Pest Risk Assessment: Importation of Adult Queens, Package Bees and Germplasm of Honey Bees, *Apis mellifera* L., From New Zealand

Qualitative, Pathway-Initiated Pest Risk Assessment

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I. Introduction

The Act of August 31, 1922, entitled "An Act to regulate foreign commerce in the importation into the United States of the adult honey bee (*Apis mellifica)"* (referred to hereinafter as the Honeybee Act of 1922), prohibits the entry of honey bees from countries where diseases and parasites are known to exist that endanger the health of honey bees. Until recently, only the United States Department of Agriculture could import adult honey bees under the rules and regulations prescribed by the Secretary of Treasury and the Secretary of Agriculture. Additional amendments and regulations, promulgated by the Department of Agriculture, extended the Act to prohibit the importation of all life stages of the genus *Apis*, expanded the prohibition to prevent the entry of diseases and pests that endanger the health of honey bees and undesirable germplasm. Regulations promulgated under the Honeybee Act are published in Title 7 CFR Part 322.

The diseases, pests and germplasm specifically identified in the Honeybee Act and amendments, including regulations under the Federal Plant Pest Act entitled Exotic Bee Diseases and Parasites (Title 7 CFR Part 319.76) are as follows:

Exotic Bee Parasites:

Acarapis woodi
Varroa jacobsoni
Tropilaelaps clareae
Euvarroa sinhai
Coelioxys spp.
Chrysis spp.

Exotic Bee Diseases:

Aspergillus spp.
Bacillus spp.
Entomophthora spp.
Beauvaria spp.
Cordyceps spp.
Saccharomyces spp.

Because the protozoan *Nosema apis* is widespread in the United States, it is not considered an exotic disease.

Recent trade agreements (the General Agreement on Tariffs and Trade, and the North American Free Trade Agreement) obligated the United States to consider imports of honey bees from countries where science-based analyses indicate acceptable risk levels and/or adequate risk management tactics. This pest risk assessment was prepared by the Animal and Plant Health Inspection Service (APHIS) and the Agricultural Research Service (ARS) of the United States

Department of Agriculture (USDA) to examine the risks associated with the importation into the United States of adult queens, package bees (adult queens, adult drones and adult workers) and germplasm (semen and ova) of honey bees, *Apis mellifera* L from New Zealand. The methods we used to initiate, conduct, and report this pest risk assessment are consistent with guidelines provided by the United Nations Food and Agriculture Organization (FAO) and by the Office International Epizootics (OIE). This document satisfies the requirements of OIE Guidelines for risk assessment (OIE 1998).

II. Risk Assessment

A. Initiating Event: Proposed Action

New Zealand first requested access of their honey bees to the United States in 1978. Their request was acted upon with a risk assessment initiated in 1984. Based upon that risk assessment, proposed rule was published in 1990 for comment in the Federal Register of February 6 (55 FR 3968-3969, Docket No. 89-117). The proposal would have relieved certain restrictions on honey bees and honey bee semen imported into the United States from New Zealand. At the time, USDA considered the proposed rule justified based on a determination by USDA that New Zealand was free of, and had adequate protection against the introduction of diseases and parasites of honey bees, and undesirable species or strains of honey bee and their semen. USDA extended the comment period from 60 to 90 days in a subsequent announcement in the Federal Register on March 2 (55 FR 7499, Docket No. 90-025). The proposed rule was not initially acted upon and the comment period for the original proposal was reopened for 30 days in a Federal Register announcement on July 18, 1994 (59 FR 36373-36374). Several of the comments received raised questions about half moon syndrome, chronic bee paralysis virus , Kashmir bee virus, melanosis, and *Malphighamoeba mellificae* that were known to occur in New Zealand, but which required further study in North America. Due to these concerns, USDA published a final rule in the Federal Register on February 1, 1995 (60 FR 5997- 6000, Docket No. 89-117-4) that amended the regulations to only allow honey bees and honey bee semen from New Zealand to transit the United States, subject to certain conditions, but did not allow full access to the United States. However, it was stated in the final rule that we would reconsider New Zealand's request as further research is conducted. New Zealand has continued to request complete access to the United States of their honey bees and honey bee germplasm since the final rule for transit became effective on March 3, 1995.

B. Previous Risk Assessments, Current Status and Pest Interceptions

In response to the 1978 request for access by New Zealand, the USDA initiated a review of the risks of such imports in 1984. A scientific literature review, a sampling program of New Zealand honey bees, an exchange of information with New Zealand, and a review of the bee enforcement program in New Zealand were conducted to determine the risks posed to the United States beekeeping industry by honey bee diseases and parasites, and undesirable species and strains of honey bees in New Zealand. A USDA Agricultural Research Service scientist visited New

Zealand from January 24 to March 17, 1984 to diagnose bee diseases and to evaluate the bee diseases situation in New Zealand (Shimanuki, 1984). A detailed report evaluating New Zealand honey bees was submitted to APHIS by the Agricultural Research Service in 1988 (Shimanuki, 1988). That report concluded that, based on visits to New Zealand and follow-up studies, no evidence of exotic diseases or pests occurred in New Zealand that would endanger honey bees in the United States.

In response to concerns about the 1989 proposed rule and the 1995 final rule, the Hawaii Department of Agriculture conducted an independent risk assessment to determine potential risks to Hawaiian honey bees posed by transshipment of New Zealand Bees (Hawaii Department of Agriculture, 1995). The results of this independent analysis supported the conclusions of the USDA evaluations completed in 1988. The conclusion to their assessment was that, relative to New Zealand honey bees, there was "no evidence to support the notion that Hawaii represents a unique repository of disease-free and genetically distinct honey bees."

Canada has allowed the importation of honey bee queens and package bees from New Zealand since 1973. In addition, the movement of honey bees from Canada into the United States has not been regulated or restricted since Canada first allowed entry of New Zealand honey bees. Although much concern was initially raised about the inadvertent import of *Melittiphis alvearius* and half moon syndrome from New Zealand into North America, no reports have indicated adverse events in either Canada or the United States.

III. Assessment of New Zealand Honey Bee Regulations and Surveillance Programs

The New Zealand legislation pertaining to the beekeeping industry is the Biosecurity Act. The Biosecurity Order pertaining to honey bees (The National American Foulbrood Pest Management Strategy) came into effect on October 1, 1998. The management agency under this legislation is the National Beekeepers' Association of New Zealand. Their performance as a management agency is audited by the MAF.

Under the Biosecurity Act, all locations where bees are kept (apiaries) must be registered and identified with a code number. Being the most important bee disease in New Zealand, all occurrences of American foulbrood (AFB) are required by law to be reported. Upon detection, immediate steps must be taken to eradicate the disease. This involves burning all bees, combs, honey and hive equipment (unless permission is granted to beekeepers to sterilize hive equipment by an approved method). Use of antibiotics to prevent or treat AFB is illegal in New Zealand.

New Zealand has a very robust government program to protect its animal health, including thorough examinations of postal items, goods, passengers and passenger baggage entering the country. To prevent the introduction of bee diseases and pests, honey, other bee products, used beekeeping equipment and live bees may only be imported if they meet stringent health requirements. In practice, New Zealand does not import live bees or used beekeeping equipment,

imports honey only from a few disease-free Pacific Island countries, and imports some highly-refined bee products.

All exports of queen and packages bees by New Zealand to other countries are accompanied by certificates issued by the MAF. On the certificate for honey bees shipped to Canada, MAF certifies that the bees are a product of New Zealand, and that New Zealand is free of trachael mite (*Acarapis woodi*), Varroa (*Varroa jacobsoni*), Asian mite (*Tropilaelaps clareae*), European foulbrood (*Melissococcus pluton*) and the African or Africanized honey bee (*Apis mellifera scutellata*) and its hybrids.

IV. Assessment of New Zealand Honey Bee Species and Strains

The honey bee is not indigenous to New Zealand and was first imported in 1839 (MAF, 1985). Numerous importations of queens from Australia, Italy and the United States occurred until 1920. From 1924 to 1948 special permits were required to import honey bees, but very few queens were actually imported. Legislation passed in 1948 to prevent the importation of undesirable strains and exotic diseases significantly reduced imports. From 1948 to 1956, only eight consignments of queens were imported; four from the United States, one from Canada, and three from Australia. No legal importations of honey bees have been allowed since 1956.

Based on the history of honey bee importations into New Zealand, the absence of any reports of species other than *Apis mellifera* or of other adverse subspecies or strains, New Zealand honey bees are considered equivalent to honey bees in the United States.

V. Pest List: Pests Associated with Honey Bees in New Zealand

Diseases or Pests in New Zealand	In U.S.	Comments	References
Fungi			
Ascosphaera apis (Chalkbrood Disease)	Yes		Anderson 1987
Bacteria			
Paenibacillus larvae larvae (American Foulbrood)	Yes	OIE List B Pathogen	Anderson 1987

Protozoa

Nosema apis (Nosema Disease)	Yes	OIE List B Pathogen	Anderson 1987
Malpighamoeba mellificae (Amoeba Disease)	Yes	Not reported in HI[1]	Anderson 1987, 1988a, Bailey and Ball 1991, MAF 1994.

Viruses

Sacbrood Virus	Yes		
Chronic Bee Paralysis Virus	Yes	Not reported in HI[1]	Liu 1991, Furgala and Mussen 1978, Liu et al. 1987, Bailey and Ball 1991, Bruce et al. 1995
Acute Bee Paralysis Virus	Yes		Furgala and Mussen 1978, Liu et al. 1987, Bailey and Ball 1991, Bruce et al. 1995
Kashmir Bee Virus	Yes	Not reported in HI[1]	Anderson 1991,Furgala and Mussen 1978, Liu et al. 1987, Bailey and Ball 1991, Bruce et al. 1995
Black Queen Cell Virus	Yes		Furgala and Mussen 1978, Liu et al. 1987, Bailey and Ball 1991, Bruce et al. 1995
Filamentous Virus	Yes		Furgala and Mussen 1978, Liu et al. 1987, Bailey and Ball 1991, Bruce et al. 1995
Bee Virus “X”	Yes		Liu 1991

Bee Virus "Y"	Yes		Liu 1991, Furgala and Mussen 1978, Liu et al. 1987, Bailey and Ball 1991, Bruce et al. 1995
Cloudy Wing Virus	Yes		

Parasitic Mites

Acarapis dorsalis Morgenthaler	Yes		Morse 1978, CAPA 1991, Delfinado-Baker 1994, Anderson 1987
Acarapis externus Morgenthaler	Yes		Morse 1978, CAPA 1991, Delfinado-Baker 1994, Anderson 1987

Nonparasitic Mite Associates

Melittiphis alvearius (Berlese)	Yes	Not reported in HI[1] Predator on other arthropods in hives.	Morse 1978, CAPA 1991, Delfinado-Baker 1994, Anderson 1987, Eickwort 1997
Neocypholaelaps zealandicus	No	Phoretic on honey bees for transport to flowers.	Morse 1978, CAPA 1991, Delfinado-Baker 1994, Anderson 1987

Noninfectious Conditions

Half-moon disorder	Yes		Anderson 1988b, Anderson and Gibbs 1988.
Melanosis	Yes		

Beekeeping Pests

Galleria mellonella (L.) Greater Wax Moth	Yes		MAF 1994

Achroia grisella (F.) Lesser Wax Moth	Yes		MAF 1994

[1]"Not Reported" acknowledges information received from local beekeepers and apiary inspectors on the apparent absence of a pest in a State. However, no data from science-based surveys have been presented or could be found in the scientific literature to substantiate the claims.

VI. List of Quarantine Pests

A. **Quarantine significant diseases or pests in New Zealand** (diseases, pests, or adverse species or strains of honey bees that occur in New Zealand but not in the United States).

NONE

B. **OIE List A Diseases in New Zealand** (transmissible diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic consequence and which are of major importance in the international trade of animals and animal products)

NONE LISTED BY OIE.

C. **OIE List B Diseases in New Zealand** (transmissible diseases which are considered to be of socio-economic importance within countries and which are significant in the international trade of animals and animal products):

1. ***Paenibacillus larvae larvae*** **(American Foulbrood)**

This honey bee disease occurs in New Zealand and the United States, including Hawaii. *Paenibacillus larvae larvae* is a slender rod-shaped bacterium with slightly rounded ends and a tendency to grow in chains. The rod varies greatly in length, from about 2.5 to 5 microns (mm), and is about 0.5 mm wide. The spore is oval and approximately twice as long as wide, about 0.6 by 1.3 mm. Approximately 2.5 billion spores are produced in each infected larva. If the larva has been infected for less than 10 days, the vegetative cells are present, and some newly formed spores may be seen.

American foulbrood (AFB) disease can destroy a colony of bees if left untreated. The disease can occur anytime during the active brood rearing season. Larvae become immune about 72 hours after egg hatch. The most common means by which this disease is transmitted is by beekeepers who interchange brood combs between healthy and infected colonies. In addition, AFB can be transmitted colony-to-colony by adult bees and also by feeding healthy colonies honey from colonies with AFB. This disease is considered an economic pest and methods to mitigate this vary from country to country and state to state. In most jurisdictions bee inspections program, as

we know them today, had their beginnings to mitigate AFB.

Possible sources of disease transmission: queens, package bees (artificial swarms), established colonies with combs, used beekeeping equipment, honey, and pollen

The disease is detected by inspection of colonies during the brood rearing season. In the U.S., health certificates are traditionally issued by the state inspection services certifying a disease-free source apiary, date of last inspection and inspectors name. No practical method is available for certifying the absence of *Paenibacillus larvae larvae* in package bees and queens.

2. *Nosema apis* (Nosema Disease, Nosemosis).

Nosema disease occurs in New Zealand and the United States, including Hawaii. *Nosema apis* is the protozoan that causes nosema disease. *Nosema apis* spores are large, oval bodies, 4-6 mm long by 2-4 mm wide. The spores develop exclusively within the epithelial cells of the ventriculus of the adult honey bee. Nosema disease usually manifests itself in bees that are confined; therefore, the heaviest infections are found in winter bees, package bees, bees used for pollination in greenhouses, etc. Since nosema disease occurs worldwide, it was excluded from the Honeybee Act and its movement within the United States is not under statutory control.

The disease reduces the longevity of adult bees and hence can affect the productivity and survival of honey bee colonies. No single symptom typifies nosema disease. Differences between healthy bees and heavily infected bees can be seen by removing the digestive tract and examining the ventriculus. The ventriculus of a healthy bee is straw brown, and the individual circular constrictions are clearly seen. In a heavily infected bee, the ventriculus is white, soft, and swollen, obscuring the constrictions (White 1918). However, positive diagnosis can only be made by sacrificing adult bees from packages or queen cages for microscopic examination. Fecal material of queens can also be examined for the presence of *Nosema apis* spores.

Possible sources of disease transmission: queens, package bees (artificial swarms), established colonies with combs, and used beekeeping equipment.

D. Other Diseases, Pests or Physiological Maladies of Concern

1. Half-moon disorder

Half-moon disorder is reported from New Zealand but is not known to occur in the United States, including Hawaii. The disorder is not an infectious condition. Although bacteria have been isolated from larvae with the half-moon disorder, the bacteria were not the causative agent. The disorder is diagnosed strictly by the gross symptoms. Canada has been importing honey bee queens and package bees from New Zealand since the late 1960's and if the half-moon disorder were a problem it would have likely been reported. Instead we have a report of possibly one case

in over 143,350 queens and 80,500 package bees imported into Canada from New Zealand.

Since half-moon disorder is not considered a transmissible disease, no sanitary measures can be imposed relative to imports of honey bees.

2. Kashmir bee virus.

Kashmir bee virus (KBV) occurs in New Zealand and the United States, but is not reported in Hawaii. KBV was first isolated from adult *Apis cerana,* the Eastern honey bee by Bailey and Woods (1977). Since then, KBV has been isolated from *A. mellifera* in New Zealand, Australia, Canada and the U.S. The KBV found in each of the countries are serologically related but not considered identical. According to Bailey and Ball (1991) "the Australian strains of KBV were associated with severe mortality of adult bees in the field and have also appeared to cause death of larvae.

Possible sources of disease transmission: queens, package bees (artificial swarms), and established colonies with combs

Since *Varroa jacobsoni* is not reported in Australia and New Zealand, it is apparent that KBV is primarily transmitted "bee to bee" and does not require mite transmission. However, diagnosis of the virus requires activation of the virus by injecting a suspect suspension in an apparently healthy pupae and observing for symptoms and confirming the presence of the virus serologically.

Although KBV is "not reported" to occur in Hawaii, no valid surveys have been conducted during at least the past decade to scientifically support claims of its absence from the State. Consequently, KBV is not considered a Quarantine Pest subject to further consideration in this assessment. However, results from future, science-based surveys in Hawaii could cause reconsideration of this pest relative to imports to that State.

3. Chronic Bee Paralysis Virus

Chronic bee paralysis disease is also referred to as the "hairless black syndrome." The virus that causes chronic bee paralysis is widespread and occurs in New Zealand and the United States, but is not reported in Hawaii. However the disease rarely causes economic damage. Because the susceptibility to the disease is genetically inherited, generally out-crossing bee stocks remedies the situation.

Possible sources of disease transmission are package bees (artificial swarms), established colonies with combs, and queens.

Chronic bee paralysis virus is not easily detected. Although individual colonies may show adult bees with the symptoms of chronic bee paralysis disease, positive confirmation requires serology.

This disease is not included in health certificates used for interstate movement of honey bees in the United States.

Although chronic bee paralysis virus is "not reported" to occur in Hawaii, no valid surveys have been conducted during at least the past decade to scientifically support claims of its absence from the State. Consequently, chronic bee paralysis virus is not considered a Quarantine Pest subject to further consideration in this assessment. However, results from future, science-based surveys in Hawaii could cause reconsideration of this pest relative to imports from New Zealand to that State.

4. *Malpighamoeba mellificae* - Amoeba disease

This honey bee pathogen occurs in New Zealand and the United States, but is not reported in Hawaii. Amoeba disease occurs when adult bees ingest the cysts of the amoeba, *M. mellifica*. Because the amoeba is found in the Malpighian tubules, the evidence suggests that the infection impairs the function of the tubules. Amoeba disease is frequently found in association with another protozoan, *Nosema apis.*

No records are available on the occurrence of amoeba disease in the United States. It is doubtful that amoeba disease has an economic impact on beekeeping. No colony loss or honey loss data are available as a result of this disease.

Since this protozoan is found in the Malpighian tubules of adult bees, diagnosis can be made only by sacrificing the adult bees and removing the tubules for microscopic examination for the amoeba cysts. The cysts measure 5-8 µm in diameter and can be seen in the infected Malpighian tubules.

Possible sources of disease transmission: package bees (artificial swarms), established colonies with combs, and used beekeeping equipment.

Although *M. mellificae* is "not reported" to occur in Hawaii, no valid surveys have been conducted during at least the past decade to scientifically support claims of its absence from the State. Consequently, *M. mellificae* is not considered a Quarantine Pest subject to further consideration in this assessment. However, results from future, science-based surveys in Hawaii could cause reconsideration of this pest relative to imports from New Zealand to that State.

5. *Melittiphis alvearius*

Melittiphis alvearius is a little-known mite that is associated with adult honey bees but is not considered to be a pest. Its distribution includes New Zealand and the United States, but is not reported in Hawaii (reports not based on science-based survey data). It is unlikely that *M. alvearius* would be confused with other mites found in honey bee colonies. The adult female mite

is ovate, flattened dorso-ventrally, 0.79 mm long and 0.68 mm wide, brown, and well sclerotized with numerous stout and spine like setae. The mite has been reported in California, Nova Scotia, New Zealand, England and continental Europe (Delfinado-Baker 1988). Although it is not reported to occur in Hawaii, no science-based survey data could be found to support such reports.

The scientific literature indicates that *Melittiphis alvearius* is one of the predatory mites that have been recorded to incidentally occur in beehives. Eickwort (1977) states that although *M. alvearius* is related to the important honey bee parasites *Tropilaelaps* and *Varroa*, the predatory mesostigmatid mites do not harm honey bees or their brood. *M. alvearius* is presumed, on the basis of its morphology, to be a predator on other arthropods in beehives, although its feeding behavior has never been directly observed. Consequently, *M. alvearius* is not considered a Quarantine Pest subject to further consideration in this assessment.

E. Undesirable Species, Subspecies or Strains of Honey bees

NONE

VII. Quarantine Pests Likely to Follow Pathway (i.e., Quarantine Pests Selected for Further Analysis)

Only *Paenibacillus larvae larvae* (American Foulbrood) is considered a quarantine pest as a consequence of its status as an OIE List B pest. However, the occurrence of this disease throughout the United States negates much of the risk related considerations in evaluating economic importance and likelihood of introduction.

Although *Nosema apis* (Nosema Disease, Nosemosis) also is an OIE List B pest, we do not list it as a quarantine pest for further analysis due to its wide distribution in the United States, and its exemption as an exotic bee disease under the Honeybee Act. Since the movement of *N. apis* is not under statutory control within the United States, the SPS agreement stipulates that no sanitary measures can be imposed relative to honey bee imports

Although several pests discussed above are reported not to occur in Hawaii, we can find no scientific evidence to support such claims. As a consequence, we have made no special consideration for the State of Hawaii in this assessment. However, the results from future, science-based surveys could cause reconsideration of this assessment relative to that State.

VIII. Economic Importance: Consequences of Introduction

Since *P. larvae larvae* already occurs in the United States, we rate the economic consequences of introducing this pest as low. This overall rating is based on low economic and environmental consequences, despite high ratings for dispersal capabilities, climatic tolerances and host availability.

IX. Likelihood of Introduction

To determine an overall estimate of the likelihood of introduction of *P. larvae larvae* we estimated the following independent likelihoods:

Expected quantity of queens and packages imported annually	Low
Likelihood of occurring in shipments	Very Low
Likelihood of surviving shipments	High
Likelihood of not being detected at the port of entry	High
Likelihood of moving to suitable habitats	High
Likelihood of finding suitable hosts	High

The "very low" estimate for the likelihood of occurring in shipments is the most critical in this pathway. This estimate is based on compulsory inspections, destruction and reporting for bee disease and prevention in New Zealand. Since the use of antibiotics is prohibited, the presence of AFB is not masked in individual colonies and more effective detection and control is possible. As a consequence, the annual incidence of AFB in New Zealand colonies peaked at 1.2% in 1990 and has been decreasing under the AFB control program to a 1998 level of 0.38% per year (Goodwin and Van Eaton, 1999). In comparison, 1977 estimates of disease in the United States where antibiotics are used, range from a low of 0.0% in several states to a high of 4.0% of colonies inspected in Tennessee and Wisconsin (Smith, 1998; see also discussions in Matheson and Reid, 1992). New Zealand colonies are also regularly inspected and all colonies with disease symptoms are removed from the production system and not used as a source of bees for export. As a consequence, it is unlikely that any infected honey bees would be included in shipments to the United States.

Based on these considerations, we conclude that the cumulative likelihood of introducing *P. larvae larvae* is low.

X. Conclusion: Pest Risk Potential and Mitigation Measures

Combining the risk ratings for consequences and likelihood of introduction, we conclude that the overall pest risk potential for *P. larvae larvae* is low. Although this pest already occurs in the United States, its listing as a pest of international importance relative to the movement of honey bees requires caution. Apiary inspection programs in the United States also monitor this pest to prevent its movement in interstate commerce. However, the statutory measures for AFB prevention and control in New Zealand are at least equivalent to those imposed within the United States. Consequently, the inspection and certification program currently used by New Zealand for

honey bee exports to other countries where AFB is endemic and under statutory control are adequate for shipments to the United States.

We found no evidence of adverse species, subspecies or strains of honey bees that would be of concern relative to the importation of honey bee germplasm from New Zealand. Likewise, we found no viruses or other disease organisms that posed significant risk to the import of germplasm.

We recommend that all queens and package bees exported from New Zealand to the United States be from apiaries inspected and certified by New Zealand regulatory officials as:

1. The bees are a product of New Zealand.
2. The bees are derived from an apiary or apiaries registered and inspected under, and otherwise complying with, the Biosecurity Act of 1993 and any regulations made under that Act.
3. The brood combs in the hives from which the bees are derived showed no clinical signs of American foulbrood on the day of collection.

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