 1984). The potential range for this insect appears to be the mild regions of the west coast and the southern tier states where U.S. Plant Hardiness Zones 8 to 10 occur (USDA, 1990). Members of the Rutaceae that are hosts (*Citrus, Murraya* and *Serverinia*) were introduced into south Florida (NRCS, 2001; Wunderlin, 2001) from tropical and neotropical regions of Asia, Africa or the Americas, but there are no native members of these host genera within the United States (CPC, 2001). Relatively limited temperature ranges appear to favor this pest, and hosts are not widespread in the United States, so the rating is Medium (2).

Planococcus kraunhiae
The distribution of *P. kraunhiae* includes China, Japan, the Republic of Korea, Taiwan (NPQS, 1998; Ben-Dov, 1993) and California (Ben-Dov, 1993). Host genera (Ben-Dov, 1993) grow in at least four Plant Hardiness Zones (ARS, 1990; NASS, 1997; NRCS, 2001; USDA, 1990). For these reasons, the rating is High (3).

Unaspis yanonensis
This predominately Asian species prefers warm temperate, Mediterranean, and tropical climates (CPC, 2001) which correspond to at least four Plant Hardiness Zones (NASS, 1997; NPQS, 1998; NRCS, 2001). Rutaceous hosts grow throughout North America, in Plant Hardiness Zones 5 to 10 (ARS, 1990). For these reasons, the rating is High (3).

Xanthomonas axonopodis pv. *citri*
Citrus canker disease occurs in Asia, Africa, Central America, the Caribbean, South America, Oceania, and only the D-strain was reported in Mexico (Podleckis, 1997). In the United States, *X. axonopodis* pv. *citri* has the potential to establish in Plant Hardiness Zones 8 to10 (ARS, 1990). This bacterium naturally infects green citrus tissues (stems, fruit, and leaves) in the later stages of growth or tissue expansion, and wounds from mechanical damage and insect feeding can cause mature tissues to become infected (Schubert *et al*., 2001). Additionally, in Florida, a well managed citrus tree will undergo three to five growth flushes every growing season, each accompanied by a period of susceptibility (Schubert *et al*., 2001). This combination of naturally susceptible tissue and wounded tissue means that canker infection can occur year-round. For these reasons, the rating is Medium (2).

Risk Element #2: Host Range
The risk posed by a plant pest depends on its ability to establish a viable, reproductive population and its potential to cause plant damage. This risk element assumes that the consequences of pest introduction are positively correlated with the pest s host range. Aggressiveness, virulence and pathogenicity also may be factors. The consequences are rated as a function of host range and consider the ability of a pest can attack a single species, multiple species within a genus, a single plant family, or multiple families.

Parlatoria ziziphi
The hosts for this scale include *C. aurantiifolia*, *C. aurantium*, *C. hystrix, C. limon, C. nobilis*, *C. x paradisi, C. reticulata*, *C. sinensis*, *Severinia buxifolia* and *Murraya paniculata* (CPC, 2001; McKenzie, 1945). Additional host genera in China include: *Camellia*, *Citrus*, *Codiaeum*, *Cocos*, *Cymbidium*, *Damnocanthus*, *Ligustrum, Poncirus*, and *Ziziphus* (Li-zhong, 2000). It is also reported on hosts in families other than the Rutaceae, but those records are unreliable (Deckle, 1976; PNKTO #44, 1984). This conflict in the reported host range suggests that this insect has not yet reached the limits of its ecological range. For these reasons, the rating is High (3).

Planococcus kraunhiae
This mealybug is reported to attack plants in 20 families and 22 genera (Ben-Dov, 1993). In addition to *C. nobilis* and *C. paradisi*, host genera include *Agave*, *Artocarpus*, *Casuarina*, *Codiaeum*, *Coffea, Crinum, Cydonia, Digitaria, Diospyros*, *Ficus*, *Gardenia*, *Ilex*, *Magnolia*, *Musa*, *Nandina, Nerium*, *Olea, Platanus, Portulaca, Trachycarpus* and *Wisteria* (Ben-Dov, 1993; SEL, 2002). Based on this broad range of hosts, this insect is rated High (3).

Unaspis yanonensis
This scale insect is associated primarily with *Citrus*, *Fortunella* and *Poncirus* (Rutaceae), *Damnacanthus* (Rubiaceae) (PNKTO #45, 1984), *Camellia* (Theaceae) and *Dimocarpus*

(Sapindaceae) (Li-zhong, 2000). For this reason, the rating for the host range risk element is High (3).

Xanthomonas axonopodis pv. *citri*
Primary hosts of *X. axonopodis* pv. *citri* include: *Casimiroa edulis*, *Citrus aurantium*, *C. maxima*, *C. hystrix*, *C. limetta*, *C. limon*, *C. medica*, *C. madurensis*, *C. natsudaidai*, *Citrus x paradisi*, *C. reticulata*, *C. reticulata x Poncirus trifoliata*, *C. sinensis*, *C. sunki*, *C. unshiu*, *Eremocitrus glauca*, *Limonia acidissima*, *Poncirus trifoliata*, *C. aurantiifolia*, *C. tankan*, *C. junos* and *C. reshni* (CPC, 2001). Secondary hosts include: *Fortunella japonica* and *F. margarita* (CPC, 2001). There are no native members of these genera within the continental United States (NRCS, 2001; Wunderlin, 2001). The following plants were also reported to be susceptible to *X. axonopodis* pv. *citri*, however, the original descriptions either were not confirmed or contradict those of other authors: *Aegle malmelos*, *Balsamocitrus paniculata*, *Feroniella obligata*, *Matthiola incana* var. *annua*, and *Toddalia asiatica* (CPC, 2001). The confirmed hosts of *X. axonopodis* pv. *citri* are members of a single plant family (Mabberly, 1998), so for these reasons, the rating is Medium (2).

Risk Element #3: Dispersal
After introduction, pests may disperse into new areas. The dispersal potential, expressed by aspects of the pest s reproductive potential, inherent mobility and dispersal facilitation, indicates the rapidity and range of the pest s potential economic and environmental impact . Criteria for rating the dispersal potential include: the presence of multiple generations per year or growing season, the relative number of offspring or propagules per generation, inherent capabilities for rapid movement, the presence of natural barriers or enemies, and dissemination enhanced by wind, water, vectors, or human assistance.

Parlatoria ziziphi
This pest may produce three to seven generations per year (CPC, 2001; PNKTO #44, 1984), and fecundity varies from 8 to 34 eggs per female (CPC, 2001; PNKTO #44, 1984). The mobile immature stages can be wind dispersed because of their small sizes and light body weights (Miller, 1985; Rosen, 1990; Stehr, 1991). For these reasons, the rating is High (3).

Planococcus kraunhiae
Females *P. kraunhiae* are generally capable of laying hundreds of eggs and all life stages will be present on fruit near the stem or the calyx area (McKenzie, 1967). In Japan three generations per year are produced (NPQS, 1998). Movement and dispersal of the immature mealybugs can be wind-assisted (McKenzie, 1967). Because of its high reproductive rate and the small, lightweight immature stages, the rating for this pest as High (3).

Unaspis yanonensis
This pest has up to three generations per year in Japan (Clausen, 1931; PNKTO #45, 1984;) and females may lay up to 200 eggs (Miller, 1985). First instar crawlers may settle on the host shortly after hatching (PNKTO #45, 1984), or disperse by wind or other means (Rosen, 1990; Stehr, 1991). Because of this high reproductive rate and wind-aided dispersal, this pest is rated High (3)

Xanthomonas axonopodis pv. *citri*
The documented evidence indicates that the primary modes for long distance dispersal of *X. axonopodis* pv. *citri* are the movement of infected or infested plant material, movement of inoculum on personnel, clothing or equipment and weather events such as thunderstorms and tropical storms (Gottwald *et al.*, 2001; Schubert *et al.*, 1998). The latter are responsible for dispersal of the bacteria from a few hundred meters to several miles (Stall *et al.*, 1980; Civerolo, 1981; Gottwald *et al.* 1992, 1997). Outbreaks of citrus canker have never ben directly attributed

to infested commercial shipments of citrus fruit (EPPO, 1997; Timmer *et al*., 2000).

Within a tree, this bacterium is disseminated by rainwater running over the surfaces of lesions and splashing onto uninfected, unprotected shoots. The concentration of bacteria is largely dependent on the age of the lesions with a maximum of 100 million 1000 million cells/drop (CPC, 2001) or about 10^5 to 10^6 colony forming units (cfu) per ml in rainwater (Stall, 1980). The effective inoculum dose is estimated at somewhere between 10^2 and 10^3 cfu per ml (Schubert *et al*., 1998). For these reasons, the rating is High (3).

Risk Element #4: Economic Impact
Introduced pests cause a variety of direct and indirect economic impacts such as reduced yield, reduced commodity value, loss of foreign or domestic markets, and non-crop impacts. Factors considered during the ranking process included: affect on fruit yield or quality, ability to cause plant mortality, ability to act as a disease vector, increased costs of production and pest control, ability to lower market prices, affect on market availability, increased research or extension costs and potential reduction in recreational land use or aesthetic value.

Parlatoria ziziphi
This insect is a major pest of citrus as a contaminant on fruit (PNKTO #44, 1984). Large populations on stems cause dieback, premature leaf and fruit drop and deformation of the fruit (PNKTO #44, 1984). Infestations may require the use of chemical pesticides (Deckle, 1976) (the annual cost, in North America, for controlling scale insects is $500 million (Kosztarab, 1996)). For these reasons, the rating is High (3).

Planococcus kraunhiae
Mealybugs cause severe damage to young trees by killing the tips of branches (CPC, 2001) and their exudate can lower the yield of the crop by promoting the growth of sooty molds which cover the fruit, making the fruit unmarketable (Cox, 1989). Direct feeding on the fruit may cause an abnormal shape, decreasing the fresh market capability (McKenzie, 1967). Due to the direct damage, the increased production costs and the potential impact on market access, the rating for this insect is High (3).

Unaspis yanonensis
Feeding by this pest can severely distort the fruit resulting in rejection of the fruit from markets, as well as inhibiting plant growth which causes the death of small trees (Clausen, 1927; CPC, 2001; PNKTO #45, 1984). This scale insect can lower the yield and value of agricultural commodities and causes damage serious enough to require the use of pesticides for control (PNKTO #45, 1984). Its effects on fruit may also effect market access. For these reasons, this pest is rated High (3).

Xanthomonas axonopodis pv. *citri*
Citrus canker, under favorable conditions, causes defoliation, shoot dieback, and fruit drop (Timmer *et al*., 2000). Development and maturity may be delayed by several years in severely infected, young trees (CPC, 2001). Although the internal quality of maturing fruit is not affected, fresh fruit with lesions is reduced in market value (EPPO, 1997; Timmer *et al*., 2000). The disease is considered serious, especially in areas of high temperature (14-38 °C) and rainfall (> 1,000 mm per year) (EPPO, 1997). This bacterium is considered a quarantine pest by EPPO, NAPPO and most citrus producing countries (EPPO, 1997).

In the absence of eradication efforts, the establishment of citrus canker disease in Florida, alone, could cause direct losses to the citrus industry of about $100 million per year (Reed, 1998). Disease establishment could lead to the abandonment of 140,000 acres of grapefruit valued at

$148 million, and the loss of exports to countries known not to accept fruit from canker countries would amount to at least $55 million per year (Reed, 1998). Domestic quarantines were projected to add an additional $60 million per year in losses (Reed, 1998). Negative economic impacts include indirect costs from additional equipment required to apply additional pesticides, the cost of those pesticides, the cost of windbreaks planted to reduce disease spread, the cost of certification of fruit for fresh markets and disinfection of groves, equipment and personnel (Muraro *et al*., 2001). During the 23 years (1910-1933) of bacterial canker eradication in Florida, over $6 million dollars was spent destroying 258,000 producing trees and 3 million nursery trees (USDA, 1985). The current cost of eradication efforts in Florida is estimated at over $30-40 million per year for a 4 5 year period (Reed, 1998), and over 870,000 trees were destroyed since 1998 (Muraro *et al*., 2001). For all these reasons, the rating is High (3).

Risk Element #5: Environmental Impact
The ratings for this Element were based on three aspects: the potential interaction with species that are listed as Threatened or Endangered (50 CFR §§ 17.11-12); the potential for disrupting native plants based on the pest s habits within its current geographic range; and the initiation of chemical or biological control programs. The importation of these oranges is as a commodity for consumption. In the marketplace, commodities for consumption are often separated from ecosystems and generally the fruit is unlikely to be in contact with non-agroecosystems.

There were no hosts that corresponded to Threatened species or species Proposed for listing by the US Fish and Wildlife Service (USFWS, 2002). None of the hosts for *U. yanonensis* or *X. axonopodis* pv. *citri* (Section F, Risk Element #2 Host Range) corresponded to any Endangered, Threatened or Proposed species (USFWS, 2002). The genera of the hosts of *P. ziziphi* and *P. kraunhiae* that correspond to genera of Endangered species are listed in Table 2.

Table 2. Hosts of *Parlatoria ziziphi* and *Planococcus kraunhiae* that Correspond to Endangered Species.

Pest	Host Genera (Family)	Listed Plant	Endangered Species Distribution
Parlatoria ziziphi	*Ziziphus* (Rhamnaceae)	*Z. celata*	FL
Planococcus kraunhiae	*Agave* (Agavaceae)	*A. arizonica*	AZ
	Gardenia (Rubiaceae)	*G. brighamii*	HI
		G. mannii	HI
	Ilex (Aquifoliaceae)	*I. sintenisii*	PR
		I. cookii	PR
	Portulaca (Portulaceae)	*P. sclerocarpa*	HI

Parlatoria ziziphi
This scale is a serious pest of citrus in many areas of the world, but the limited presence in Florida suggests that this pest is not likely to become highly problematic throughout the United States (Fasulo and Brooks, 2001). The endangered species, *Z. celata* is located in Florida, so any risk to this plant is already realized by the current presence of this pest in Florida. Additional application of pesticides is not likely to be needed because of the efficacy of existing integrated pest management programs (Anon., 1991; Browning, 2002). For these reasons, the rating is Low (1).

Planococcus kraunhiae
This pest attacks a wide range of hosts (Ben-Dov, 1993; McKenzie, 1967; SEL, 2002), but none have members listed as Threatened or Proposed species (USFWS, 2002). The Endangered species that correspond to a host genus are listed in Table 2. Identification of these plants is part

of the guidelines criteria (PPQ, 2000), and only the possibility of an extension of a host range may be inferred (Cave, 2000). The Endangered species in Hawaii (*G. brighamii*, *G. mannii*, and *P. sclerocarpa*) are unaffected by the proposed expansion of the importation because Korean Unshu oranges are currently permitted entry into Hawaii (7 CFR § 319.28(b)). The importation of Unshu oranges into Puerto Rico is not part of the Korean importation request. While the introduction of a mealybug may stimulate biological or chemical control programs, it is likely that existing insect control programs will be effective at limiting this pest (McKenzie, 1967). For these reasons, the risk rating is Medium (2).

Unaspis yanonensis
The host range of this pest suggests that establishment in non-agronomic ecosystems may be limited if this pest is introduced into the continental United States (Li-zhong, 2000; PNKTO #45, 1984). None of the host genera have members listed as Threatened or Endangered species (USFWS, 2002). Chemical or biological control programs were successful for this pest in commercial citrus growing areas in Japan and France (PNKTO #45, 1984), but these types of programs are not expected to be used in non-agronomic areas. The rating for this insect is Medium (2).

Xanthomonas axonopodis pv. *citri*
The host range includes many members of the Rutaceae, and one non-rutaceous host, *Lansium domestica* (Meliaceae) (Podleckis, 1997). Introduction of this disease is likely to increase the need for chemical control programs in citrus groves. The copper compounds widely used as preventive bactericides for leaf spot plant diseases like canker, have limitations due to phytotoxicity, pollution, environmental vulnerability, duration, and high probability of inducing copper-resistant strains (Sun *et al.*, 2001). Also, their efficacy depends on the type of pathogens, affected hosts, pathogenesis, and environmental factors affecting disease development (Sun *et al.*, 2001). In Japan, copper compounds may have to be sprayed every week during the active growth of new shoots to prevent primary bacterial inocula from attacking spring shoots (Sun *et al.*, 2001). For these reasons, the rating is Medium (2).

Table 3: Summary of the Risk Ratings and the Value for the Consequences of Introduction.

Pest	Climate/ Host	Host Range	Dispersal Potential	Economic Impact	Environ-mental Impact	Consequences of Introduction value[1]
Parlatoria ziziphi	Medium (2)	High (3)	High (3)	High (3)	Low (1)	Medium (12)
Planococcus kraunhiae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Unaspis yanonensis	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Xanthomonas axonopodis pv. *citri*	Medium (2)	Medium (2)	High (3)	High (3)	Medium (2)	Medium (12)

[1] Low = 5 to 8; Medium = 9 to 12; High = 13 to 15

G. Likelihood of Introduction

The Likelihood of Introduction for each pest is based on the amount of the commodity likely to be imported, converted into standard units of 40-foot long shipping containers, and Pest Survival

Potential, estimated using five biological features (USDA, 2000). These ratings and the value for the Likelihood of Introduction are summarized in Table 4.

Quantity Imported Annually
Korea s export of Unshu oranges to the United States began in 1995. The mean annual export volume, between 1995 and 2000, was 16.75 containers/year (range 2 containers (1998) to 59.5 containers (1997)).

The Korean officials indicated that if shipment to all 50 States were approved, they expected to annually export between 1000 and 2000 metric tons of Unshu oranges to the United States (Thomas, 2001). This translates to a predicted volume of between 50 and 100 standard 40-foot shipping containers annually, based on a conversion factor of 20 metric tons per 40-foot shipping container (Cargo Systems, 2001). The quantity of commodity imported is estimated to fall within the range of 10 to 100 containers per year, so the Quantity Imported Annually is rated Medium (2) for all of the pests.

Survive Postharvest Treatment
Postharvest treatments include culling, washing and chemical treatments (such as waxing). This risk element evaluates the efficacy of postharvest treatments in terms of the mortality of pests exposed to the treatments. The surface sterilization (currently prescribed as a treatment of a 200 ppm sodium hypochlorite fruit dip) is not expected to have significant adverse effects on the arthropod pests, but acts as a safeguard against diseases (USDA, 1998a). Bacteria adhering to the fruit surface are highly likely to be killed by this treatment (Brown and Schubert, 1987; Schubert *et al*., 2001; Obata *et al*., 1969; Stapleton, 1986a; Stapleton, 1986b). The baseline rating for all pests is High (3). However, when a sodium hypochlorite fruit dip is employed, the bacteria are highly likely to be removed from the pathway.

Survive Shipment
This sub-element evaluates the mortality of the pest population during shipment of the commodity. Shipments of Unshu oranges are likely to be refrigerated and spend two to four weeks in transit to the United States (www.containershipping.com; PPQ 280 Database). The insect pests (*P. ziziphi*, *P. kraunhiae*, and *U. yanonensis*) can survive refrigeration, but may be killed by exposure to below-freezing temperatures if it exceeds a species specific duration (CPC, 2001; Lee and Denlinger, 1991; McKenzie, 1967; PNKTO #44, 1984; PNKTO #45, 1984; Rosen, 1990). From 1985 to 2001, *P. ziziphi* was intercepted 25,297 times (50 times on *Citrus* spp. from Korea), 112 interceptions of *P. kraunhiae*, (10 from Korea on persimmon, *Diospyros* spp.) and 5,017 interceptions of *U. yanonensis* (23 interceptions on citrus from Korea) (PIN309, 2001). This is evidence that when these pests are present on transported fruit (in passenger baggage, ships stores, *etc*.) they can survive the ambient transport conditions. For all of these insect pests, the baseline rating is High (3). If these insect pests are not present on the fruit during harvest and processing, and these insects are prevented from entering the packages of fruit during shipment, then there are no populations that follow the pathway, and the survivability of these pests is no longer a factor.

The pathogen, *X. axonopodis* pv. *citri*, is a relatively labile bacterium (Civerolo, 1995). And it is generally believed that bacterial populations decline rapidly even within lesions of infected fruit after harvest (Civerolo, 1981; USDA, 1985). The extended drying period during shipping could cause mortality of the bacterium in superficial populations of *X. axonopodis* pv. *citri*, and the epidemiological significance of the surviving bacteria is questionable (Schubert *et al*., 1998). Nevertheless, viable bacteria were reisolated from infected citrus tissues even after several months under dry conditions (Graham *et al*., 1987; Koziumi, 1972). It appears likely that the bacteria can survive the relatively short transport duration, so the rating is High (3).

Not Detected at the Port of Arrival
As a baseline, all of the insect pests are rated Medium (2) because careful inspection for the mobile stages of these insects can detect them despite their small size (Rosen, 1990). The very high number of interceptions of these pests from any country and on any commodity confirms that trained PPQ inspectors can find them in shipments. Neither the mealybug, *P. kraunhiae*, nor the scale, *P. ziziphi,* were detected in pest surveys of the unshu orange export areas conducted by the Cheju regional office of NPQS in 2000 (An, 2000) and by the National Institute of Agricultural Science and Technology during 1996 1998 (An, 2000) indicating that these pests may not be following the pathway from Korea simply because they are not present in the export production areas. The other scale insect, *U. yanonensis*, was detected in pest surveys by the National Institute of Agricultural Science and Technology during 1996 1998, but was categorized as a very minor pest in commercial Unshu orange groves and only partially occurs in groves that are not managed (An, 2000).

Trained PPQ officers can readily detect symptomatic canker diseased fruit, by the necrotic lesions on the rind (EPPO, 1997; Schubert *et al*., 2001; Timmer *et al*., 2000). On the other hand, latent bacterial populations cannot be detected by visual examination, and these apparently dormant bacteria may remain viable even after several months under dry conditions (Graham *et al*., 1987; Koziumi, 1972). This pathogen was intercepted numerous times on citrus fruit, but there were no interceptions on commercially exported Unshu oranges from Korea (Appendix B). For these reasons, the rating is Medium (2).

Moved to a Suitable Habitat
This sub-element considers the geographic location of likely markets and the chance of the commodity moving to locations suitable for the pest s survival. Fruit that arrives in the United States does not normally arrive at a single port, but is distributed according to market demand. Restricting the distribution of commodities reduces the likelihood that any associated pests can reach a suitable habitat. Since 1995, an estimated 24 million Korean Unshu oranges have been shipped to the United States. In that time, there was only one PPQ interception of an Unshu orange shipment from Korea being sent into a citrus producing State (Schwartz, 2002). In that situation, it was an incidental redirection of an air shipment that led to the re-exportation to a non-citrus producing state (Schwartz, 2002).

The current export program does not directly move the fruit into suitable habitats within the citrus producing states. The proposed expansion into those states increases the risk that the pests can move into suitable habitats, however, populations of scale insects often do not build quickly like some other pest groups (Browning, 2002). In contrast, the climate in Florida is particularly favorable for citrus canker because sufficient amounts of viable bacteria are easily disseminated through wind-driven rain under natural conditions (Civerolo, 1981; Gottwald *et al*., 2001). Depending on the weather, this disease could be rapidly spread into suitable habitats commonly occurring in Florida. For these reasons, the rating for the insects is Medium (2), and High (3) for citrus canker.

Contact with Host Material
The current export program restricts the distribution of fruit to non-citrus producing states, so the limited number of non-rutaceous hosts throughout the United States makes it highly unlikely that these quarantine pests could contact suitable host material. Lack of suitable hosts restricts the opportunities for pests to establish populations. While passive factors such as wind, water, or animals may aid in the dispersal of stages of the insect pests (Kosztarab and Kozar, 1988; Rosen, 1990), the opportunity for these mechanisms of dispersal is only moderately increased by the proposed expansion of importation, and is directly reflected in the Dispersal Potential ratings. For these reasons, the ratings for all the insects is Medium (2).

Canker infection could occur year-round in Florida because there is a continuous combination of naturally susceptible tissue and damaged tissue (Schubert *et al*., 2001). This bacterium naturally infects green citrus tissues (stems, fruit, and leaves) during the later stages of growth or tissue expansion, and even mechanically damaged and insect damaged mature tissues can become infected (Schubert *et al*., 2001). In Florida, latent bacterial populations on discarded rinds could pose a risk to urban and suburban citrus trees, and could be rapidly disseminated by wind and rain to commercial groves. Asymptomatic fruit is very highly unlikely to have sufficient level(s) of viable bacteria as inoculum to cause infection (Civerolo, 2002). This disease infrequently establishes in Florida (Schubert *et al*., 2001). For these reasons, the rating is Medium (2).

Table 4. Summary of the ratings for the Pest Survival Potential and the value for the Likelihood of Introduction.

Pest	Quantity Imported Annually	Pest Survival Potential					Likelihood of Introduction[1]
		Survive Postharvest Treatment	Survive Shipment	Not Detected at the Port of Entry	Move to Suitable Habitat	Contact with Host Material	
Parlatoria ziziphi	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	Medium (14)
Planococcus kraunhiae	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	Medium (14)
Unaspis yanonensis	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (2)	Medium (14)
Xanthomonas axonopodis pv. *citri*	Medium (2)	Low (1)	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (11)

[1]Low = 6 to 9; Medium = 10 to 14; High = 15 to 18

Likelihood of Establishment: Ability to complete disease/life cycle

The ability of a pest to complete its disease or life cycle is not a risk element of the current risk assessment model, but instead, is assumed to impact the ability of the pest to establish populations in a new location. The minimum number of pests needed to establish a viable population is related to the basic biology of the pest. This basic biology includes characteristics of the pest s reproductive strategy and method of survival, the duration of the life cycle, the genetic adaptability of the species and the number of generations per year or presence of a resting stage. The ability of *P. ziziphi* and *U. yanonensis* to complete their life cycles and become established through introduced infestations was assessed in the compilations and findings of an *ad hoc* working group (Miller, 1985). On commercial fruit, the likelihood was moderate to low and low, respectively.

Infection by bacterial citrus canker occurs through a narrow window of plant susceptibility because mature leaves are immune from infection (unless insect or mechanically damaged [Schubert *et al*., 2001]) and fruit is only susceptible from petal fall to 90 days thereafter (Civerolo, 1981; EPPO, 1997; Grahan and Gottwald, 1991; Timmer *et al*., 2000). The bacterium can survive up to 120 days on decomposing leaf litter, fallen tree limbs and fallen fruit (Graham *et al*., 1987; Goto *et al*., 1978). Natural spread is by wind-driven rain (Civerolo 1981; Gottwald *et al*., 2001). So for infection to occur, wind and rain must transport a sufficient amount of viable bacteria to susceptible tissue. These multiple, dependent interactions may explain the relative infrequency of epidemics over time and the potential for a rapid rate of disease spread.

H. Pest Risk Potential

The sum of the values for the Consequences of Introduction and the Likelihood of Introduction produce the Baseline Pest Risk Potential (PRP) value. This cumulative total expresses the risk on the following scale: Low = 11 to18 points, Medium = 19 to 26 points, and High = 27 to 33 points. The Baseline PRP for each quarantine pest is summarized in Table 5.

Table 5. Summary of the values for the Consequences of Introduction and the Likelihood of Introduction and the Baseline Pest Risk Potential.

Pest	Consequences of Introduction Value	Likelihood of Introduction Value	Baseline Pest Risk Potential
Parlatoria ziziphi	Medium (12)	Medium (14)	Medium (26)
Planococcus kraunhiae	High (14)	Medium (14)	High (28)
Unaspis yanonensis	High (14)	Medium (14)	High (28)
Xanthomonas axonopodis pv. *citri*	Medium (12)	Medium (11)	Medium (23)

Pests with a Low Baseline PRP value typically do not require mitigation measures other than port of arrival inspection, while a value within the Medium or High ranges indicates that specific phytosanitary measures, supplemental to port of arrival inspection, are necessary. The Baseline PRP values for *P. ziziphi* and *X. axonopodis* pv. *citri* are Medium and High for *P. kraunhiae*, and *U. yanonensis*. As a stand-alone mitigation measure, port of arrival inspection is insufficient to provide phytosanitary security for the quarantine pests analyzed in this document, and the development of additional specific phytosanitary measures is recommended.

III. Pest Risk Management

Pest risk management is the decision-making process used to reduce the risk of introduction of a quarantine pest (FAO, 1996). The reduction of phytosanitary risk occurs through the use of mitigation measures. These measures eliminate, reduce, or prevent the presence of pest populations within shipments of commodities primarily in the country of origin. Systems Approaches use independently effective control measures as part of an integrated pest management program to provide redundant safeguards for shipments. Systems Approaches are alternatives to single mitigation measures that achieve a level of phytosanitary protection established by an importing country. This combination of specific mitigation measures that provide overlapping or redundant safeguards is distinctly different from the use of a single mitigation methodology such as fumigation or inspection (Paull and Armstrong, 1994). The Agricultural Risk Protection Act of 2000 defines a Systems Approach as, a defined set of phytosanitary procedures, at least two of which have an independent effect in mitigating pest risk associated with the movement of commodities. H.R. 2559 § 403(18). Although systems approaches vary in complexity, they all require the integration of different measures, at least two of which act independently, with a cumulative effect (Natl.Plant Board, 2002). Options for specific measures may be selected from a range of preharvest and postharvest measures and include measures to compensate for uncertainty.

Systems Approaches have been successfully used by PPQ for 35 years (Natl. Plant Board, 2002). Import programs that use these combined mitigation methods for quarantine security include Unshu oranges from Japan (7 CFR § 319.28), tomatoes from Spain, France, Morocco, and Western Sahara (7 CFR § 319.56-2dd) and peppers from Israel (7 CFR § 319.56-2u). These programs have been very effective in excluding pests and providing a clean product for export. (Cave and Lightfield, 1994). When difficulties with a program are detected, APHIS-PPQ investigates and takes appropriate action. In 2001, for example, APHIS stopped the Chinese Ya pear export program when rejection rates at the ports exceeded 15 percent (Podleckis, 2002). This was the maximum allowable level of rejected shipments mandated in the operational workplan established for the program at its inception in 1997 (Podleckis, 2002). Prior to the 2002 shipping season, APHIS sent teams to China during the growing season to ensure compliance with the workplan and to make recommendations on measures to strengthen it (Podleckis, 2002). Before permitting resumption of exports, APHIS instituted more stringent disease testing and inspection requirements and committed to a further review of the export program at the conclusion of the shipping season (Podleckis, 2002).

The use of a Systems Approach that combines a variety of effective mitigation measures is designed to reduce the overall Mitigated PRP to an acceptable level because all the known pests, and biologically similar unknown pests, are effectively removed from the pathway. The effectiveness of the combined components is likely to reduce the pest risk to an acceptable level of protection because the commodity is sequentially protected from infestation (and reinfestation) from crop production to the entry of the shipment in the United States.

The implementation of phytosanitary measures via a Systems Approach is exemplified in both the Current and Proposed export programs. The effect of these combinations of phytosanitary measures is to eliminate, reduce, or prevent the presence of these pests in shipments of commodities so that they do not follow the pathway (Table 6). The term, effectively removed from the pathway means that the mitigation measures taken as a whole, are reasonably expected to eliminate or reduce pest populations to the extent that the pest will not follow the pathway on the imported commodity.

Table 6. Values for the Mitigated Pest Risk Potential when Unshu Oranges from Korea are Produced and Shipped Using a Systems Approach.

Pest	Consequences of Introduction Value	Likelihood of Introduction Value		Mitigated Pest Risk Potential Value
		Quantity Imported Annually	Pest Survival Potential	
Parlatoria ziziphi	Medium (12)	Medium (2)	Effectively Removed from the Pathway	Low (14)
Planococcus kraunhiae	High (14)	Medium (2)	Effectively Removed from the Pathway	Low (16)
Unaspis yanonensis	High (14)	Medium (2)	Effectively Removed from the Pathway	Low (16)
Xanthomonas axonopodis pv. *citri*	Medium (12)	Medium (2)	Effectively Removed from the Pathway	Low (14)

The Current Systems Approach consists of the specific mitigation measures as stated in 7 CFR § 319.28(b) and as summarized below. The Current Systems Approach export program does not directly move the fruit into suitable habitats within the citrus producing States. Under this program, an estimated 24 million Korean Unshu oranges were shipped to the United States since 1995. In that time, there was only one PPQ interception of an Unshu orange shipment from Korea being sent into a citrus producing State (Schwartz, 2002). In that situation, it was an accidental redirection of an air shipment that led to the re-exportation to a non-citrus producing state (Schwartz, 2002).

The proposed importation changes would allow the importation of Unshu oranges into all States of the continental United States. This proposed expansion to allow importation into those additional States increases the risk that the pests can move into suitable habitats, but populations of scale insects often do not quickly build-up like some other pest groups (Browning, 2002) which provides additional time to identify and take action against these pests. The climate in Florida is favorable for citrus canker because sufficient amounts of viable bacteria can be disseminated to susceptible tissue through wind-driven rain under natural conditions (Civerolo, 1981; Gottwald *et al*., 2001). Depending on the weather, this disease could be rapidly spread into suitable habitats commonly occurring in Florida. Suitable US habitats for bacterial canker development also occur in States along the Gulf Coast (especially Louisiana and Texas), but hot dry climates, as in the arid Southwest United States (Arizona and California) are inhospitable to bacterial diseases in general (Schubert *et al*., 1998).

Both the Current Systems Approach and the Proposed Systems Approach combine a range of mitigation measures to provide redundant safeguards. Briefly, these mitigation measures are: (1) a grove certification program, (2) the presence of buffer zones around each export production groves, (3) grove and buffer zone pest surveys, (4) the use of a field pest control program, (5) the use of cultural practices to reduce pests in the groves, (6) packing house safeguards to ensure high fruit quality, (8) preclearance inspections, (9) shipment safeguards, and (10) port of arrival inspection.

This risk analysis assumes that all of the imported fruit adheres to all of the components of the Proposed Systems Approach as described in this document and that: (1) measures are simultaneously applied within a growing season at the appropriate stage of production, harvest, or shipment, (2) all measures are maximally effective, (3) survey results are followed by appropriate action to reduce pests or eliminate orchards from the export production program, (4) packing house procedures do not allow hitchhiker organisms to remain with the fruit, and (5) the integrity of shipments is not breached before inspection at a port of arrival. The estimation of the efficacy of each mitigation measure already accounts for potential human errors which are likely to be random in type and extent.

In the remainder of this section, the Current Systems Approach is summarized, then the components of the Proposed Systems Approach are described and the relative effectiveness of each mitigation measure is discussed.

A. The Current Systems Approach

The following is a non-binding summary of the mitigation measures which comprise the Systems Approach that currently regulate the importation of fresh Unshu oranges into the United States (7 CFR § 319.28(b)). This Systems Approach relies on stringent production practices, buffer zones, pest monitoring and testing, and inspections to be effective against all quarantine pests of concern.

Unshu oranges must be grown in isolated, canker-free groves, and each export certified grove is surrounded by a 400-meter-wide buffer that contains only canker resistant citrus species (7 CFR §

319.28(b)(1)). Ten resistant varieties of *Citrus* are allowed to be grown in the buffer zones (7 CFR § 319.28(b)(1)). Fruit is inspected before harvest, at harvest, and during packing at the packing house (preclearance inspection). These inspections are jointly conducted by qualified inspectors from Korea and the United States (7 CFR § 319.28(b)(2)). Imported fruit must be free of leaves and soil (7 CFR § 319.56). Prior to packing, fruit is surface sterilized by dipping the fruit into a 200 ppm sodium hypochlorite solution for two minutes at a pH of 6.0 to 7.5. As an alternative, fruit may be surface sterilized by dipping into a 1.866 to 2.0 percent sodium o-phenyl phenate (SOPP) bactericide solution for 45 seconds to one minute (7 CFR § 319.28(b)(3)). Identity of the origin of the fruit is maintained by stamps on individual shipping boxes, and an accompanying phytosanitary certificate (7 CFR § 319.28(b)(4)). Importation through ports of entry into American Samoa, Arizona, California, Florida, Louisiana, the Northern Marianas Islands, Puerto Rico, Texas and the Virgin Islands of the United States is prohibited (7 CFR § 319.28(b)).

B. The Proposed Systems Approach

All of the measures in the Current Systems Approach remain in effect, **except** that distribution to Arizona, California, Florida, Louisiana, and Texas may occur, the production areas are subjected to additional detection surveys, and the harvested fruit is subjected to an increased level of inspection in Korea. The Proposed Systems Approach for the Korean unshu orange export program calls for a joint Korean/U.S. inspection of export groves prior to and during harvest. The following summary of the Proposed Systems Approach was developed from the Korean Mandarin Workplan (USDA, 1997).

Grove Certification

Only Unshu variety oranges are grown in certified groves within a PPQ approved export production area by growers registered with NPQS (Korean National Plant Quarantine Service). Initial grove certification and export production area approval is granted by NPQS and PPQ. PPQ and NPQS will inspect production groves and buffer areas for signs of pest infestations during the growing season, and ensure that the oranges meet all requirements. If citrus canker is found, the grove is not certified, and is excluded from the export program. Export production areas are certified to be free of citrus canker and that other pests are controlled. If citrus canker infected trees are found prior to or during the inspection of production areas, the infected trees shall be removed from the groves and burned. Groves with citrus canker infected trees shall be excluded from the export program for a minimum of two years and are eligible for readmission to the export program only after disease diagnoses based on surveys and testing of the remaining trees in the grove are negative. The two-year symptom-free requirement for re-eligibility of an infested orchard was driven from the fact that Australia used it effectively before allowing movement of citrus from a citrus-canker infested Australian island in 1980's (Gadh, 2002). A five-year period is cited in literature when the intent is a complete eradication of the disease in the area (Gadh, 2002).

Generally, grove certification programs are effective because they exclude groves with existing pest infestations or a high initial inoculum level (Hill, 1983; Van der Plank, 1963). For diseases in particular, having a reduced inoculum level at the beginning of the season delays or reduces disease progress (Van der Plank, 1963).

Grove and Buffer Zone Surveys

In addition to the initial joint inspections, a citrus canker survey will be conducted by PPQ and NPQS, twice a year in the export production and buffer zone areas. These surveys will occur once prior to the fall harvest, and again when the citrus trees are flush with new growth. If *P. ziziphi*, *P. kraunhiae*, or *U. yanonensis* are detected during these bi-annual inspections, the grove will be excluded as an export production area during the next growing season. If citrus canker infected trees are detected at any time, the infected trees shall be removed from the groves and burned. Every area identified with citrus canker infected trees will be excluded from the export program for a minimum of two years. Affected groves may be readmitted to the export program after two years (USDA, 1997). Removal of inoculum sources drastically reduces the probability that fruit will become infected (Van der Plank, 1963). Visual inspection of orchards during the growing season are required essentially as a redundant measure or safeguard against pests of concern (Gadh, 2002). The survey is required even when the pests are not known to occur in the orchards or are external and can be detected during phytosanitary inspections at the packing house or port of arrival (Gadh, 2002). Orchards found infested will be removed from export program for that season (Gadh, 2002).

Another component of this Proposed Systems Approach is the monitoring of citrus canker by fruit-testing. The procedure requires the collection of one kilogram of fruit per hectare from each farm, and uses a protocol for bacteriophage testing (Obata *et al*., 1969; Park, 2001). In the future, an ELISA based testing procedure may be substituted using a 48-hour incubation period because this procedure will meet both PPQ and NPQS requirements for efficacy (Gottwald, 2001; Hartung, 2001; Park, 2001).

Surveys, coupled with subsequent phytosanitary actions, are effective at reducing risk (Hill, 1983; Johnston and Booth, 1983). These phytosanitary actions can range from eliminating groves from the program, to applying chemicals, to increasing grove sanitation (Timmer *et al*., 2000) depending on survey results and what is appropriate to mitigate the detected pest. Canker testing is effective as a survey component because early detection of leaf infections allows remedial actions to be taken before a crop is affected (Timmer *et al*., 2000). In the workplan (USDA, 1997), however, the only remedial action is the most stringent option which consists of removal from the program until remaining trees in the grove are demonstrated to be disease-free.

Buffer Zone with No Hosts or Canker-Resistant Varieties

Export production areas are surrounded by 400-meter-wide buffer zones that receive the same treatments and inspections as the export production areas. These zones give the export production areas an additional measure of protection by suppressing pests over a wider acreage. Approved resistant varieties (7 CFR § 319.28(b)(1)) are allowed in the buffer zones, because resistance is an important pest reduction method (Hill, 1983; Van der Plank, 1963), but only the Unshu variety orange is allowed in the export production areas. Plants of the genus *Poncirus* that are not root stocks, and any above ground growth (offshoots) from root stocks must be removed. When pests of quarantine significance, other than citrus canker, are detected in a grove then additional pest management procedures shall be used to control these pests. These management procedures may include alterations to the cultivation practices or chemical sprays as permitted by NPQS.

The effective size of a buffer zone is determined by its purpose. The 1900-foot eradication zone used in the United States is supported by bacterial distribution studies in Florida (Gottwald *et al*., 2000). The Japanese Unshu orange program successfully uses a 400-meter wide buffer zone (7 CFR § 319.28) as a disease exclusion method. If citrus canker is detected in the buffer zones or export production areas, the infected grove is removed from the program. In general, buffer zones are effective because fewer pests propagules (primarily bacteria and spores) are expected to cross that distance and successfully disperse the disease into a new area (Agrios, 1997; Johnston and Booth, 1983; NRC, 2002; Van der Plank, 1963). Buffer zones also may be effective against moderately mobile insect pests when alternative or secondary hosts are removed from the buffer zone (Hill, 1983).

The 400-meter zone was proposed by Japan in bilateral discussions at the initiation of their program based upon the best available knowledge at that time about the potential spread of the bacterium and this size of a buffer zone is still effective in that country 30 years later (Gadh, 2002). This buffer was not intended as an eradication strategy but rather as a single component in a systems approach (Gadh, 2002). This is consistent with US regulations for both Japan and the Korean Cheju Island, and both the United States and Korea are in agreement following bilateral discussions (Gadh, 2002).

Chemical Controls and Cultural Practices
Registered growers are responsible for following an NPQS-approved pesticide program and controlling weeds to reduce pest populations. Weed control, mowing, and grass removal reduces insect populations during the growing season (Hill, 1983) and reduces plants acting as disease reservoirs (Johnston and Booth, 1983, Stevens, 1960). Surveys of insect populations during the growing season are recommended as part of selecting a pesticide spray schedule. Insect surveys, however, shall not be substituted for thorough inspections by NPQS during packing and by PPQ inspectors at the port of arrival or for other disinfestation methods during the packing processes.

Flexibility is essential to comply with foreign import and domestic pesticide regulations (Tollett, 1999) to account for the development of pest resistance (Anon., 1991), the development of new chemical products (Johnston and Booth, 1983), or the elimination of chemicals based on unacceptable residue levels. Standard programs in the citrus industry include insecticides (Anon., 1991) and copper sprays to reduce or eliminate bacteria and fungi (Timmer *et al.*, 2000).

Fallen fruit will be removed from the grove floors and harvested Unshu oranges must not be stored on the ground to minimize the potential for insect infestation and disease infection (Stevens, 1060). This prevents mites and other pests from migrating into the commodity. Harvested Unshu oranges in the groves must be covered to prevent pests from infesting the fruit (Irwin, 1998; Ishikawa, 1997; Suggs, 1997).

Packing house Practices and Safeguards
Packing houses must be kept clean and free of plant pests and plant debris including citrus intended for the domestic market. The packing houses may not concurrently process citrus for other markets while Unshu oranges for export to the United States are present. Export eligible fruit must be placed in separate containers from fruit that was not produced under the same phytosanitary conditions to prevent accidental commingling. Only new and clean packing boxes shall be used for export to the United States.

During the sorting process, all injured, infested, scarred, deformed, and poor quality fruit must be immediately removed from the packing house, but must be made available for PPQ inspection to ensure the absence of citrus canker (USDA, 1997). Before packing, oranges shall be given a prescribed surface sterilization (7 CFR § 319.28(b)(3)). The USDA currently prescribes 1.86 to 2.0 percent SOPP for 45 seconds or 200 ppm sodium hypochlorite at pH 6 for 2 minutes (USDA, 1998a). The SOPP treatment is a dip for one minute if there is not visible foaming (Brown and Schubert, 1987). The SOPP solution will be tested twice each day to ensure required concentration levels are met.

A 200 ppm sodium hypochlorite (chlorine) dip for two minutes essentially eradicated citrus canker bacteria (Obata *et al.*, 1969), and four canker strains did not survive a two minute exposure to more than 10 ppm chlorine in an aqueous solution (Stapleton, 1986a). While microflora populations may interfere with chlorine efficacy to some degree, significant reductions in the bacterial populations still occur (Brown and Schubert, 1987; Stapleton, 1986b).

Compliance with packinghouse practices and safeguards is confirmed in trip reports filed by PPQ personnel making site visits (Roman, 2000). The efficacy of similar practices is demonstrated by the existing Systems Approach for Unshu oranges from Japan (7 CFR § 319.28). All of these practices and safeguards effectively reduce or eliminate pests associated with the fruit (Agrios, 1997; Ishikawa, 1997; Johnston and Booth, 1983; Roman, 2000; Suggs, 1997; Van der Plank, 1963).

Preclearance Inspection and Phytosanitary certification
Prior to the surface disinfestation, drying and waxing, fruit shall be inspected for pests and pathogens by PPQ and NPQS officers, at the sampling rate of 10% per lot. Discarded fruit will be be subject to additional inspections for signs of citrus canker. The sample sizes for inspections in this Systems Approach is comparable to the APHIS, PPQ standards (AQIM, 1998). Inspectors are trained PPQ Officers who work from standard operating protocols and procedures that provide the applicable information (APHIS, 2002). By itself, the value of a phytosanitary certificate varies, and receipt of a phytosanitary certificate is not a guarantee that the consignment is healthy (Johnston and Booth, 1983). In this situation, however, the presence of a PPQ Officer during preclearance inspections ensures that phytosanitary security is met (Ishikawa, 1997; Roman, 2000; Suggs, 1997).

Numerous interceptions of *P. krauhniae* on fresh fruit commodities, including *Citrus* sp., demonstrate the efficacy of inspection despite the small size of this pest (PIN 309, 2001). Generally, mealybugs are highly visible when eggs in a loose cottony wax and honeydew which supports sooty mold growth are present (Borrer *et al.*, 1989; Cox, 1989). Many interceptions of adult females of *U. yanonensis* occurred on light-colored citrus fruit (PIN309, 2001) because of the color contrast of this blackish-brown pest (PNKTO #45, 1984), despite the general cryptic nature of scales (Rosen, 1990). The black colored *P. ziziphi* adults are conspicuous also discolor infested fruit (McKensie, 1945; PNKTO #44, 1984).

PPQ officers selected to conduct inspections as part of the Korean unshu orange preclearance program receive specific instruction for detecting quarantine pests that may encounter as part of the program. In particular, they receive specific instruction on citrus canker detection. In addition to the orchard and packinghouse visual inspections, 1 kg of fruit per hectare of export orchard is subjected to a bacteriophage laboratory test for *X. axonopodis* pv. *citri* (USDA, 1997). The bacterium causes symptoms in the leaves , branches and fruit of citrus. The first symptoms are tiny greasy or watery, translucent patches on the lower leaf surface. Lesions spread to the upper leaf surface forming pale irregular patches. Lesions become visible about 7 to 10 days after infection. On fruit, lesions can vary in size because the rind is susceptible for a longer time than leaves and several infection cycles can occur. Canker lesions on fruit are up to 1 mm deep, 15 mm wide and are superficially similar to those on leaves. A characteristic symptom of the disease on leaves is the yellow lesion that surrounds a lesion. Another useful symptom is the water-soaked margin that develops around the necrotic tissue and is easily viewed with transmitted light (Timmer, *et al.*, 2000). Inspectors are instructed to look for spongy canker lesions which are elevated with a water-soaked margin around the necrotic area (USDA, 1993). *X. axonopodis* pv. *citri* has been intercepted numerous times on citrus fruit, though never on Korean Unshu orange export fruit (Appendix 2), indicating that PPQ officers can readily detect canker diseased fruit.

A Foreign Site Certificate of Inspection and/or Treatment, PPQ Form 203, shall be completed by the PPQ Officer. This form shall accompany the shipment with the appropriate information. A Ministry of Agriculture and Forestry NPQS phytosanitary certificate shall be issued for each shipment, and these certificates serve as official confirmation that the requirements of the regulations were met. In addition, the phytosanitary certificate issued by NPQS will contain the following declaration: This shipment of Korean mandarins is believed to be free from the citrus canker disease (*Xanthomonas axonopodis* pv. *citri*) and meets all of the requirements specified by PPQ in 7 CFR §§ 319.28 and 319.56.

Shipment Safeguards
All the boxes must identify the grower and the packing house to ensure that the fruit can be traced to the grove of origin if pests are detected. Shipping containers will be loaded at the packing house to prevent contamination while en route to the port. The shipping containers will be sealed by a PPQ official with a number that is noted on the preclearance document. Fruit that is not immediately loaded after packing will be stored in secure refrigerated warehouses until loading. Phytosanitary certificates and seals are an effective way to confirm that the integrity of the shipment is not breached during transport (IPPC, 2002), and therefore excluded pests cannot enter the commodity.

Port of Arrival Inspection
To ensure that the shipment complies with PPQ regulations, the Inspector reviews documentation, including the Phytosanitary Certificate, PPQ Form 203, the bill of lading, invoices, etc. Although Unshu oranges imported into the United States from Korea are expected to arrive in the United States precleared, PPQ Inspectors may inspect the shipment at the port of arrival (7 CFR § 319.56-6). Shipments are also periodically monitored to detect plant pests. The inspection ranges from an inspection of several boxes, to an intensive inspection of a sample based on a hypergeometric inspection rate of 29 cartons per 1500 carton shipment (AQIM, 1998; Steel and Torrie, 1980). 1.9% (29 cartons out of 1500) POE inspection is used to monitor the whole system, not a particular lot, and is based on the fact that this provides a 95% confidence level of detecting a 10% infection or higher rate (Steel and Torrie, 1980). This is further subject to review as the program progresses (Gadh, 2002). In contrast, the export citrus program in California only requires a 0.5 to 2% inspection (Gadh, 2002).

Port of arrival inspections are designed to provide additional effective mitigation for external, macroscopic pests including the insect pests analyzed in this assessment. Shipments with quarantine pests may be disinfested, destroyed or refused entry (7 CFR § 319.56-6(c)). If a shipment is rejected based upon inspection by a PPQ Officer, then the number on the Phytosanitary Certificate will be used to trace the origin of the shipment to the corresponding production areas and appropriate measures will be applied. The ability to refuse entry or apply a probit 9 treatment (Paull and Armstrong, 1994) to a commodity based on pest findings is an ultimate safeguarding option because pest detection and elimination occur even if all other mitigation measures fail.

C. Conclusion
The currently approved export program for Korean Unshu oranges incorporates a Systems Approach that relies on stringent production practices, buffer zones, pest monitoring, and repeated inspections to be effective against the quarantine pests of concern. The overall efficacy of these combined mitigation measures is evidenced by the lack of interceptions of the quarantine pests of concern from cargo since the 1995 initiation of this program. It is not reasonable to expect this outcome to change with the implementation of the modifications in the Proposed Systems Approach, because of the increased stringency of the inspections. Although an increase in the volume of Unshu oranges and a wider market distribution in the United States will increase the risks associated with the pest proximity to suitable habitats and host plants; this will be offset with increased detection requirements in Korea which will decrease the pest entry potential because they will be effectively removed from the pathway. The requirement of fruit originating from citrus canker-free zones remains unchanged, and the Proposed Systems Approach requires grove inspections and testing for citrus canker to ensure canker-free production areas. The

combined mitigation measures ensures that pests do not travel with shipments of the fruit.

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V. List of Appendices

Appendix A. Weediness Potential of *Citrus* spp.

Appendix B. Pest Interceptions on *Citrus* spp. from the Republic of Korea as reported in the PPQ Pest Interception Database from 1985 to 2001.

Appendix C. Pests Associated with Citrus in Korea

Appendix D. Literature Cited

Appendix A. Weediness Potential of *Citrus* spp.

Commodity: *Citrus reticulata* Blanco var. *unshu* Swingle

Phase 1: Many species of *Citrus* are cultivated in the United States.

Phase 2: Is the genus listed as a weed in:

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

Phase 3: *Citrus reticulata* var. *unshu* is prevalent in the United States and the answer to all of the questions in Phase 2 is no , therefore the pest risk assessment proceeds.

Appendix B. Pest Interceptions on *Citrus* spp. from the Republic of Korea as reported in the PPQ Pest Interception Database from 1985 to 2001.

PEST	HOST	WHERE	TOTAL
Acarina	*Citrus reticulata*	Permit cargo	1
Aleurolobus marlatti	*Citrus* sp. (Leaf)	Baggage	1
Ascochyta citri	*Citrus sinensis* (Fruit)	Baggage	1
Cladosporium sp.	*Citrus* sp. (Fruit)	Baggage	1
Coccidae, species of	*Citrus* sp.	Baggage	1
Diaspididae, species of	*Citrus sinensis* (Fruit)	Baggage	1
Elsinoë australis	*Citrus* sp. (Fruit)	Baggage	1
Elsinoë sp.	*Citrus reticulata* (Fruit)	Baggage	1
Elsinoë sp.	*Citrus* sp. (Fruit)	Baggage	1
Guignardia citricarpa	*Citrus paradisi* (Fruit)	Stores	1
Guignardia citricarpa	*Citrus reticulata* (Fruit)	Baggage	4
Guignardia citricarpa	*Citrus sinensis* (Dried Fruit)	Baggage	2
Guignardia citricarpa	*Citrus sinensis* (Fruit)	Baggage	6
Guignardia citricarpa	*Citrus sinensis* (Fruit)	Stores	3
Guignardia citricarpa	*Citrus* sp. (Dried Fruit)	Baggage	2
Guignardia citricarpa	*Citrus* sp. (Dried Fruit)	Mail	1
Guignardia citricarpa	*Citrus* sp. (Fruit)	Baggage	29
Guignardia citricarpa	*Citrus* sp. (Fruit)	Quarters	1
Guignardia citricarpa	*Citrus* sp. (Leaf)	Baggage	3
Guignardia citricarpa	*Citrus* sp. (Seed)	Mail	1
Insecta, species of	*Citrus aurantifolia*	Permit cargo	1
Insecta, species of	*Citrus reticulata*	Permit cargo	1
Longitarsus sp.	*Citrus reticulata*	Permit cargo	1
Microsphaeropsis sp.	*Citrus* sp. (Leaf)	Baggage	1
Nezara antennata	*Citrus reticulata* (Fruit)	Permit cargo	1
Parlatoria ziziphi	*Citrus aurantifolia* (Fruit)	Baggage	2
Parlatoria ziziphi	*Citrus aurantifolia* (Leaf)	Baggage	1
Parlatoria ziziphi	*Citrus limon* (Fruit)	Baggage	2
Parlatoria ziziphi	*Citrus paradisi* (Fruit)	Baggage	1

PEST	HOST	WHERE	TOTAL
Parlatoria ziziphi	*Citrus reticulata*	Baggage	1
Parlatoria ziziphi	*Citrus reticulata* (Fruit)	Baggage	3
Parlatoria ziziphi	*Citrus reticulata* (Fruit)	Quarters	2
Parlatoria ziziphi	*Citrus sinensis* (Fruit)	Baggage	3
Parlatoria ziziphi	*Citrus sinensis* (Leaf)	Baggage	1
Parlatoria ziziphi	*Citrus sinensis*	Baggage	1
Parlatoria ziziphi	*Citrus* sp. (Fruit)	Baggage	12
Parlatoria ziziphi	*Citrus* sp. (Fruit)	Stores	1
Parlatoria ziziphi	*Citrus* sp. (Leaf)	Baggage	19
Parlatoria ziziphi	*Citrus* sp.	Baggage	4
Phyllosticta citricarpa	*Citrus* sp. (Dried Fruit)	Mail	1
Phyllosticta citricarpa	*Citrus* sp. (Fruit)	Baggage	5
Phyllosticta citricarpa	*Citrus* sp. (Fruit)	Mail	3
Phyllosticta citricarpa	*Citrus reticulata* (Fruit)	Baggage	1
Pseudococcidae, species of	*Citrus reticulata*	Permit cargo	1
Pseudococcidae, species of	*Citrus sinensis* (Fruit)	Baggage	1
Pseudococcidae, species of	*Citrus* sp. (Fruit)	Baggage	2
Pseudococcidae, species of	*Citrus* sp. (Fruit)	Cargo	1
Pseudococcidae, species of	*Citrus* sp.	Baggage	2
Pyraustinae, species of	*Citrus* sp. (Fruit)	Baggage	1
Tarsonemus sp.	*Citrus reticulata* (Fruit)	Permit cargo	2
Unaspis yanonensis	*Citrus maxima* (Fruit)	Baggage	1
Unaspis yanonensis	*Citrus paradisi* (Fruit)	Baggage	1
Unaspis yanonensis	*Citrus reticulata* (Fruit)	Baggage	2
Unaspis yanonensis	*Citrus reticulata* (Fruit)	Quarters	2
Unaspis yanonensis	*Citrus reticulata*	Baggage	1
Unaspis yanonensis	*Citrus sinensis* (Fruit)	Baggage	2
Unaspis yanonensis	*Citrus* sp. (Fruit)	Baggage	18
Unaspis yanonensis	*Citrus* sp.	Baggage	1
Utetheisa pulchella	*Citrus* sp. (Fruit)	Baggage	1
Xanthomonas axonopodis pv.*citri*	*Citrus aurantiifolia* (Fruit)	Baggage	1

PEST	HOST	WHERE	TOTAL
Xanthomonas axonopodis pv.*citri*	*Citrus aurantiifolia* (Fruit)	Stores	2
Xanthomonas axonopodis pv.*citri*	*Citrus hystrix* (Fruit)	Baggage	1
Xanthomonas axonopodis pv.*citri*	*Citrus hystrix*	Baggage	1
Xanthomonas axonopodis pv.*citri*	*Citrus limon* (Fruit)	Baggage	3
Xanthomonas axonopodis pv.*citri*	*Citrus limon* (Fruit)	Mail	1
Xanthomonas axonopodis pv.*citri*	*Citrus limon*	Stores	1
Xanthomonas axonopodis pv.*citri*	*Citrus paradisi* (Fruit)	Baggage	1
Xanthomonas axonopodis pv.*citri*	*Citrus reticulata* (Dried Fruit)	Baggage	1
Xanthomonas axonopodis pv.*citri*	*Citrus reticulata* (Fruit)	Baggage	20
Xanthomonas axonopodis pv.*citri*	*Citrus reticulata* (Fruit)	Stores	2
Xanthomonas axonopodis pv.*citri*	*Citrus sinensis* (Dried Fruit)	Baggage	3
Xanthomonas axonopodis pv.*citri*	*Citrus sinensis* (Dried Fruit)	Cargo	1
Xanthomonas axonopodis pv.*citri*	*Citrus sinensis* (Fruit)	Baggage	6
Xanthomonas axonopodis pv.*citri*	*Citrus sinensis*	Baggage	2
Xanthomonas axonopodis pv.*citri*	*Citrus* sp. (Dried Fruit)	Baggage	6
Xanthomonas axonopodis pv.*citri*	*Citrus* sp. (Dried Fruit)	Mail	2
Xanthomonas axonopodis pv.*citri*	*Citrus* sp. (Fruit)	Baggage	43
Xanthomonas axonopodis pv.*citri*	*Citrus* sp. (Fruit)	Mail	4
Xanthomonas axonopodis pv.*citri*	*Citrus* sp. (Fruit)	Quarters	1
Xanthomonas axonopodis pv.*citri*	*Citrus* sp. (Leaf)	Baggage	25
Xanthomonas axonopodis pv.*citri*	*Citrus* sp.	Baggage	2

Appendix C. Pests Associated with Citrus in Korea

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
ARTHROPODA					
ACARINA					
ERIOPHYIDAE					
Aculops pelekassi (Keifer)	KR, US (FL)	F, L	No	Yes	Anon., 1990, 1998b; Denmark, 1962
TARSONEMIDAE					
Tarsonemus sp.	KR	F	Yes	Yes	PPQ Interception
TETRANYCHIDAE					
Eotetranychus sexmaculatus (Riley)	KR, US	F, L	No	Yes	Anon., 1998b; Baker and Tuttle, 1994
Panonychus citri (McGregor)	KR, US	F, L, S	No	Yes	Anon., 1990; CPC, 2001; Seizo, 1966
Tetranychus cinnabarinus (Boisduval)	KR, US	F, L	No	Yes	Anon., 1990; Jeppson *et al*., 1975
Tetranychus hydrangea Pritchard & Baker	KR, US	F, L, S	No	Yes	Anon., 1998b; Navajas *et al*., 2001
Tetranychus urticae (Koch)	KR, US	F, L, S	No	Yes	Anon., 1994; CPC, 2001; Hill, 1983
Panonychus ulmi (Koch)	KR, US	F, L	No	Yes	CPC, 2001; IIE, 1996
INSECTA					
COLEOPTERA					
ANTHRIBIDAE					
Araecerus fasciculatus DeGeer	KR, US	S	No	No	Anon., 1994; CPC, 2001; Shiraki, 1952
BUPRESTIDAE					
Chalcophora japonica (Gory)	KR	S	Yes	No	Lee *et al*., 1992
Chrysochroa fulgidissima Schonherr	KR	S	Yes	No	Anon., 1990; Shiraki, 1952
CANTHARIDAE					
Athemus suturellus Motschulsky	KR	Fl	Yes	No	Anon., 1990; Shiraki, 1952
CERAMBYCIDAE					
Anoplophora chinensis (Forster)	KR, US (HI)	S	Yes,	No	Duffy,1968 ; CPC, 1998

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Anoplophora malasiaca (Thompson)	KR	S	Yes	No	Anon., 1990; CPC, 2001; Duffy 1968; EPPO, 1996; Seizo, 1966
Apriona germari Hope	KR	S	Yes	No	Anon., 1990; Duffy, 1968
Chlorophorus annularis (F.)	KR	S	Yes	No	Anon., 1990, 1997; Duffy, 1968; Shiraki, 1952
Mesosa myops (Dalman)	KR	S	Yes	No	Anon., 1990; Duffy, 1968
Pterolophia jugosa (Bates)	KR	S	Yes	No	Anon., 1986, 1997; Shiraki, 1952
Pterolophia zonata Bates	KR	S	Yes	No	Anon., 1986, 1997; Shiraki, 1952
CHRYSOMELIDAE					
Aulacophora femoralis (Motschulsky)	KR	L	Yes	No	Anon., 1990; Shiraki, 1952
Aulacophora nigripennis Motschulsky	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Coptocephala flaviventre (Motschulsky)	KR	L	Yes	No	Anon., 1990
Longitarsus sp.	KR	F	Yes	Yes	PPQ Interception
Physauchenia bifasciata Jacoby	KR	L	Yes	No	Anon., 1990
CURCULIONIDAE					
Mesalcidodes trifidus (Pascoe)	KR	R	Yes	No	Anon., 1998b; Anon., 1990; Shiraki, 1952
Scepticus insularis Roelofs	KR	L, R	Yes	No	Anon., 1990, 1997, 1998b; Shiraki, 1952
DERMESTIDAE					
Anthrenus verbasi (L.)	KR, US	Fl, L	No	No	Anon., 1990; Metcalf and Metcalf, 1993
ELATERIDAE					
Agriotes sericeus (Candeze)	KR	R	Yes	No	Anon., 1997; ShirakI,1952
Agriotes sericeus (Candeze)	KR	R	Yes	No	Anon., 1997; ShirakI,1952

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Cardiophorus vulgaris Motschulsky	KR	L, R	Yes	No	Anon., 1997; Anon., 1990; Shiraki, 1952
Ectinus sericeus Candeze	KR	R	Yes	No	Anon., 1990
Melanotus annosus Candeze	KR	R	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Melanotus legatus Candeze	KR	R	Yes	No	Anon., 1990
Paracardiophorus pullatus (Candeze)	KR	R	Yes	No	Anon., 1990
OEDEMERIDAE					
Xanthochroa waterhousei Harold	KR	Fl, L	Yes	No	Anon., 1990; Shiraki, 1952

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
SCARABAEIDAE					
Adoretus sinicus Burmeister	KR	Fl, L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Adoretus tenuimaculatus Waterhouse	KR	Fl, L	Yes	No	Anon., 1990, 1997
Anomala albopilosa Hope	KR	L, R	Yes	No	Anon., 1990, 1997
Anomala cuprea Hope	KR	L, R	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Anomala daimiana Harold	KR	L, R	Yes	No	Lee *et al*., 1992
Anomala orientalis (Waterhouse)	KR, US	L, R	No	No	Anon., 1990; CPC, 2001
Anomala rufocuprea Motschulsky	KR	L, R	Yes	No	Lee *et al*., 1992
Ectinohoplia obducta Motschulsky	KR	L, R	Yes	No	Anon., 1990; Shiraki, 1952
Glycyphana fulvistemma Motschulsky	KR	L, R	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Eucetonia pilifera (Motschulsky)	KR	L, R	Yes	No	Anon., 1990
Maladera orientalis Motschulsky	KR	L, R	Yes	No	Anon., 1997; Shiraki, 1952
Mimela flavilabris Waterhouse	KR	L, R	Yes	No	Anon., 1990
Mimela testaceipes Motschulsky	KR	L, R	Yes	No	Anon., 1990
Miridiva coreana Mijima & Kinoshita	KR	L, R	Yes	No	Anon., 1990
Nipponovalgus angusticollis Waterhouse	KR	L, R	Yes	No	Anon., 1990; Shiraki, 1952
Oxycetonia jucunda Faldermann	KR	L, R	Yes	No	Anon., 1997; Clausen, 1931; Shiraki, 1952
Poecilophilides rusticola (Burmeister)	KR	L,R	Yes	No	Lee *et al*., 1992
Protaetia brevitarsis Lewis	KR	L, R	Yes	No	Anon., 1990; Shiraki, 1952
Protaetia orientalis Gory & Percheron	KR	L, R	Yes	No	Anon., 1990
HETEROPTERA					
ALYDIDAE					

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Megalotomus costalis Stal	KR	L	Yes	No	Anon., 1990, 1998b; Shiraki, 1952
COREIDAE					
Acanthocoris striicomis (Scott)	KR	F	Yes	No	Anon., 1998b
PENTATOMIDAE					
Glaucias subpunctatus Walker	KR	F	Yes	No	Anon., 1998b; Anon., 1990
Halyomorpha halys (Stal)	KR	F	Yes	No	Anon., 1998b; Anon., 1997; Anon., 1990
Homalogonia obtusa (Walker)	KR	L	Yes	No	Lee *et al.*, 1992
Nezara antennata Scott	KR	F	Yes	No	Anon., 1990, 1997, 1998b; PPQ Interception; Shiraki, 1952
Nezara viridula (L.)	KR, US	F	No	No	Anon., 1990; Clausen, 1931; Henry and Froeschner, 1988
Plautia stali Scott	KR	F	Yes	No	Anon., 1990, 1997, 1998b; Shiraki, 1952
HOMOPTERA					
ADELGIDAE					
Adelges viridana (Cholodkovsky)	KR	L	Yes	No	Blackman and Eastop, 1994
ALEYRODIDAE					
Aleurocanthus spiniferus (Quaintance)	KR, US (HI)	L	Yes	No	Anon., 1990, 1997; PNKTO #14, 1982; Shiraki, 1952
Aleurolobus marlatti Quaintance	KR	L	Yes	No	PIN 309, 2001
Dialeurodes citri Ashmead	KR, US	L	No	No	Anon., 1990; CPC, 2001; Syoziro *et al.*, 1965
APHIDIDAE					
Aphis craccivora Koch	KR, US	L	No	No	Anon., 1990; Stoetzel, 1994
Aphis citricola van der Goot	KR, US	L, S	No	No	Anon., 1993; Blackman and Eastop, 1984; Metcalf and Metcalf, 1993

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Aphis gossypii Glover	KR, US	L, S	No	No	Anon., 1990; Blackman and Eastop, 1984
Aphis spiraecola Patch	KR, US	L, S	No	No	Anon., 1990; Stoetzel, 1994
Aulacorthum magnoliae Essi and Kuwana	KR	L	Yes	No	Anon., 1990; Blackman and Eastop 1984; Syoziro *et al.*, 1965
Aulacorthum solani (Kaltenbach)	KR, US	L	No	No	Anon., 1990; Blackman and Eastop, 1984
Macrosiphum euphorbiae (Thomas)	KR, US	L	No	No	Anon., 1994; Blackman and Eastop, 1984; CIE, 1984; Stoetzel, 1994; Syoziro *et al.*, 1965
Macrosiphum ibarae Matsumura	KR	L	Yes	No	Lee *et al.*, 1992
Myzus persicae (Sulzer)	KR, US	L	No	No	Anon., 1990; Stoetzel, 1994
Tinocallis kahawaluckalami (Kirkaldy)	KR, US	L	No	No	Alverson and Allen, 1992; Anon., 1990
Tinocallis zelkowae (Takahashi)	KR	L	Yes	No	Anon., 1990
Toxoptera aurantii (Boyer de Fonscolombe)	KR, US	L, S	No	No	Anon., 1994; CPC, 2001; Stoetzel, 1994
Toxoptera citricidus Kirkaldy	KR, US (FL, PR)	L, S	Yes	No	Anon., 1990, 1997; Blackman and Eastop, 1984; CPC, 2001; Kranz *et al.*, 1977; Stoetzel, 1994
Toxoptera odinae van der Goot	KR	L, S	Yes	No	Anon., 1990, 1997; Blackman and Eastop, 1984
CERCOPIDAE					
Aphrophora intermedia Uhler	KR	L, S	Yes	No	Anon., 1990, 1998b; Shiraki, 1952
CICADIDAE					
Chryptotympana dubia (Haupt)	KR	L	Yes	No	Anon., 1990
Cryptotympana dubia (Haupt)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Graptopsaltria nigrofuscata (Motschulsky)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Meimuna mongolica (Distant)	KR	L	Yes	No	Anon., 1990
Meimuna opalifera (Walker)	KR	L	Yes	No	An, 2000
Platypeura kaempferi (F.)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
CICADELLIDAE					
Bothrogonia japonica Ishihara	KR	L, S	Yes	No	Anon., 1990, 1997, 1998b
Cicadella viridis (L.)	KR	L, S	Yes	No	Anon., 1997, 1998b; Shiraki, 1952
Dictyophara patruelis (Stal)	KR	L, S	Yes	No	Anon., 1998b
Empoasca vitis (Gothe)	KR	L	Yes	No	Anon., 1990, 1997, 1998b; CPC, 2001
Epiacanthus stramineus (Motschulsky)	KR	L	Yes	No	Anon., 1990, 1998b
Hishimonus sellatus Uhler	KR	L	Yes	No	Anon., 1990, 1998b
Kolla atramentaria (Motschulsky)	KR	L, S	Yes	No	Anon., 1990, 1998b; Syoziro *et al.*, 1965
Ledra auditura Walker	KR	L, S	Yes	No	Anon., 1990, 1998b
Nephotettix cinctceps (Uhler)	KR	L	Yes	No	Anon., 1990, 1998b
Recilia dorsalis (Motschulsky)	KR	L	Yes	No	Anon., 1990, 1997, 1998b
Stroggylocephalus agretis (Fallen)	KR	L	Yes	No	Anon., 1990, 1998b
COCCIDAE					
Ceroplastes ceriferus (Fabricius)	KR, US	L, S	No	No	CPC, 2001; An, 2000
Ceroplastes floridensis (Comstock)	KR, US	L, S	No	No	CIE, 1982; CPC, 2001; Shiraki, 1952
Ceroplastes japonicus Green	KR	L, S	Yes	No	Anon., 1990, 1997; CPC, 2001
Ceroplastes pseudoceriferus Green	KR	L, S	Yes	No	Anon., 1990, 1997; Syoziro *et al.*, 1965
Ceroplastes rubens Maskell	KR, US (FL)	L, S	Yes	No	Anon., 1990, 1997; Shiraki, 1952; Syoziro et al., 1965

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Coccus hesperidum L.	KR, US	L, S	No	No	Anon., 1990; Gill, 1988; Hill, 1983; Syoziro *et al.*, 1965
Parasaissetia nigra (Neitner)	KR, US	L	No	No	Anon., 1990
Parthenolecanium corni (Bouche)	KR, US	L	No	No	Ben-Dov, 1993; CPC, 2001
Saissetia coffeae (Signoret)	KR, US	L, S	No	No	Anon., 1990 ;CPC, 2001; Hamon and Williams, 1984; Hill, 1983
Takahashia japonica Cockerell	KR	L, S	Yes	No	Anon., 1990, 1998b
DELPHACIDAE					
Sogatella furcifera (Horvath)	KR	L	Yes	No	Anon., 1990, 1998b; CIE, 1980
DIASPIDIDAE					
Aonidiella citrina Coquillete	KR, US	F, L	No	Yes	Anon., 1990; CPC, 2001; EPPO, 1996; Metcalf and Metcalf, 1993; Nakahara, 1982
Aspidiotus destructor Signoret	KR, US	L	No	No	Anon., 1990; Nakahara, 1982
Chrysomphalus aonidum L.	KR, US	F, L	No	Yes	CPC, 2001; Nakahara, 1982
Chrysomphalus bifasciculatus Ferris	KR, US	F, L	No	Yes	Anon., 1990; Shiraki, 1952; Syoziro *et al.*, 1965
Chrysomphalus dictyospermi (Morgan)	KR, US	F, L	No	Yes	Anon., 1990; Nakahara, 1982
Hemiberlesia lataniae (Signoret)	KR, US	F, L	No	Yes	Anon., 1990; Nakahara, 1982
Lepidosaphes gloveri (Packard)	KR, US	F, L	No	Yes	Anon., 1990; Nakahara, 1982
Lepidosaphes ulmi (L.)	KR, US	F, L	No	Yes	Anon., 1990; Nakahara, 1982
Lopholeucaspis japonica Cockerell	KR, US	F, L	No	Yes	Anon., 1990; CPC, 2001; EPPO, 1996; Nakahara, 1982
Parlatoria pergandii Comstock	KR, US	F, L	No	No	Anon., 1990; Nakahara, 1982; Syorizo *et al.*, 1965

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Parlatoria proteus (Curtis)	KR, US	F, L	No	Yes	Anon., 1990; Nakahara, 1982; Syoziro *et al.*, 1965
Parlatoria theae Cockerell	KR, US	F, L	No	Yes	Anon., 1990; Nakahara, 1982
Parlatoria ziziphi Lucas	KR, US (FL)	F, L	Yes	Yes	Anon., 1998b; Deckle, 1976; PPQ Interception
Pinnaspis aspidistrae Signoret	KR, US	L	No	No	Anon., 1990; Nakahara, 1982; Shiraki, 1952
Pseudaonidia duplex (Cockerell)	KR, US	L	No	No	Anon., 1990; Nakahara, 1982; Shiraki, 1952
Pseudaulacaspis pentagona (Targioni & Tozzetti)	KR, US	L	No	No	Anon., 1990; Nakahara, 1982
Quadraspidiotus perniciosus Comstock	KR, US	L	No	No	Anon., 1990; Metcalf and Metcalf, 1993; Nakahara, 1982
Unaspis euonymi Comstock	KR, US	F, L, S	No	Yes	Anon., 1990; Nakahara, 1982
Unaspis yanonensis Kuwana	KR	F, L, S	Yes	Yes	Anon., 1990, 1997; PPQ Interception; PNKTO #45, 1984
FLATIDAE					
Geisha distinctissima Walker	KR	L, S	Yes	No	Anon., 1990, 1998b
MARGARODIDAE					
Drosicha corpulenta (Kuwana)	KR	F, L, S	Yes	No	Anon., 1997, 1998b; Shiraki, 1952
Drosicha howardi (Kuwana)	KR	L	Yes	No	Anon., 1990; Shiraki, 1952
Icerya purchasi Maskell	KR, US	F, L, S	No	No	Anon., 1990; CPC, 2001; Syoziro *et al.*, 1965
MEENOPLIDAE					
Nisia atrovenosa (Leithierry)	KR	L	Yes	No	Anon., 1990, 1998b
MEMBRACIDAE					
Gargara genistae F.	KR, US	L	No	No	Anon., 1990, 1997, 1998b; Cave and Lightfield, 1994; Shiraki, 1952

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Machaerotypus sibricus (Lethierry)	KR	L	Yes	No	Anon., 1990, 1998b
Orthobelus flavipes Uhler	KR	L, S	Yes	No	Anon., 1990, 1998b; Syoziro *et al.*, 1965
PENTHIMIIDAE					
Penthimia nitida Walker	KR	L	Yes	No	Anon., 1990, 1998b
PSEUDOCCIDAE					
Antonia crawii Cockerell	KR	L	Yes	No	Anon., 1990, 1998b
Nipaecoccus nipae (Maskell)	KR, US	L, S	No	No	Anon., 1994; CPC, 2001
Phenacoccus pergandei Cockerell	KR	L	Yes	No	Lee *et al.*, 1992
Planococcus citri (Risso)	KR, US	L, F, S	No	Yes	Cave and Lightfield, 1994; CPC, 2001
Planococcus kraunhiae Kuwana	KR, US (CA)	L, S, F	Yes	Yes	Anon., 1990, 1997, 1998b; Ben-Dov, 1993; Shiraki, 1952
Pseudococcus sp.	KR	L, F, S	Yes	Yes	Anon., 1997
Pseudococcus comstocki Kuwana	KR, US	L, F, S	No	Yes	Anon., 1990; Shiraki, 1952
RICANIIDAE					
Ricania japonica Melichar	KR	L, S	Yes	No	Anon., 1990, 1997, 1998b
HYMENOPTERA					
FORMICIDAE					
Formica japonica Motschulsky	KR	S	Yes	No	Anon., 1990; Syoziro *et al.*, 1965
VESPIDAE					
Vespa crabro Smith	KR, US	F	No	No	Anon., 1990
Vespa mandarina Smith	KR	F	Yes	No	Anon., 1990
LEPIDOPTERA					
ARCTIIDAE					
Amsacta lactinea (Cramer)	KR	L	Yes	No	Anon., 1990, 1997; Clausen, 1931; CPC, 2001
Hyphantria cunea (Drury)	KR, US	L	Yes	No	Anon., 1990; Nagalingam, 1981

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Utetheisa pulchella L.	KR	L	Yes	No	PPQ Interception
GEOMETRIDAE					
Apochima juglansiaria (Graeser)	KR	L	Yes	No	Anon., 1990
Ascotis selenaria (Denis & Schiffermuller)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Chariaspilates formosaria (Eversmann)	KR	L	Yes	No	Anon., 1997; Anon., 1990l
Ectropis bistortata (Goetze)	KR	L	Yes	No	Anon., 1990
Ectropis excellens (Butler)	KR	L	Yes	No	Anon., 1990
Hemithia aestivaria Hubner	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Ophthalmitis irrorataria Bremer & Grey	KR	L	Yes	No	Anon., 1990; Shiraki, 1952
Pylargosceles steganioides (Butler)	KR	L	Yes	No	Anon., 1990
GRACILARIIDAE					
Phyllocnistis citrella Stainton	KR, US (FL, LA, TX)	L	Yes	No	Anon., 1990, 1997; CPC, 2001; INKTO #65, 1958; Shiraki, 1952
HEPIALIDAE					
Endoclita excrescens Butler	KR	S	Yes	No	Lee *et al.*, 1992
HESPERIIDAE					
Parnara guttata Bremer & Grey	KR	L	Yes	No	Anon., 1990, 1997; CPC, 2001
LASIOCAMPIDAE					
Dendrolimus spectabilis (Butler)	KR	L	Yes	No	Anon., 1990
LIMACODIDAE					
Cnidocampa flavescens Walker	KR, US	L	No	No	Anon., 1990; Shiraki, 1952
Monema flavescens Walker	KR	L	Yes	No	Anon., 1990
Parasa consocia (Walker)	KR	L	Yes	No	Anon., 1990, 1997
Thosea sinensis coreana Okano & Park	KR	L	Yes	No	Anon., 1990, 1997; CPC, 2001
LYMANTRIIDAE					
Euproctis piperita Oberthür	KR	L	Yes	No	Lee *et al.*, 1992

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Euproctis pseudoconspersa (Strand)	KR	L	Yes	No	Anon., 1990
Euproctis pulverea (Leech)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Euproctis similis (Fuessly)	KR	L	Yes	No	Anon., 1994, 1997; CIE, 1978
Latoia consocia (Walker)	KR	L	Yes	No	Lee *et al*., 1992
Latoia sinica (Moore)	KR	L	Yes	No	Lee *et al*., 1992
Lymantria dispar L	KR, US	L	Yes	No	Anon., 1994; Zhang, 1994
NOCTUIDAE					
Acronicta rumicis oriens (Strand)	KR	L	Yes	No	Anon., 1997
Agrotis segetum (Schiffermuller)	KR	L, R, S	Yes	No	Anon., 1994; IIE, 1987; INKTO #25, 1957
Agrypnus binodulus Motschulsky	KR	R	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Agrotis ipsilon (Hufnagel)	KR, US	R, S	No	No	Anon., 1994; Zhang, 1994
Amata germana (Felder & Felder)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Anomis mesogona (Walker)	KR	F	Yes	No	Anon., 1990; Poole, 1989; Zhang, 1994
Apamea aquila Donzel	KR	L	Yes	No	Anon., 1990; Poole, 1989
Arcte coerulea (Guenee)	KR	Fp	Yes	No	Anon., 1990; Poole, 1989; Yoon and Lee 1974
Artena dotata (F.)	KR	Fp	Yes	No	Anon., 1990; Poole, 1989; Yoon and Lee, 1974
Autographa gamma L.	KR	L	Yes	No	Anon., 1997; PNKTO #75, 1986
Calyptera lata (Butler)	KR	Fp	Yes	No	Anon., 1990; Poole, 1989
Calyptera thalictri (Borkhousen)	KR	Fp	Yes	No	Anon., 1990; Poole, 1989
Chrysodeixis eriosoma Doubleday	KR, US (HI)	Fl, L	Yes	No	Anon., 1997

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Dysgonia arctotaenia (Guenee)	KR	Fp	Yes	No	Anon., 1990; Cave and Lightfield, 1994
Dysgonia maturata (Walker)	KR	Fp	Yes	No	Anon., 1990; Poole, 1989
Eudocema fullonia (Clerck)	KR	F	Yes	No	Anon., 1990, 1997; Poole, 1989; Shiraki, 1952
Eudocema tyrrannus Guenee	KR	F	Yes	No	Anon., 1990; Poole, 1989
Eudocima tyrannus amurensis Staudinger	KR	F, Fp	Yes	No	Anon., 1993; Zhang, 1994
Helicoverpa armigera (Hubner)	KR	F, L	Yes	No	Anon., 1994, 1997; Avidov and Harpaz, 1969; CPC, 2001
Helicoverpa assulta assulta Guenee	KR	F, L	Yes	No	Anon., 1997, 2000
Mamestra brassicae L.	KR	L	Yes	No	Anon., 1997
Ophiusa tirhaca Cramer	KR	Fp, L, S	Yes	No	CPC, 2001; Zhang, 1994
Oraesia emarginata (F.)	KR	Fp	Yes	No	Anon., 1990, 1997; CPC, 2001; Poole, 1989; Shiraki, 1952
Oraesia excavata (Butler)	KR	Fp	Yes	No	Anon., 1990, 1997; Clausen, 1931; CPC, 2001; Poole, 1989; Shiraki, 1952
Parallelia maturata (Walker)	KR	L	Yes	No	Anon., 1990, 1997
Parallelia arctotaenia (Guenee)	KR	L	Yes	No	Anon., 1990
Spodoptera exigua (Hubner)	KR, US	L	No	No	Anon., 1994; Kranz *et al*., 1977
Spodoptera litura (F.)	KR	L	Yes	No	Anon., 1990, 1997; CPC, 2001; PNKTO #24, 1982; Poole, 1989; Shiraki, 1952
Thyas juno (Dalman)	KR	Fp, L	Yes	No	Anon., 1990; Clausen, 1931; Poole, 1989; Zhang, 1994
Xestia c-nigrum (L.)	KR, US	L	No	No	Anon., 1990; Poole, 1989
NOTODONTIDAE					
Phalera assimilis Bremer & Grey	KR	L	Yes	No	Lee *et al*., 1992

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
OECOPHORIDAE					
Psorosticha melanocrepida Clarke	KR	L	Yes	No	Anon., 1990, 1997, 1998b; Shiraki, 1952
PAPILIONIDAE					
Papilio bianor Cramer	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Papilio maackii Menetries	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Papilio protenor (Cramer)	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952
Papilio xuthus L.	KR	L	Yes	No	Anon., 1990, 1997; CPC, 2001; Ebeling, 1959
PIERIDAE					
Aporia crataegi L.	KR	L	Yes	No	Anon., 1997; INKTO #149, 1962
PSYCHIDAE					
Bambalina sp.	KR	L	Yes	No	Lee *et al*., 1992
PYRALIDAE					
Cadra cautella (Walker)	KR, US	F, L	No	No	Anon., 1994; Zhang,1994
Conogethes punctiferalis (Guenee)	KR	F	Yes	No	Anon., 1990, 1997, 1998b; INKTO #19, 1957
Glyphodes pyloalis Walker	KR	L	Yes	No	Anon., 1990, 1998b
SATURNIIDAE					
Dictyoploca japonica (Moore)	KR	L	Yes	No	Lee *et al*., 1992
Samia cynthia walkeri C & R Felder	KR	L	Yes	No	Anon., 1990
SESIIDAE					
Synanthedon hector Butler	KR	L	Yes	No	Lee *et al*., 1992
TORTRICIDAE					
Adoxophyes orana Fischer von Roeslerstamm	KR	F, L, Fl, S	Yes	No	Anon., 19998b, 1990, 1997; Shiraki, 1952
Archips breviplicana (Walsingham)	KR	L	Yes	No	Anon., 1990, 1998b, 1997; Shiraki, 1952
Archips crataeganus (Hubner)	KR	L	Yes	No	Anon., 1990, 1998b

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Archips ingentana Christopher	KR	L	Yes	No	Anon., 1990, 1998b, 1997; Shiraki, 1952
Archips xylosteana L.	KR	L	Yes	No	Anon., 1990, 1997, 1998b; Shiraki, 1952
Homona magnanima Diakonoff	KR	L	Yes	No	Anon., 1998b; Anon., 1997; Anon., 1990
ORTHOPTERA					
ACRIDIDAE					
Chondracris rosea (De Geer)	KR	L	Yes	No	Anon., 1994; CPC, 2001
Oxya chinensis formosana Shiraki	KR	L	Yes	No	Anon., 1990, 1997
Oxya japonica Thunberg	KR	L	Yes	No	Anon., 1990, 1997
GRYLLOTALPIDAE					
Gryllotalpa africana Palisot De Beauvois	KR	L	Yes	No	Anon., 1997; CPC, 2001
PYROGOMORPHIDAE					
Atractomorpha bedeli Bolivar	KR	L	Yes	No	Anon., 1990, 1997; Shiraki, 1952; Syoziro *et al*., 1965
TETTIGONIIDAE					
Gampsocleis sedakovi abscura Walker	KR	L	Yes	No	Anon., 1993
Gompsocleis sedakovi obscura (Walker)	KR	L	Yes	No	Anon., 1990, 1998b
Holochlora japonica Brunner von Watten	KR	L	Yes	No	Anon., 1990, 1997, 1998b; Shiraki, 1952
THYSANOPTERA					
PHLAEOTHRIPIDAE					
Haplothrips chinensis Priesner	KR	Fl, L, S	Yes	No	Anon., 1998b; Anon., 1997; Anon., 1990; Shiraki, 1952
THRIPIDAE					
Frankliniella intonsa Brybom	KR	Fl, L	Yes	No	Anon., 1990, 1997; CPC, 2001
Heliothrips haemorrhoidalis Bouche	KR, US	L	No	No	Anon., 1990; Hill, 1983; Syoziro *et al.*, 1965

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Megalurthrips distalis Karny	KR	Fl, L	Yes	No	Anon., 1990, 1997, 1998b
Thrips hawaiiensis (Morgan)	KR, US	L	No	No	Anon., 1994; CPC, 2001
Thrips palmi Karny	KR, US (FL, HI)	F, Fl, L	Yes	Yes	Anon., 1998b; CPC, 2001
Thrips setosus Moultan	KR	Fl, L	Yes	No	Anon., 1998b
BACTERIA					
Rhizobium tumefaciens (Smith & Townsend) Conn (Proteobacteria alpha subdivision: Rhizobiaceae)	KR, US	Wp	No	No	Bradbury, 1986; Cave and Lightfield, 1994
Pseudomonas syringae pv. *syringae* van Hall (Proteobacteria gamma subdivision: Pseudomonas group)	KR, US	F, L, S	No	Yes	Bradbury, 1986; Cave and Lightfield, 1994
Xanthomonas axonopodis pv. *citri* Vauterin *et al.* (Proteobacteria gamma subdivision: Lysobacterales)	KR	F, L, S	Yes	Yes	Anon., 1990, 1997, 1998a; PNKTO #27, 1983; Podleckis, 1997; PIN309, 2001
FUNGI					
Alternaria citri Ellis & N. Pierce in Pierce[3] (Fungi Imperfecti: Hyphomycetes)	KR, US	F	No	Yes	Anon., 1986, 1990, 1993, 1998a; Knorr, 1973; Reuther *et al.*, 1978; Timmer *et al.*, 2000
Antennella citrina Hara (Loculoascomycetes: Dothideales)	KR	L	Yes	No	Anon., 1986
Ascochyta citri Penz. (Fungi Imperfecti: Coelomycetes)	KR	F, L	Yes	Yes	PPQ Interception
Ascochyta pisi Lib. (Fungi Imperfecti: Coelomycetes)	KR, US	F	No	Yes	CMI, 1985; Timmer *et al.*, 2000
Aspergillus niger Tiegh. (Fungi Imperfecti: Hyphomycetes)	KR, US	F	No	Yes	Onions, 1966; Timmer *et al.*, 2000
Botryosphaeria rhodina (Cook) Arx (Loculoascomycetes: Dothideales)	KR, US	F, S	No	Yes	Anon., 1998a; Farr *et al.*, 1989; Santacroce, 1993; Timmer *et al.*, 2000
Botrytis cinerea Pers. *ex* Fr. (Fungi Imperfecti: Hyphomycetes)	KR, US	F	No	Yes	Anon., 1998a; Bai, 1977; Timmer *et al.*, 2000
Capnodium tanakae Shirai & Hara (Loculoascomycetes: Dothideales)	KR	F, L, S	Yes	No	Anon., 1986, 1990
Capnophaeum fuliginodes (Rehm) Yamamoto (Loculoascomycetes: Dothideales)	KR	F	No	No	Anon., 1986; Cave and Lightfield, 1994

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Chaetothyrium spinigerum (Hohnel) Yamamoto (Loculoascomycetes: Dothideales)	KR	L	Yes	No	Anon., 1986, 1990
Cladosporium sp. (Fungi Imperfecti: Hyphomycetes)	KR	F	Yes	Yes	PPQ Interception
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. in Penz. (Fungi Imperfecti: Coelomycetes)	KR, US	F	No	Yes	Anon., 1986, 1990, 1998a; Knorr, 1973; Timmer *et al*., 2000
Corticium rolfsii Curzi (Basidiomycetes: Corticiaceae)	KR, US	F	No	Yes	CMI, 1992; CMI, 1974
Diaporthe citri F. A. Wolf (Pyrenomycetes: Diaporthales)	KR, US	F	No	Yes	Anon., 1986, 1990, 1998a; Timmer *et al*., 2000
Elsinoë australis Bit. & Jenkins (Loculoascomycetes: Dothideales)	KR	F	Yes	Yes	PPQ Interception
Elsinoë fawcetti Bit. & Jenkins (Loculoascomycetes: Dothideales)	KR, US	F	No	Yes	Anon., 1986, 1990, 1998a; CMI, 1986; Timmer *et al*., 2000
Elsinoë sp. (Loculoascomycetes: Dothideales)	KR	F	Yes	Yes	PPQ Interception
*Geotrichum citri-aurantii (*Feiraris) E. E. Butler (Fungi Imperfecti: Hyphomycetes)	KR, US	F	No	Yes	Anon., 1998a; Farr *et al*., 1989
Guignardia citricarpa Kiely Anamorph: *Phoma citricarpa* McAlpine (Fungi Imperfecti: Coelomycetes)	KR[4]	F	Yes	Yes	CMI, 1990; CPC, 2001; PPQ Interception; Sutton and Waterston, 1966
Guignardia sp.[4] Anamorph: *Phoma citricarpa* McAlpine var. *mikan* Hara (Fungi Imperfecti: Coelomycetes)	KR, US	F	No	Yes	Anon., 1990; CMI, 1990; CPC, 2001; PPQ Interception
Helicobasidium mompa Tanaka (Basidiomycetes: Ceratobasidiaceae)	KR	R, S	Yes	No	Anon., 1986; Knorr, 1973
Macrophomina phaseolina (Tassi) Goidanich (Fungi Imperfecti: Coelomycetes)	KR, US	R	No	No	CPC, 2001; Farr *et al*., 1989; Knorr, 1973
Microsphaeropsis sp. (Fungi Imperfecti: Coelomycetes)	KR	F	Yes	Yes	PPQ Interception
Limacinia japonica Hara (Loculoascomycetes: Dothideales)	KR	F	Yes	No	Anon., 1990; Anon., 1986
Penicillium digitatum Sacc. (Fungi Imperfecti: Hyphomycetes)	KR ,US	F	No	Yes	Anon., 1998a
Penicillium italicum Wehmer (Fungi Imperfecti: Hyphomycetes)	KR, US	F	No	Yes	Anon., 1998a; Bai, 1977; Hong *et al*., 1991; Timmer *et al*., 2000
Phaeopeltis japonica Yamamoto (Loculoascomycetes: Dothideales)	KR	F	Yes	No	Anon., 1986, 1990
Phyllosticta beltranii Penzig (Fungi Imperfecti: Coelomycetes)	KR	L	Yes	No	Anon., 1986, 1990, 1998a; Knorr, 1973

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Phyllosticta erratica Ellis & Everh. (Fungi Imperfecti: Coelomycetes)	KR, US	L	No	No	Anon., 1998a; Farr *et al*., 1989
Phytophthora citrophthora (R.E. Sm. & E.H. Sm.) Leonian (Oomycetes: Pythiaceae)	KR, US	F	No	Yes	Anon., 1986, 1990, 1998a; Timmer *et al*., 2000
Phytophthora nicotianae Breda de Haan var. *parasitica* Dastur (G.M.Waterhouse) (Oomycetes: Pythiaceae)	KR, US	F	No	Yes	Anon., 1998a; Timmer *et al*., 2000
Rosellinia necatrix Prill. (Ascomycetes: Xylariaceae)	KR, US	R	No	No	CMI, 1987; Farr *et al*., 1989
Sclerotinia sclerotiorum (Lib.) deBary (Ascomycetes: Sclerotiniaceae)	KR, US	F	No	Yes	Bai, 1977; Reuther *et al*., 1978; Timmer *et al*., 2000
NEMATODA					
CRICONEMATIDAE					
Criconemoides informis (Micoltzdy)	KR	R	Yes	No	Anon., 1990; Anon., 1984
Hemicriconemoides mangiferae Siddiqi	KR, US	R	No	No	Anon., 1984; CPC, 2001
LONGIDORIDAE					
Xiphinema americanum Cobb	KR, US	R	No	No	Anon., 1984; CPC, 2001
Xiphinema insigne Loos (Longidoridae)	KR	R	Yes	No	CPC, 2001
PRATYLENCHIDAE					
Pratylenchus penetrans (Cobb) Filipjev & Schuurmans Stekhoven	KR, US	R	No	No	Anon., 1984; CPC, 2001
TRICHORDORIDAE					
Paratrichodorus porosus (Allen) Siddiqi	KR, US	R	No	No	Anon., 1984; CPC, 2001
TYLENCHIDAE					
Tylenchulus semipenetrans Cobb	KR, US	R	No	No	Anon., 1990; Anon., 1984
MOLLUSCA					
BRADYBAENIDAE					
Acusta despecta (Grey)	KR	Wp	Yes	No[5]	An, 2000
VIRUSES					
Citrus tatter leaf virus (Capillovirus)	KR, US (CA, FL)	Wp	No	No	Brunt *et al*., 1995; Cave and Lightfield, 1994; CPC, 2001;
Citrus tristeza virus (Closteroviridae: Closterovirus)	KR, US	Wp	No	No	Anon., 1990; Brunt *et al*., 1995; CPC, 2001

Pests Associated with *Citrus* in Korea					
Pest	Distribution[1]	Plant part affected[2]	Quarantine Pest	Follow Pathway	References
Satsuma dwarf virus (Bromoviridae: Nepovirus)	KR	Wp	Yes	No	Anon., 1990; CPC, 2001

[1]KR = Korea; US = the United States; AZ = Arizona; CA = California; FL = Florida; HI = Hawaii; PR = Puerto Rico; LA = Louisiana; TX = Texas.

[2]F = fruits; Fl = flower; Fp = fruit-piercing insects; L = leaf; R = root; S = stem or trunk; Wp = whole plant.

[3] *Alternaria* spp. cause four distinct diseases of citrus: Alternaria brown spot of mandarins, Alternaria leaf spot of rough lemon, postharvest black rot of fruit, and mancha foliar de los citricos. The taxonomy of this group of organisms is in a state of flux. The causal agent of Alternaria brown spot of mandarins, leaf spot of rough lemon and postharvest rot was described originally as *A. citri* Ell. & Pierce. More recently, the pathogen that affects mandarins was designated *A. alternata* Fr. (Keissler) pv. *citri* Solel. Recently, 10 new species were described among isolates pathogenic to mandarins and rough lemons. Timmer *et al.*, 2000.

[4]A brief discussion of synonymy / taxonomy for *Guignardia* is at Risk Assessment section E.

[5]Snails of this size are not likely to follow the pathway because packing house procedures such as hand-packing, brushing with rollers, and handling during the SOPP procedure are highly likely to remove snails (Robinson, 2002).

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Guidelines for Pathway-Initiated Pest Risk Assessments

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Introduction

This document presents guidelines for pathway-initiated, qualitative pest risk assessments conducted by Plant Protection and Quarantine (PPQ) within the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture. The goal is to harmonize PPQ risk assessment procedures with guidelines provided by the Food and Agriculture Organization (FAO) and the North American Plant Protection Organization (NAPPO). The use of biological and phytosanitary terms conforms with the FAO Glossary of Phytosanitary Terms (FAO, 1999) (included as Appendix 1 of this document), the Definitions and Abbreviations (Introduction Section) in International Standards for Phytosanitary Measures, Section 1 Import Regulations: Guidelines for Pest Risk Analysis (FAO 1996) and the NAPPO Compendium of Phytosanitary Terms (NAPPO 1996).

Pest risk assessment is one of three stages of an overall pest risk analysis (FAO, 1996):

Stage 1: Initiating the process for analyzing pest risk (identifying pests or pathways for which the pest risk analysis is needed)
Stage 2: Assessing pest risk (determining which pests are quarantine pests, characterized in terms of likelihood of entry, establishment, spread, and economic importance)
Stage 3: Managing pest risk (developing, evaluating, comparing and selecting options for dealing with the risk)

This document provides a template for conducting FAO Stages 1 and 2. The FAO process (1996) also describes two general categories of initiating events for pest risk analyses. A pest risk analysis can be either pest initiated (a quarantine pest is discovered in a new area, a pest is intercepted at a port of entry, *etc*.) or pathway initiated (international trade is initiated in a new commodity, *etc*.). This document describes procedures used by PPQ for pathway-initiated pest risk assessments.

PPQ conducts pathway-initiated pest risk assessments at both qualitative and quantitative levels. This document outlines the process for qualitative pest risk assessments. Both types of assessments are similar in most respects, however, in quantitative assessments quarantine pests are examined in greater detail and provide a quantitative assessment of the likelihood of introduction (see Step 6). PPQ completes six basic steps in pathway-initiated pest risk assessments:

Stage 1 (FAO): Initiating Pest Risk Analysis Process
Step 1. Document the initiating event(s) for the PRA.

Stage 2 (FAO): Assessing Pest Risk
Step 2. Assess Weediness Potential (of the species to be imported).

Step 3. Identify Previous Risk Assessments, Current Status of Importations, and Pertinent Pest Interceptions.

Step 4a. Pest Categorization. Produce a list of pests of the commodity parent species and then determine their quarantine status.

Step 4b. Identify Potential Quarantine Pests. Identify pests of potential quarantine significance reported to be associated with the host species in the exporting country/region.

Step 4c. Identify Quarantine Pests Likely to Follow the Pathway. Determine which quarantine pests may reasonably be expected to follow the pathway.

Step 5. Assess Consequences of Introduction. For each quarantine pest expected to follow the pathway, estimate the consequences of introduction. Issues to consider include ...the establishment, spread and economic importance potential in the PRA area (FAO, 1996). Environmental impacts are also addressed.

Step 6. Assess Introduction Potential. For each quarantine pest expected to follow the pathway, estimate the likelihood of introduction via the pathway.

Step 7. Conclusion/Phytosanitary Measures: Pest Risk Potential of Quarantine Pests. Produce a single rating which represents an overall estimate of the risk posed by each quarantine pest. Comment briefly on the meaning of the Pest Risk Potentials for each quarantine pest. Although this document focuses on risk assessment, the risk assessment (FAO Stages 1 and 2) and risk management (FAO Stage 3) stages are interrelated. Accordingly, the risk assessor may occasionally make brief comments regarding risk management options associated with the requested commodity importations.

Methods: Pest Risk Assessment Guidelines

FAO Stage 1: Initiating Pest Risk Analysis (PRA) Process

Step 1. Document the Initiating Event(s) for the PRA

Document the reason(s) for initiating the pathway-initiated PRA, *e.g.,* importation of a new commodity or new importation from a new area provides a potential pathway for the introduction of plant pests.

Stage 2 (FAO): Assessing Pest Risk

Step 2. Assess Weediness Potential (Table 1)

Assess the weediness potential of the imported species. This step is important to the initiation process because if the assessment finds that the species being considered for import poses a risk as a weed pest, then a pest-initiated pest risk assessment may be initiated. If the species to be imported passes the weediness screening, the pathway-initiated pest risk assessment continues. Table 1 shows how weediness potential is assessed and can be used to present findings and conclusions.

Table 1. Process for Determining Weediness Potential of Commodity

Commodity: (Scientific and common names of commodity)
Phase 1: Consider whether the species is new to or not widely prevalent in the United States (exclude plants grown under USDA permit in approved containment facilities)?

Phase 2: Answer Yes or No to the following questions:
Is the genus, species, or subspecies listed in:

____ Geographical Atlas of World Weeds (Holm *et al.*, 1979)
____ World's Worst Weeds (Holm *et al.*, 1977)
____ World Weeds: Natural Histories and Distribution (Holm *et al.*, 1997)
____ Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982)
____ Economically Important Foreign Weeds (Reed, 1977)
____ Weed Science Society of America list (WSSA, 1989)
____ Is there other literature reference indicating weediness (*e.g.*, AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "species name" combined with "weed").

Phase 3: Conclusion:
IF: 1. The species is widely prevalent in the United States and the answers to all of the questions are **no**...
Proceed with the pest risk assessment.

2. The species is widely prevalent in the United States and the answer to **one** or more of the questions is **yes**...
Proceed with the pest risk assessment, provide comments on findings in text, and incorporate findings regarding weediness into the Risk Elements described below.

3. The species is new to or not widely prevalent in the United States and the answers to all of the questions are **no**...
Proceed with the pest risk assessment.

4. The species is new to or not widely prevalent in the United States and the answer to **one or more** of the questions is **yes**...

Consult authority under the Federal Noxious Weed Act for listing plant species as a noxious weed and consider the advisability of performing a pest-initiated pest risk assessment on the plant species. Provide explanations of findings in text.

Step 3. Identify and Cite Previous Risk Assessments
Identify previous pest risk assessments from the same country/region and the same, or related commodity. If there is an existing risk assessment that adequately assesses the risks in question, the risk assessment stops. Describe appropriate current importations, *e.g.*, same commodity from other countries, other commodities from the country in question. Report pertinent pest interceptions at United States ports of entry.

Step 4a. Pest Categorization (Table 2)
PPQ adheres to accepted international definitions of quarantine pest: a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 1996; NAPPO, 1996). The first step in

identifying quarantine pests is to present a comprehensive pest list of potential quarantine pests known to occur in the country or region from which the commodity is to be exported (Table 2). The list includes all pests in the exporting country known to be associated with the parent species of the proposed export commodity. Because all pests on the list are associated with the plant species they are considered to be of potential economic importance (FAO, 1996). The listed pests may or may not also occur in the United States.

There are two primary components to the definition of quarantine pest (FAO, 1996; NAPPO, 1996). First, a pest must be of potential economic importance. To be included on the comprehensive list of potential quarantine pests, an organism is considered to be of potential economic importance because scientific evidence, as indicated in the literature, demonstrates that an organism has an association with the plant species being assessed. Thus, all of the listed organisms are potential quarantine pests. Second, to be considered a quarantine pest, an organism must satisfy geographic and regulatory criteria, specifically, the pest must be not yet present there, or present but not widely distributed and being officially controlled (FAO, 1996; NAPPO, 1996). Information should be collected and provided in the risk assessment which documents how each organism satisfies these criteria. Pertinent geographic and regulatory information, *i.e.*, with respect to the exporting country and the United States, should be provided on the comprehensive pest list. If none of the potential quarantine pests satisfy the geographic and regulatory criteria as a quarantine pest, the PRA stops. For each pest on the list, include:

- scientific name (when available)
- selected references
- limited pertinent information regarding:
  - the regulatory status of a pest, as determined by APHIS or other Federal Agencies
  - pest biology, *e.g.*, pest-parent species or pest-commodity association, pathway association, life history, climatic tolerance
  - geographic distribution with respect to the exporting country and the U.S.
  - regulatory history, *e.g.,* interception records at U.S. ports.

The list of information sources, at a minimum, should include:

- Literature reviews using electronic databases, *e.g.*, AGRICOLA, CAB database, University of California computer information system, MELVYL
- Previous risk assessments covering importation of the commodity
- The PPQ catalogue of intercepted pests and interception records
- CIE and CMI. Distribution Maps/Descriptions of Plant Pests (Arthropods, Fungi, Bacteria)
- Various texts and indices of plant diseases and pathogens
- PPQ files on Pests Not Known To Occur in the U. S. (PNKTOs) and Insects Not Known To Occur (INKTOs)
- International databases, *e.g.* EPPO*,* FAO, CABI/CPC

Step 4b. Identify Quarantine Pests Likely to Follow the Pathway

Quarantine pests identified as likely to be associated with the potential export commodity are subjected to steps 5-7. The biology and pest potential for these pests is documented as completely as possible. It must be reasonable to assume these quarantine pest will:

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

Because pests associated with the parent species are listed, there will be quarantine pests not expected to follow the pathway. For example:

- a pest may be associated only with plant parts other than the commodity
- a pest may not reasonably be expected to remain with the commodity during harvest and packing

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

IF NO POTENTIAL QUARANTINE PESTS ARE IDENTIFIED, THE PRA STOPS AT THIS POINT.

Table 2. Pests Associated With Commodity in Country					
Pest	Geographic Distribution[1]	Plant Part Affected[2]	Quarantine Pest[3]	Follow Pathway[3]	References
Arthropods					
Pest species Author (Order: Family)					
Viruses					
name (Family)					
Bacteria					
Pest species Author (Order)					
Fungi					
Pest species Author (Class or Superclass: Order)					
Nematodes					
Pest species Author (Family)					
Mollusks					
Pest species Author (Family)					

[1]Use two letter abbreviations to represent countries and states
[2]Use abbreviations, *e.g.*, L (leaf), F (fruit), to indicate affected plant parts
[3]Use Yes or No
*Additional explanatory notes for Table entries may be placed here

IF NO QUARANTINE PESTS ARE EXPECTED TO FOLLOW THE PATHWAY, THE PRA STOPS.

Step 5. Assess Consequences of Introduction (Table 3)
The undesirable outcomes being considered are the negative impacts resulting from the introduction of quarantine pests. After identifying those quarantine pests that could reasonably be expected to follow the pathway, the assessment of risk continues by considering the consequences of introduction (Table 3). For each of these quarantine pests, the potential consequences of introduction are rated using five Risk Elements. These elements reflect the biologies, host ranges and climatic/geographic distributions of the pests. For each Risk Element, pests are assigned a rating of or or Low (L, 1 point), Medium (M, 2 points) or High (H, 3 points).
A Cumulative Risk Rating is then calculated by summing all Risk Element values.

Risk Element #1: Climate Host Interaction
When introduced to new areas, pests can be expected to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of the pests and their biotic and abiotic environments are considered in the element. Estimates are based on availability of both host material and suitable climate conditions. To rate this Risk Element, the U.S. "Plant Hardiness Zones" U.S. Department of Agriculture (USDA, 1990) is used (Figure 1). Due to the availability of both suitable host plants and suitable climate, the pest has potential to establish a breeding colony:

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

IF NONE OF THE QUARANTINE PESTS ARE CAPABLE OF BECOMING ESTABLISHED IN THE PRA AREA BECAUSE OF THE ABSENCE OF SUITABLE CLIMATES OR HOSTS, THE PRA STOPS.

Risk Element #2: Host Range
The risk posed by a plant pest depends on both its ability to establish a viable, reproductive
population and its potential for causing plant damage. For arthropods, risk is assumed to be correlated positively with host range. For pathogens, risk is more complex and is assumed to depend on host range, aggressiveness, virulence and pathogenicity; for simplicity, risk is rated as a function of host range.

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

Risk Element #3: Dispersal Potential
A pest may disperse after introduction to a new area. The following items are considered:

reproductive patterns of the pest (*e.g.*, voltinism, biotic potential)
inherent powers of movement
factors facilitating dispersal (wind, water, presence of vectors, human, *etc.*)

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

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

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

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

Risk Element #5: Environmental Impact (Table 4)
The assessment of the potential of each pest to cause environmental damage (Table 4) (FAO, 1995) proceeds by considering the following factors:

Introduction of the pest is expected to cause significant, direct environmental impacts, *e.g.*, ecological disruptions, reduced biodiversity. When used within the context of the National Environmental Policy Act (NEPA) (7CFR §372), significance is qualitative and encompasses both the likelihood and severity of an environmental impact.
Pest is expected to have direct impacts on species listed by Federal Agencies as endangered or threatened (50CFR §17.11 and §17.12), by infesting/infecting a listed plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host.
Pest is expected to have indirect impacts on species listed by Federal Agencies as endangered or threatened by disrupting sensitive, critical habitat.
Introduction of the pest would stimulate chemical or biological control programs.

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

For each pest, sum the five Risk Elements to produce a Cumulative Risk Rating. This Cumulative Risk Rating is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts. The Cumulative Risk Rating should be interpreted as follows:

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

Table 3. Risk Rating for Consequences of Introduction: (Risk Elements #1-5)						
Pest	Risk Element 1 Climate/Host Interaction	Risk Element 2 Host Range	Risk Element 3 Dispersal Potential	Risk Element 4 Economic Impact	Risk Element 5 Environmental Impact	Cumulative Risk Rating
Pest species (Order: Family)	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	(1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (5 - 15)

Step 6. Assess Introduction Potential (Table 4)
Use Risk Element 6 to rate the potential likelihood of introduction for quarantine pests likely to follow the pathway. The cumulative score for the Likelihood of Introduction Risk Elements is referred to as the Likelihood of Introduction Risk Score.

Risk Element #6: Pest Opportunity (Survival and Access to Suitable Habitat and Hosts)

For each pest, consider six sub-elements:

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

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

2. **Survive postharvest treatment**: For this sub-element, postharvest treatment refers to any manipulation, handling or specific phytosanitary treatment to which the commodity is subjected. Examples of postharvest treatments include culling, washing, chemical treatment, cold storage, etc. If there is no postharvest treatment, estimate the likelihood of this sub-element as High.

3. **Survive shipment:** Estimate survival during shipment; assume standard shipping conditions.

4. **Not be detected at the port of entry**: Unless specific protocols are in place for special inspection of the commodity in question, assume standard inspection protocols for like commodities. If no inspection is planned, estimate this sub-element as high.

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

6. **Come into contact with host material suitable for reproduction:** Even if the final destination of infested commodities are suitable for pest survival, suitable hosts must be available in order for the pest to survive. Consider the complete host range of the pest species.

Rate sub-elements 2-6 as follows:

Low (1 point): < 0.1% (less than one in one thousand)
Medium (2 points): Between 0.1% - 10% (between one in one thousand to one in ten)
High (3 points): > 10% (greater than one in ten)

The events described in sub-elements 2 - 6 should be considered as a series of independent events that must all take place before a pest outbreak can occur, *i.e.*, the estimates for one element should not affect estimates for other elements.

For each pest, sum the six sub-elements to produce a Cumulative Risk Rating for the Likelihood of Introduction (Table 4). This Cumulative Risk Rating is considered to be an indicator of the likelihood that a particular pest would be introduced. Interpret the Cumulative Risk Rating for the Likelihood of Introduction as follows:

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

Table 4. Risk Rating for Likelihood of Introduction: (Risk Element #6)							
Pest	Subelement 1 Quantity imported annually	Subelement 2 Survive postharvest treatment	Subelement 3 Survive shipment	Subelement 4 Not detected at port of entry	Subelement 5 Moved to suitable habitat	Subelement 6 Contact with host material	Cumulative Risk Rating
Pest species	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (1, 2, 3)	L, M, H (6 - 18)

Step 7. Conclusion/Pest Risk Potential: Pests Requiring Phytosanitary Measures (Table 5)
To estimate the Pest Risk Potential for each pest, sum the Cumulative Risk Rating for the Consequences of Introduction and the Cumulative Risk Rating for the Likelihood of Introduction (Table 5). Rate the Pest Risk Potential as follows:

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

Table 5. Pest Risk Potential			
Pest	Consequences of Introduction Cumulative Risk Rating	Likelihood of Introduction Cumulative Risk Rating	Pest Risk Potential
Pest species	L, M, H (5 - 15)	L, M, H (6 - 18)	L, M, H (11 - 33)

Following assignment of the Pest Risk Potential for each pest, the risk assessor may comment briefly on risk management options associated with the requested commodity importations. The following guidelines are offered as an interpretation of the Low, Medium and High Pest Risk Potential ratings:

Low: Pest will typically not require specific mitigations measures; the port-of-entry inspection to which all imported commodities are subjected can be expected to provide sufficient phytosanitary security.
Medium: Specific phytosanitary measure may be necessary.
High: Specific phytosanitary measures are strongly recommended. Port-of-entry inspection is not considered sufficient to provide phytosanitary security.

Identification and selection of appropriate sanitary and phytosanitary measures to mitigate risk for pests with particular Pest Risk Potential ratings is undertaken as part of the risk management phase and is not discussed in this document. The appropriate risk management strategy for a particular pest depends on the risk posed by that pest. APHIS risk management programs are risk based and dependent on the availability of appropriate mitigation methods and are Details of APHIS risk management programs are published, primarily, in the *Federal Register* as quarantine notices.

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Acknowledgments

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APPENDIX 1

GLOSSARY OF PHYTOSANITARY TERMS AND DEFINITIONS
Note: This version of the Glossary is still under consultation/comment by the various National Plant Protection Organizations and Regional Plant Protection Organizations.

Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information pertinent to the phytosanitary condition of a consignment [FAO, 1990]
Antagonist*	An organism (usually pathogen) which does no significant damage to the host but its colonization of the host protects the host from significant subsequent damage by a pest [ISPM Pub. No. 3, 19961
Area	An officially defined country, part of a country or all or parts of several countries [FAO, 1990; revised FAO, 1995; CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Area endangered	See Endangered area
Area of low pest prevalence*	An area, whether all of a country, part of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures [IPPC, 1997]
Authority*	The National Plant Protection Organization, or other entity or person officially designated by the government to deal with matters arising from the responsibilities set forth in the Code [ISPM Pub. No. 3, 1996]
Biological control agent*	A natural enemy, antagonist or competitor, and other self-replicating biotic entity used for pest control [ISPM Pub. No. 3, 1996]
Biological control (Biocontrol)*	Pest control strategy making use of living natural enemies, antagonists or competitors and other selfreplicating biotic entities [ISPM Pub. No.3, 1996]

**Indicates terms with specific use*

Biological pesticide* (Biopesticide)	A generic term, not specifically definable, but generally applied to a biological control agent, usually a pathogen, formulated and applied in a manner similar to a chemical pesticide, and normally used for the rapid reduction of a pest population for short-term pest control [ISPM Pub. No. 3, 1996]
Buffer zone*	An area in which a specific pest does not occur or occurs at a low level and is officially controlled, that either encloses or is adjacent to an infested area, an infested place of production, a pest free area, a pest free place of production or a pest free production site, and in which phytosanitary measures are taken to prevent spread of the pest [ISPM Pub. No. 10, 1999]
Bulbs and tubers	Dormant underground organs of plants intended for planting [FAO, 1990]
Certificate	An official document which attests to the phytosanitary status of any consignment affected by phytosanitary regulations [FAO, 1990]
Classical biological control*	The intentional introduction and permanent establishment of an exotic biological agent for longterm pest control [ISPM Pub. No.3, 1996]
Clearance (of a consignment)	Verification of compliance with phytosanitary regulations [FAO, 1995]
Commission*	The Commission on Phytosanitary Measures established under Article XI, [IPPC, 1997] Commodity A type of plant, plant product or other regulated article being moved for trade or other purpose [FAO, 1990]
Commodity class	A category of similar commodities that can be considered together in phytosanitary regulations [FAO, 1990]
Commodity pest list	A list of pests occurring in an area which may be associated with a specific commodity [CEPM, 1996]
Competitor*	An organism which competes with pests for essential elements (e.g. food, shelter) in the environment [ISPM Pub. No. 3, 1996]
Compliance procedure (for a consignment)	Official procedure used to verify that a consignment complies with stated phytosanitary requirements [CEPM, 1999]

Consignment	A quantity of plants, plant products and/or other regulated articles being moved from one country to another and covered by a single phytosanitary certificate (a consignment may be composed of one or more lots) [FAO, 1990]
Consignment in transit	Consignment which passes through a country without being imported, and without being exposed in that country to contamination or infestation by pests. The consignment may not be split up, combined with other consignments or have its packaging changed [FAO, 1990; revised CEPM, 1996; CEPM 1999; formerly country of transit]
Containment	Application of phytosanitary measures in and around an infested area to prevent spread of a pest [FAO, 1995]
Contaminating pest	A pest that is carried by a commodity and, in the case of plants and plant products, does not infest those plants or plant products [CEPM, 1996; revised CEPM, 1999]
Contamination	Presence in a commodity, storage place, conveyance or container, of pests or other regulated articles, not constituting an infestation (See Infestation) [CEPM, 1997; revised CEPM, 1999]
Control (of a pest)	Suppression, containment or eradication of a pest population [FAO, 1995]
Controlled area	A regulated area which an NPPO has determined to be the minimum area necessary to prevent spread of a pest from a quarantine area [CEPM, 1996]
Country of origin (of a consignment plant products)	Country where the plants from which the plant products are derived were grown [FAO, 1990; revised CEPM, 1996; CEPM, 1999]
Country of origin (of a consignment of plants)	Country where the plants were grown [FAO, 1990; revised CEPM, 1996; CEPM, 1999]
Country of origin (of regulated articles other than plants and plant products)	Country where the regulated articles were first exposed to contamination by pests [FAO, 1990; revised CEPM, 1996; CEPM, 1999]
Country of re-export*	Country into which a consignment of plants, plant products, or other regulated articles has been imported and was stored, split up, had its packaging changed or was otherwise exposed to contamination by pests, prior to export to a third country [ISPM Pub. No. 7, 1998]

Cut flowers and branches	Fresh parts of plants intended for decorative use and not for planting [FAO, 1990]
Debarking	Removal of bark from round wood (debarking does not necessarily make the wood bark-free) [FAO, 1990]
Delimiting survey	Survey conducted to establish the boundaries of an area considered to be infested by or free from a pest [FAO, 1990]
Detection survey	Survey conducted in an area to determine if pests are present [FAO, 1990, revised FAO, 1995]
Detention	Keeping a consignment in official custody or confinement for phytosanitary reasons (See Quarantine) [FAO, 1990; revised FAO, 1995; CEPM, 1999]
Dunnage	Wood used to wedge or support cargo [FAO, 1990]
Ecoarea*	An area with similar fauna, flora an climate and hence similar concerns about the introduction of biological control agents [ISPM Pub. No. 3, 1996]
Ecosystem*	A complex of organisms and their environment, interacting as a defined ecological unit (natural or modified by human activity, e.g. agroecosystem), irrespective of political boundaries [ISPM Pub. No. 3, 1996]
Endangered area	An area where ecological factors favor the establishment of a pest whose presence in the area will result in economically important loss [FAO, 1995]
Entry (of a consignment)	Movement through a point of entry into an area [FAO, 1995]
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled [FAO, 1995]
Equivalence	The situation of phytosanitary measures which are not identical but have the same effect [FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Eradication	Application of phytosanitary measures to eliminate a pest from as area [FAO, 1990; revised FAO, 1995; formerly Eradicate]

Establishment	Perpetuation, for the foreseeable future, of a pest within an area after entry [FAO, 1990; revised FAO, 1995; IPPC, 1997; formerly Established]
Establishment (of a biological control agent)*	The perpetuation, for the foreseeable future, of a biological control agent within an area after entry [ISPM Pub. No. 3, 1996]

Exotic*	Not native to a particular country, ecosystem or ecoarea (applied to organisms intentionally or accidently introduced as a result of human activities). As this Code is directed at the introduction of biological control agents from one country to another, the term exotic is used for organisms not native to a country [ISPM Pub. No. 3, 1996]
Field	A plot of land with defined boundaries within a place of production which a commodity is grown [FAO, 1990]
Find free	To inspect a consignment, field or place of production and consider it to be free from a specific pest [FAO, 1990]
Free from (of a consignment, field or place of production)	Without pests (or a specific pest) in numbers or quantities that can be detected by the application of phytosanitary procedures [FAO, 1990; revised FAO, 1995; CEPM, 1999]
Fresh	Living; not dried, deep-frozen or otherwise conserved [FAO, 1990]
Fruits and vegetables	Fresh parts of plants intended for consumption or processing [FAO, 1990]
Fumigation	Treatment with a chemical agent that reaches the commodity wholly or primarily in a gaseous state [FAO, 1990; revised FAO, 1995]
Germplasm	Plants intended for use in breeding or conservation programs [FAO, 1990]
Grain	Seeds intended for processing or consumption and not for planting (See Seeds) [FAO, 1990]
Growing medium	Any material in which plans roofs are growing or intended for that purpose [FAO, 1990]
Growing season	Period of the year when plants will actively grow in an area [FAO, 1990]
Harmonization	The establishment, recognition and application by different countries of phytosanitary measures based on common standards [FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Harmonized phytosanitary measures*	Phytosanitary measures established by contracting

	parties to the IPPC, based on international standards [IPPC, 1997]
Hitch-hiker pest	See Contaminating pest
Host pest list	A list of pests that infest a plant species, globally or in an area [CEPM, 1996; revised CEPM, 1999]
Host range	Species of plants capable, under natural conditions, of sustaining a specific pest [FAO, 1990]
Import permit	Official document authorizing importation of a commodity in accordance with specified phytosanitary requirements [FAO, 1990; revised FAO, 1995]+
Import permit (of a biological control agent)*	An official document authorizing importation (of a biological control agent) in accordance with specified requirements [ISPM Pub. No. 3, 1996]
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection [CEPM, 1997; revised CEPM, 1999]
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations [FAO, 1990; revised FAO, 1995; formerly Inspect]

Inspector	Person authorized by a National Plant Protection Organization to discharge its functions [FAO, 1990] Interception (of a consignment) The refusal or controlled entry of an imported consignment due to failure to comply with phytosanitary regulations [FAO, 1990; revised FAO, 1995]
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment [FAO, 1990; revised CEPM, 1996]
Intermediate quarantine	Quarantine in a country other then the country of origin or destination [CEPM, 1996]
International Plant Protection Convention	International Plant Protection Convention as deposited with FAO in Rome in 1951 and as subsequently amended [FAO, 1990]
International Standard for Phytosanitary	An international standard adopted by the Conference Measures of FAO, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPPC [CEPM, 1996; revised CEPM, 1999]
International standards*	International standards established in accordance with Article X paragraph 1 and 2 of the IPPC [IPPC, 1997]
Introduction	The entry of a pest resulting in its establishment [FAO, 1990; revised FAO, 1995; IPC, 1997]
Introduction (of a biological control agent)*	The release of a biological control agent into an ecosystem where it did not exist previously (see also establishment) [ISPM Pub. No. 3, 1996]
Inundative release*	The release of overwhelming numbers of a massproduced, invertebrate biological control agent in the expectation of achieving a rapid reduction of a pest population without necessarily achieving continuing impact [ISPM Pub. No. 3, 1996]

IPPC	Acronym for the International Plant Protection Convention, as deposited in 1951 with FAO in Rome and as subsequently amended [FAO, 1990]
ISPM	Acronym for International Standard for Phytosanitary Measures [CEPM, 1996]
Legislation*	Any act, law, regulation, guideline or other administrative order promulgated by a government [ISPM Pub. No. 3, 1996]
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin etc., forming part of a consignment [FAO, 1990]
Micro-organism*	A protozoan, fungus, bacterium, virus or other microscopic self-replicating biotic entity [ISPM Pub. No. 3, 1996]
Monitoring	An official ongoing process to verify phytosanitary situations [CEPM,1996]
Monitoring survey	Ongoing survey to verify the characteristics of a pest population [FAO, 1995
National Plant Protection Organization	Official service established by a government to discharge the functions specified by the IPPC [FAO, 1990; formerly Plant Protection Organization (National)
Natural enemy*	An organism which lives at the expense of another organism and which may help to limit the population of its host. This includes parasitoids, parasites, predators and pathogens [ISPM Pub. No. 3, 1996]
Naturally occurring*	A component of an ecosystem or a selection from a wild population, not altered by artificial means [ISPM Pub. No. 3, 1996]
Non-quarantine pest	Pest that is not a quarantine pest for an area [FAO, 1995]

NPPO	Acronym for National Plant Protection Organization [FAO, 1990]
Occurrence	The presence in an area of a pest officially reported to be indigenous or introduced and/or not officially reported to have been eradicated [FAO, 1990; revised FAO, 1995; formerly Occur]
Official	Established, authorized or performed by a National Plant Protection Organization [FAO, 1990]
Organism*	Biotic entity capable of reproduction or replication, vertebrate or invertebrate animals, plants and microorganisms [ISPM Pub. No. 3, 1996]
Outbreak	An isolated pest population, recently detected and expected to survive for the immediate future [FAO, 1995]
Parasite*	An organism which lives on or in a larger organism, feeding upon it [ISPM Pub. No. 3, 1996]
Parasitoid*	An insect parasitic only in its immature stages, killing its host in the process of its development, and free living as an adult [ISPM Pub. No. 3, 1996]
Pathogen*	Micro-organism causing disease [ISPM Pub. No. 3, 1996]
Pathway	Any means that allows the entry or spread of a pest [FAO, 1990; revised FAO 1995]
Pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products [FAO, 1990; revised FAO, 1995; IPPC, 1997]
Pest free area	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained [FAO, 1995]

Pest free place of production*	Place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which where appropriate, this condition is being officially maintained for a defined period [ISPM Pub. No. 10, 1999]
Pest free production site*	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production [ISPM Pub. No. 10, 1999]
Pest record	A document providing information concerning the presence or absence of a specific pest at a particular location at a certain time, within an area (usually a country) under described circumstances [CEPM, 1997]
Pest risk analysis	The process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it [FAO, 1995; revised IPPC, 1997]
Pest risk assessment	Determination of whether a pest is a quarantine pest and evaluation of its introduction potential [FAO, 1995]
Pest risk management	The decision-making process of reducing the risk of introduction of a quarantine pest [FAO,1995]
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate it distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information [CEPM, 1997; revised ISPM, 1998]
PFA	Acronym for pest-free area [FAO, 1995]

Phytosanitary certificate	Certificate patterned after the model certificates of the IPPC [FAO, 1990]
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate [FAO, 1990] Phytosanitary legislation Basic laws granting legal authority to a National Plant Protection Organization from which phytosanitary regulations may be drafted [FAO, 1990; revised FAO, 1995]
Phytosanitary measure	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of pests [FAO, 1995; revised IPPC, 1997]
Phytosanitary procedure	Any officially prescribed method for performing inspections, tests, surveys or treatments in connection with regulated pests [FAO, 1990; revised FAO, 1995; CEPM, 1999]
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of pests, by regulating the production, movement or existence of commodities or other articles, or the normal activity of persons, and by establishing procedures for phytosanitary certification [FAO, 1990; revised FAO, 1995; CEPM, 1999]
Place of production	Any premises or collection of fields operated as a single production or farming unit. This may include production sites which are separately managed for phytosanitary purposes [FAO, 1990; revised CEPM, 1999]
Plating (including replanting)	Any operation for the placing of plants in a growing medium, or by grafting or similar operations, to ensure their subsequent growth, reproduction or propagation [FAO, 1990; revised CEPM, 1999]
Plant pest	See Pest

Plant products	Unmanufactured material of plant origin (including grain) and those manufactured products that, by their nature or that of their processing, may create a risk for the introduction and spread of pests [FAO, 1990; revised IPPC, 1997; formerly Plant product]
Plant protection organization (national)	See National Plant Protection Organization
Plant quarantine	All activities designed to prevent the introduction and/or spread of quarantine pests or to ensure their official control [FAO, 1990; revised FAO, 1995]
Plants	Living plants and parts thereof, including seeds and germplasm [FAO, 1990; revised IPPC, 1997]
Plants for planting	Plants intended to remain planted, to be planted or replanted [FAO, 1990]
Plants in tissue culture	Plants in an aseptic medium in a closed container [FAO, 1990; revised CEPM, 1999]
Point of entry	Airport, seaport or land border officially designated for the importation of consignments, and/or entrance of passengers [FAO, 1995]
Post-entry quarantine	Quarantine applied to a consignment after entry [FAO, 1995]
PRA	Acronym for pest risk analysis [FAO, 1995]
PRA area	Area in relation to which a pest risk analysis is conducted [FAO, 1995]
Practically free	Of a consignment, field, or place of production, without pests (or a specific pest) in numbers or quantities in excess of those that can be expected to result from, an be consistent with good cultural and handling practices employed in the production and marketing of the commodity [FAO, 1990; revised FAO, 1995]

Preclearance	Phytosanitary certification and/or clearance in the country of origin, performed by or under the regular supervision of the National Plant Protection Organization of the country of destination [FAO, 1990; revised FAO, 1995]
Predator*	A natural enemy that preys and feeds on other animal organisms, more than one of which are killed during its lifetime [ISPM Pub. No. 3, 1996]
Prohibition	A phytosanitary regulation forbidding the importation or movement of specified pests or commodities [FAO, 1990; revised FAO, 1995]
Protected area	A regulated area which an NPPO has determined to be the minimum area necessary for the effective protection of an endangered area [FAO, 1990; omitted from FAO, 1995; new concept from CEPM, 1996]
Quarantine	Official confinement of regulated articles for observation and research of for further inspection, testing and/or treatment [FAO, 1990; revised FAO, 1995; CEPM, 1999]
Quarantine area	An area within which a quarantine pest is present and is being officially controlled [FAO, 1990; revised FAO, 1995]
Quarantine (of a biological control agent)*	Official confinement of biological control agents subject to phytosanitary regulations for observation and research, or for further inspection and/or testing [ISPM Pub. No. 3, 1996]
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled [FAO, 1990; revised FAO, 1995; IPPC, 1997]
Quarantine station	Official station for holding plants or plant products in quarantine [FAO, 1990; revised FAO, 1995; formerly Quarantine station or facility]
Re-exported consignment	Consignment which has been imported into a country from which it is then exported without being exposed to infestation or contamination by pests. The consignment may be stored, split up, combined with other consignments or have its packaging changed [FAO, 1990; revised CEPM, 1996; CEPM, 1999]

Refusal	Forbidding entry of a consignment or other regulated article when it fails to comply with phytosanitary regulations [FAO, 1990; revised FAO, 1995]
Region	The combined territories of the member countries of a Regional Plant Protection Organization [FAO, 1990]
Regional Plant Protection Organization	An intergovernmental organization with the functions laid down by Article IX of the IPPC [FAO, 1990; revised FAO, 1995; CEPM, 1999; formerly Plant Protection Organization (Regional)]
Regional standards	Standards established by a regional plant protection organization for the guidance of the members of that organization [IPPC, 1997]
Regulated area	An area into which, within which and/or from which plants, plant products and other regulated articles are subjected to phytosanitary measures in order to prevent the introduction and/or spread of regulated pests (See Controlled area and Protected area) [CEPM, 1996; revised CEPM, 1999]
Regulated article	Any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harboring or spreading pests, deemed to requite phytosanitary measures, particularly where international transportation is involved [FAO, 1990; revised FAO, 1995; lPPC, 1997]

Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party [IPPC, 1997]
Regulated pest	A quarantine pest or a regulated non-quarantine pest [IPPC, 1997]
Release (Into the environment)*	Intentional liberation of an organism into the environment (see also introduction and establishment) [ISPM Pub. No. 3, 1996]
Release (of a consignment)	Authorization for entry after clearance [FAO, 1995]
Replanting	See Planting
Restriction	A phytosanitary regulation allowing the importation or movement of specified commodities subject to specific requirements [CEPM, 1996, revised CEPM, 1999]
Round wood	Wood not sawn longitudinally, carrying its natural rounded surface, with or without bark [FAO, 1990]
RPPO	Acronym for Regional Plant Protection Organization [FAO, 1990]
Sawn wood	Wood sawn longitudinally, with or without its natural rounded surface with or without bark [FAO, 1990]
Secretary*	Secretary of the Commission appointed pursuant to Article X11 [IPPC, 1997]
Seeds	Seeds for planting not for consumption or processing (see Grain) [FAO, 1990]

Specificity*	A measure of the host range of a biological control agent on a scale ranging from an extreme specialist only able to complete development on a single species or strain of its host (monophagous) to a generalist with many hosts ranging over several groups of organisms (polyphagous) [ISPM Pub. No. 3, 1996]
Spread	Expansion of the geographical distribution of a pest within an area [FAO, 1995]
Standar	Document established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context [FAO, 1995; ISO/IEC GUIDE 2:1991 definition]
Stored product	Unmanufactured plant product intended for consumption or processing, stored in a dried form (this includes in particular grain and dried fruits and vegetables) [FAO, 1990]
Suppression	The application of phytosanitary measures in an infested area to reduce pest populations [FAO, 1995; revised CEPM, 1999]
Surveillance	An official process which collects and records data on pest occurrence or absence by survey, monitoring or other procedures [CEPM, 1996]
Survey	An official procedure conducted over a defined period of time to determine the characteristics of a pest population or to determine which species occur in an area [FAO, 1990; revised CEPM, 1996]
Technically justified	Justified on the basis of conclusions reached by using an appropriate pest risk analysis or, where applicable, another comparable examination and evaluation of available scientific information [IPPC, 1997]

Test	Official examination, other than visual, to determine if pests are present or to identify pests [FAO, 1990]
Tissue culture	See Plants in tissue culture
Transience*	Presence of a pest that is not expected to lead to establishment [ISPM Pub. No. 8, 1998]
Transit	See Consignment in transit
Transparency	The principle of making available, at the international level, phytosanitary measures and their rationale [FAO, 1995; revised CEPM, 1999; based on the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures]
Treatment	Officially authorized procedure for the killing, removal or rendering infertile of pests [FAO, 1990, revised FAO, 1995]
Wood	Round wood, sawn wood, wood chips or dunnage, with or without bark [FAO, 1990]

Figure 1: Climatic Zones Map (USDA, 1990).