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CRS Report for Congress

Recent Honey Bee Colony Declines

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Summary

In 2006, commercial migratory beekeepers along the East Coast of the United States began reporting sharp declines in their honey bee colonies. Because of the severity and unusual circumstances of these colony declines, scientists have named this phenomenon Colony Collapse Disorder (CCD). Current reports indicate that beekeepers in 35 states have been affected. Recent surveys indicate that about one-half of surveyed beekeepers have experienced "abnormal" or "severe" colony losses.

Honey bees are the most economically valuable pollinators of agricultural crops worldwide. Many scientists at universities and the U.S. Department of Agriculture (USDA) frequently assert that bee pollination is involved in about one-third of the U.S. diet, and contributes to the production of a wide range of fruits, vegetables, tree nuts, forage crops, some field crops, and other specialty crops. The monetary value of honey bees as commercial pollinators in the United States is estimated at about $15 billion annually.

Honey bee colony losses are not uncommon. However, current losses seem to differ from past situations in that colony losses are occurring mostly because bees are failing to return to the hive (which is largely uncharacteristic of bee behavior); bee colony losses have been rapid; colony losses are occurring in large numbers; and the reason(s) for these losses remains largely unknown. To date, the potential causes of CCD, as reported by the scientists who are researching this phenomenon, include but may not be limited to

- parasites, mites, and disease loads in the bees and brood;
- emergence of new or newly more virulent pathogens;
- poor nutrition among adult bees;
- lack of genetic diversity and lineage of bees;
- level of stress in adult bees (e.g., transportation and confinement of bees, overcrowding, or other environmental or biological stressors);
- chemical residue/contamination in the wax, food stores, and/or bees;
- a combination of these and/or other factors.

In March 2007, the House Subcommittee on Horticulture and Organic Agriculture held a hearing to review the recent honey bee colony declines. In June 2007, the Subcommittee on Fisheries, Wildlife, and Oceans of the House Committee on Natural Resources held a hearing on the role of pollinators in ecosystem health, which also addressed concerns about bee colony declines. Policy options that were discussed at these subcommittee hearings focused on increasing federal funding for research and monitoring; providing technical support and assistance for beekeepers; expanding crop insurance to cover honey; providing a one-time payment for losses; improving existing USDA conservation programs to better prevent habitat loss and sustain wildlife populations; emphasizing the importance of pollinator diversity and sustaining wild and native pollinator species; developing or improving existing federal and state best management practices for beekeepers; improving regulatory enforcement to prevent misuse of agricultural chemicals; and renewing the marketing loan assistance program for honey producers.

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In 2006, commercial migratory beekeepers along the East Coast of the United States began reporting sharp declines in their honey bee colonies. Because of the severity and unusual circumstances of these colony declines, scientists have named this phenomenon Colony Collapse Disorder (CCD). Current reports indicate that beekeepers in 35 states have been affected. Recent surveys indicate that about one-half of surveyed beekeepers have experienced "abnormal" or "severe" colony losses.

This report is organized in four parts. First, it provides an overview of the importance of honey bee pollination to U.S. agricultural production, especially specialty crops. Second, it describes the extent and symptoms of CCD and how it differs from previous honey bee colony losses. Third, it discusses some of the reasons why scientists believe honey bee colonies are being affected by CCD. Fourth, it discusses various policy options and subsequent action that Congress could consider in this area.

In March 2007, the House Subcommittee on Horticulture and Organic Agriculture held a hearing to review the recent honey bee colony declines. In June 2007, the Subcommittee on Fisheries, Wildlife, and Oceans of the House Committee on Natural Resources held a hearing on the role of pollinators in ecosystem health, which also addressed concerns about bee colony declines. Based on information presented to Congress, both by scientists researching recent bee colony declines and by agricultural producers who may be potentially affected by these losses, Congress could consider options for subsequent legislative action in this area.

Importance of Honey Bee Pollination

Honey bees (genus *Apis*) are the most economically valuable pollinators of agricultural crops worldwide.[1] In the United States, bee pollination of agricultural crops is said to account for about one-third of the U.S. diet, and to contribute to the production of a wide range of high-value fruits, vegetables, tree nuts, forage crops, some field crops, and other specialty crops.[2]

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[1] Some other known animal pollinators are stingless bees, bumble bees, and other bees; wasps, hover flies and other flies; beetles; thrips; ants; butterflies; moths; bats; and hummingbirds and other birds.

[2] Berenbaum, M.R., University of Illinois, Statement before the Subcommittee on Horticulture and Organic Agriculture, U.S. House of Representatives, March 29, 2007, at [http://agriculture.house.gov/testimony/110/h70329/Berenbaum.pdf]; Pettis, J., USDA's Agricultural Research Service (ARS), interview with University of Pennsylvania staff, January 23, 2007, available at [http://podcasts.psu.edu/taxonomy/term/62]. Staple crops such as wheat, corn, and rice do not rely on insect pollination and are mostly wind

(continued...)

The monetary value of honey bees as commercial pollinators in the United States is estimated at about $15 billion annually[3] (**Table 1**). This estimated value is measured according to the additional value of production attributable to honey bees, in terms of the value of the increased yield and quality achieved from honey bee pollination, including the indirect benefits of bee pollination required for seed production of some crops. About one-third of the estimated value of commercial honey bee pollination is in alfalfa production, mostly for alfalfa hay. Another nearly 10% of the value of honey bee pollination is for apples, followed by 6%-7% of the value each for almonds, citrus, cotton, and soybeans.

A number of agricultural crops are almost totally (90%-100%) dependent on honey bee pollination, including almonds, apples, avocados, blueberries, cranberries, cherries, kiwi fruit, macadamia nuts, asparagus, broccoli, carrots, cauliflower, celery, cucumbers, onions, legume seeds, pumpkins, squash, and sunflowers. Other specialty crops also rely on honey bee pollination, but to a lesser degree. These crops include apricot, citrus (oranges, lemons, limes, grapefruit, tangerines, etc.), peaches, pears, nectarines, plums, grapes, brambleberries, strawberries, olives, melon (cantaloupe, watermelon, and honeydew), peanuts, cotton, soybeans, and sugarbeets.[4]

In the United States, most pollination services are provided by commercial migratory beekeepers who travel from state to state and provide pollination services to crop producers. These operations are able to supply a large number of bee colonies during the critical phase of a crop's bloom cycle, when honey bees pollinate a crop as they fly from flower to flower collecting nectar and pollen, which they carry back to the nest.[5] The latest *Census of Agriculture* by the U.S. Department of Agriculture (USDA) reports that there were about 17,000 operations with 2.4 million bee colonies in 2002.[6] Other available data for 2006 indicate that there were also 2.4 million bee colonies during that year.[7] The majority of these, more than 2 million bee colonies, are reported to belong to commercial migratory beekeepers. About one-

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[2] (...continued)
pollinated.

[3] Morse, R.A. and N.W. Calderone, *The Value of Honey Bees as Pollinators of U.S. Crops in 2000*, March 2000, Cornell University, at [http://www.masterbeekeeper.org/pdf/pollination.pdf]. Other studies show a range of estimated values from $5.7 billion to $19.0 billion (see National Research Council, *Status of Pollinators in North America*, 2006).

[4] Ibid. Another study found that pollinators are essential for the production of some U.S.-grown crops, particularly macadamia nuts, squash, and pumpkins. Klein, A.-M., B.E. Vaissière, J.H. Cane, I. Steffan-Dewenter, S.A. Cunningham, C. Kremen, and T. Tscharntke, "Importance of pollinators in changing landscapes for world crops," *Proceedings of the Royal Society B: Biological Sciences*, Vol. 274, No. 1608, February 7, 2007

[5] Some "spillover" pollination occurs, including pollination from colonies owned by part-time beekeepers and hobbyists, or pollination of adjacent fields from commercial hives.

[6] USDA, *2002 Census of Agriculture*, Table 19. Based on honey production statistics. Other estimates by Cornell University indicate that the number of colonies in the early 2000s may have been greater, at 2.9 million colonies in 2000.

[7] USDA, *Honey*, February 2007, at [http://usda.mannlib.cornell.edu/usda/nass/Hone/2000s/2007/Hone-02-28-2007.pdf].

third of all colonies are in California (about 20%) and Florida (10%). The Dakotas accounted for another 7% each of all bee colonies, and Texas and Montana accounted for another 5% each. Other states with a large number of bee colonies were Minnesota, Idaho, Michigan, Washington, Wisconsin, Oregon, and New York, which together accounted for about 20%. While these operations also produce honey for commercial sale, it is their value as crop pollinators that provides the greatest economic impact in the production of food and feed crops.

Table 1. Estimated Value of the Honey Bee to U.S. Crop Production, by Major Crop Category, 2000 Estimates

Crop Category (ranked by share of honey bee pollinator value)	Dependence on Insect Pollination	Proportion of Pollinators That Are Honey Bees	Value Attributed to Honey Bees[a] ($ millions)	Major Producing States[b]
Alfalfa, hay & seed	100%	60%	4,654.2	CA, SD, ID, WI
Apples	100%	90%	1,352.3	WA, NY, MI, PA
Almonds	100%	100%	959.2	CA
Citrus	20% - 80%	10% - 90%	834.1	CA, FL, AZ, TX
Cotton (lint & seed)	20%	80%	857.7	TX, AR, GA, MS
Soybeans	10%	50%	824.5	IA, IL, MN, IN
Onions	100%	90%	661.7	TX, GA, CA, AZ
Broccoli	100%	90%	435.4	CA
Carrots	100%	90%	420.7	CA, TX
Sunflower	100%	90%	409.9	ND, SD
Cantaloupe/honeydew	80%	90%	350.9	CA, WI, MN, WA
Other fruits & nuts[c]	10% - 90%	10% - 90%	1,633.4	—
Other vegetables/melons[d]	70% - 100%	10% - 90%	1,099.2	—
Other field crops[e]	10% - 100%	20% - 90%	70.4	—
Total	—	—	**$14,563.6**	—

Source: Compiled by CRS using values reported in Morse, R.A., and N.W. Calderone, *The Value of Honey Bees as Pollinators of U.S. Crops in 2000*, March 2000, Cornell University, at [http://www.masterbeekeeper.org/pdf/pollination.pdf].

a. Attributed value is the additional value of production attributable to honey bees, in terms of the value of the increased yield and quality achieved from honey bee pollination, including the indirect benefits of bee pollination required for seed production of some crops. Calculated from total average production value (1996-1998).
b. For most commodities, major producing states reflect reported 2006 production ([http://www.nass.usda.gov/QuickStats/]). Melon production is based on reported 2002 harvested acreage.
c. Apricots, avocados, blueberries, brambleberries, cherries, cranberries, grapes, kiwi fruit, macadamia nuts, olives, peaches, pears, nectarines, plums, and strawberries.
d. Asparagus, cauliflower, celery, cucumbers, pumpkins, squash, watermelon, and vegetable seeds.
e. Peanuts, canola (rapeseed), and sugarbeets.

Each year, an estimated more than 2 million bee colonies are rented for U.S. crop pollination. Available limited information indicates that the greatest number of honey bee colony rentals are for apple and almond production, followed by clover seed, cherries, and pears.[8] Rental fees collected by commercial beekeepers for pollination services may vary by crop type, and often tend to be lower for some seed crops and higher for berry and tree crops. In recent years, pollination fees paid by crop producers have increased. For example, fees paid by California's almond industry have risen from a reported $35 per colony in the late 1990s to about $75 per colony in 2005.[9] More recent estimates of fees for pollinating almond trees are even higher, at $150 per colony or more. Among the reasons for higher pollination fees are expanding almond acreage and relatively high honey prices, but also fewer available honey bees for pollination due, in part, to colony declines and bee mortalities. About one-half of the nation's honey bee colonies are used to pollinate California's current 550,000 acres of almond trees.[10]

Extent and Symptoms of Colony Collapse Disorder

Starting in the last three months of 2006, a seemingly new phenomenon began to occur based on reports of an "alarming" number of bee colony losses and die-off along the East Coast. By the end of 2006, beekeepers on the West Coast also began to report "unprecedented" losses.[11] Current reports indicate that beekeepers in 35 states have been affected (**Figure 1**).[12] Because of the severity and lack of precedent, scientists coined a new term, Colony Collapse Disorder (CCD), for this phenomenon.

Much of the current research on CCD is being conducted by scientists at Pennsylvania State University, University of Montana, USDA's Agriculture Research Service (Beltsville bee laboratory), and the Pennsylvania and Florida Departments of Agriculture. Many of these researchers also participate in the CCD Working Group, which includes Bee Alert Inc., the Florida and Pennsylvania Departments of Agriculture, Pennsylvania State University, and USDA. Up-to-date information is regularly posted to the website of the Mid-Atlantic Apiculture Research and Extension Consortium (MAAREC), which represents beekeeping associations in New Jersey, Maryland, Delaware, Pennsylvania, and West Virginia.

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[8] Burgett, M., *1999 Pacific Northwest Honey Bee Pollination Survey*, Oregon State University.

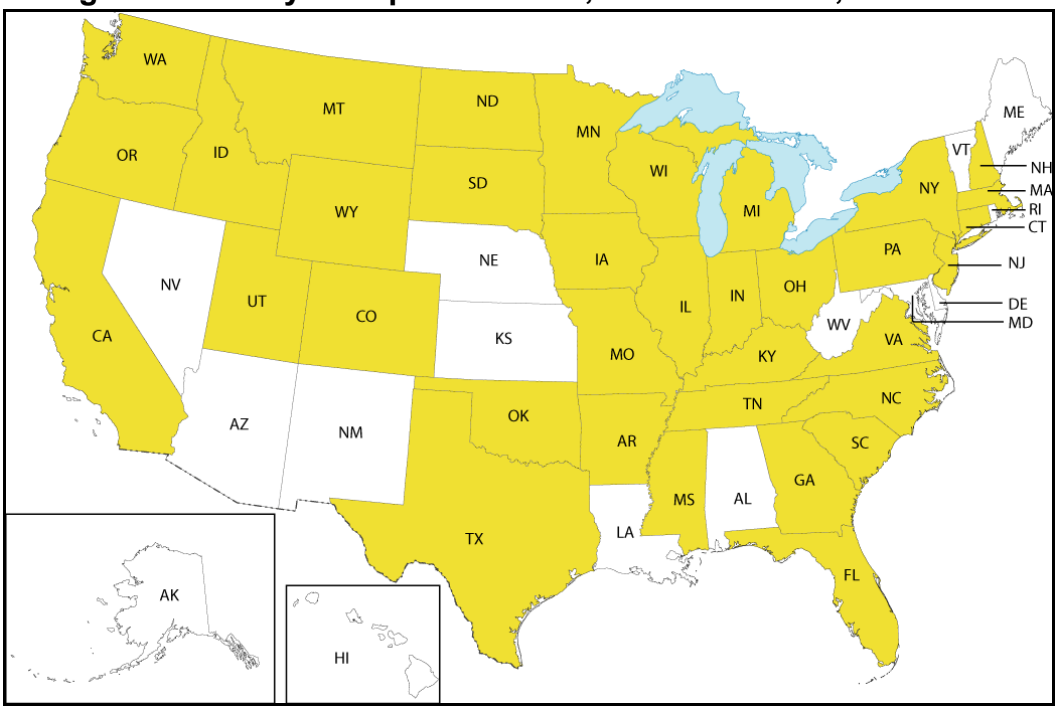
[9] National Academy of Sciences, National Research Council, *Status of Pollinators in North America*, 2006.

[10] USDA, CCD Steering Committee, "Colony Collapse Disorder Action Plan," June 20, 2007, at [http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf].

[11] vanEngelsdorp, D. et al., "Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006.

[12] Bee Alert, Inc., "Latest U.S. CCD Map," [http://www.beealert.info/].

Figure 1. Colony Collapse Disorder, Affected States, June 2007



Source: Bee Alert Inc., "Latest U.S. CCD Map," [http://www.beealert.info/]. Shaded areas show reported affected states.

Past Honey Bee Population Losses

Honey bee colony losses are not uncommon. A recent report by the National Research Council (NRC) documents the extensive literature on honey bee population losses due to bee pests, parasites, pathogens, and disease. Most notable are declines due to two parasitic mites, the so-called vampire mite (*Varroa destructor*) and the tracheal mite (*Acarapis woodi*), and also colony declines due to the pathogen *Paenibacillus larvae*.[13] Other reasons for bee colony declines reported by the NRC include interspecific competition between native and introduced bees, pathogen spillover effects, habitat loss, invasive plant species that reduce nectar- and pollen-producing vegetation, bee genetics, and pesticides, among other factors.

Mite infestations are a relatively new occurrence. The 1980s saw two periods of large die-offs due to *Varroa* and tracheal mites: The first *Varroa* mite infestation was reported in 1987; tracheal mites were first detected in 1984.[14] *Varroa* mites are also said to have eliminated most feral bee colonies in the mid-1990s.[15] *Varroa*

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[13] National Academy of Sciences, National Research Council, *Status of Pollinators in North America*, 2006.

[14] National Academy of Sciences, National Research Council, *Status of Pollinators in North America*, 2006; Interview with Maryann Frazier, Senior Extension Agent, Pennsylvania State University, January 28, 2007, at [http://podcasts.psu.edu/taxonomy/term/62].

[15] Morse, R. A. and N. W. Calderone, *The Value of Honey Bees as Pollinators of U.S. Crops*

(continued...)

parasitism affects both worker bees and male larvae and can affect the ability of the queen to reproduce. It is associated with viral pathogens and if left untreated can cause colony mortalities usually within six months to two years after the initial infestation. Less is known about the effects of the tracheal mite. The pathogen *Paenibacillus larvae* is the most serious honey bee pathogen and causes American foulbrood (AFB), which is a disease of larval honey bees. AFB resulted in large colony losses in the 1940s, but its incidence has been reduced by the use of antibiotics and increased apiary inspection programs. Nevertheless, mite and pathogen infestations have likely raised beekeeper operating costs to pay for miticides and/or antibiotics, labor and expenses for treatment, improved management and inspection, and colony replacement of dead bees.

Symptoms similar to those observed for CCD have been described in the past, and heavy losses have been documented. It is still not clear whether the current colony losses are being caused by the same factors or if new contributing factors are involved.[16] MAAREC also reports that large beekeeper operations may have experienced higher than normal losses compared with the past few years, and heavy overwintering losses were reported in 2003-2004 for many northern beekeepers.

Recent Colony Losses from Available Surveys

The first report of CCD was in mid-November 2006 by a Pennsylvania beekeeper overwintering in Florida. By February 2007, large commercial migratory beekeepers in several states had reported heavy losses associated with CCD. Their reports of losses vary widely, ranging from 30% to 90% of their bee colonies; in some cases beekeepers fear loss of nearly all of their colonies.[17] Surviving colonies are reportedly weakened and may no longer be viable to pollinate or produce honey. Losses have been reported in migratory operations wintering in California, Florida, Oklahoma and Texas. In late February, some larger non-migratory beekeepers in the mid-Atlantic and Pacific Northeast regions also reported significant losses of more than 50%.[18] Bee colony losses also have been reported in five Canadian provinces, several European countries, and countries in South and Central America and Asia.

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[15] (...continued)
in 2000, March 2000, Cornell University, at [http://www.masterbeekeeper.org/pdf/pollination.pdf].

[16] Similar conditions have been termed autumn collapse, May disease, spring dwindle, disappearing disease, and fall dwindle disease.

[17] Interview with Maryann Frazier, Senior Extension Agent, Pennsylvania State University, January 28, 2007, at [http://podcasts.psu.edu/taxonomy/term/62]; vanEngelsdorp et al., "Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006; Pastis, S., "Mysterious Bee Deaths Strike Central Valley," *Valley Voice*, [no date], at [http://www.valleyvoice newspaper.com/vv/stories/beedeaths.htm].

[18] MAAREC, "Colony Collapse Disorder," at [http://maarec.cas.psu.edu/FAQ/FAQCCD.pdf]

In March 2007, the Apiary Inspectors of America (AIA) conducted a survey of its members in 15 states.[19] The survey tracked changes from September 2006 and March 2007. Overall, responding beekeepers suffered an average loss of 38% of their colonies during the winter of 2006-2007. If these losses are representative of the nation, between 651,000 and 875,000 of the nation's estimated 2.4 million colonies were lost over the winter.[20] While a majority of losses were attributable to known causes, approximately 25% of beekeepers are believed to have suffered from CCD.[21] The survey indicates that, among the beekeepers surveyed, more than 50% reported "abnormally heavy losses" with total colony losses of 55%. This compared to those reporting "normal losses" with total colony losses of 16%. Of the responding beekeepers, about one-fourth reported conditions associated with CCD. Beekeeping operations experiencing CCD-like conditions reported losses of 45% of their managed bee colonies. Among the leading causes reported by most affected commercial beekeeping operations were pest diseases.

An ongoing survey conducted by Bee Alert Technology, Inc., published preliminary results in March 2007.[22] Of the beekeepers surveyed, more than 40% reported "severe losses," with losses of nearly 60% of their colonies. Most losses occurred during the time period between October 2006 and March 2007. The majority of beekeepers surveyed were at smaller operations with less than 100 colonies, with colony losses mostly less than 10 colonies per keeper. Information for about 10 larger operations (1,000 to more than 10,000 colony size) indicates an average of 1,800 colonies lost. This compares to other estimates of winter losses from various different surveys showing overall colony losses of about 30% during the period 2000-2006, mostly associated with losses due to *Varroa* mites.[23]

Overall, USDA reports that bee colony losses have averaged 17%-20% per year since the 1990s, attributable to a variety of factors, such as mites, diseases, and management stress. This compares to current estimates of bee colony losses for 2007, which could average about 30% during the year.[24]

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[19] vanEngelsdorp, D., R. Underwood, D. Caron, and J. Hayes Jr., "An Estimate of Managed Colony Losses in the Winter of 2006-2007: A Report Commissioned by the Apiary Inspectors of America," *American Bee Journal*, July 2007, at [http://www.ento.psu.edu/MAAREC/CCDPpt/CCDJuly07ABJArticle-1.pdf]. Based on a survey of beekeepers that included 384 respondents representing 153,000 managed bee colonies located in AR, FL, GA, MD, MI, MS, MT, NM, ND, OH, PA, SD, TN, and WI.

[20] Estimated at the 95% confidence interval.

[21] These statistics may have been misrepresented in the popular press, which often state that 25% of the nation's 2.4 million colonies have been lost (citing the AIA survey as its source).

[22] Henderson, C., L. Tarver, D. Plummer, R. Seccomb, S. Debnam, S. Rice, J. Bromenshenk, and J. Glassy, "U.S. National Bee Colony Loss Survey, Preliminary Findings with Respect to Colony Collapse Disorder (CCD)," March 26, 2007, at [http://www.beealert.info/]. More than 400 responses received.

[23] Burdick, E. and D.M. Caron, MAAREC Beekeeper Survey, University of Delaware, at [http://maarec.cas.psu.edu/pdfs/MAARECSurveyPub.pdf].

[24] Statements by USDA personnel at a briefing for House Agriculture Committee staff, July

(continued...)

How CCD Differs from Past Bee Colony Losses

Ways in which current bee colony losses seem to differ from past losses include

- colony losses are occurring mostly because bees are failing to return to the hive (which is largely uncharacteristic of bee behavior),
- bee colony losses have been rapid,
- colony losses are occurring in large numbers, and
- the reason why these losses are occurring remains still largely unknown.

The current phenomenon was first called "Fall-Dwindle Disease," but has been renamed CCD because of the unusual characteristics of the honey bee colony declines. First, the condition is not only seasonal but manifests itself throughout the year. Second, the term "dwindle" implies a gradual loss; CCD onset is sudden. Third, the term "disappearance" has been used to describe other types of conditions, which differ from the symptoms currently being associated with CCD. Finally, the term "disease" is usually associated with a biological agent, but none has yet been identified.[25]

Symptoms of Colony Collapse Disorder

One of the key symptoms of CCD in collapsed colonies is that the adult population is suddenly gone without any accumulation of dead bees.[26] The bees are not returning to the hive but are leaving behind their brood (young bees), their queen, and maybe a small cluster of adults. What is uncharacteristic about this situation is that the honey bee is a very social insect and colony-oriented, with a complex and organized nesting colony. Failing to return to the hive is considered highly unusual. An absence of a large number of dead bees makes an analysis of the causes of CCD difficult. Also there is little evidence that the hive may have been attacked. In actively collapsing colonies, an insufficient number of adult bees remain to care for the brood. The remaining workforce seems to be made up of young adult bees. The queen is present, appears healthy and is usually still laying eggs, but the remaining cluster is reluctant to consume feed provided by the beekeeper, and foraging is greatly reduced.

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[24] (...continued)
11, 2007.

[25] vanEngelsdorp, D., Cox Foster, D. Frazier, M., Ostiguy, N., and Hayes, J., "Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006.

[26] vanEngelsdorp, D. et al., "Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006; published interview with Maryann Frazier, Penn State University, January 28, 2007, at [http://podcasts.psu.edu/taxonomy/term/62]; published interview with Jerry Hayes, Florida's Department of Agriculture, Apiary Section, March 2, 2007, available at [http://www.loe.org].

Possible Causes of Colony Collapse Disorder

To date, the potential causes of CCD, as reported by the scientists who are researching this phenomenon, include but may not be limited to[27]

- parasites, mites, and disease loads in the bees and brood;
- emergence of new or newly more virulent pathogens, such as fungal diseases;
- poor nutrition among adult bees;
- lack of genetic diversity and lineage of bees;
- level of stress in adult bees, as indicated by stress-induced proteins (e.g., transportation and confinement of bees, overcrowding, or other environmental or biological stressors);
- chemical residue/contamination in the wax, food stores, and/or bees, including acute or cumulative exposure to new types of agricultural pesticides as well as exposure to chemicals that beekeepers use to control mites; and
- a combination of these and/or other factors.

As of July 2007, USDA reported that the current theories about the causes of CCD are focused on increased losses due to the *Varroa* mite; new or emerging diseases, especially mortality by a new species of a single-celled parasite *Nosema ceranae*; pesticide exposure; and potential immune-suppressing stress on bees due to one or a combination of these factors.[28]

Researchers have tentatively removed some practices and conditions from the list of possible causes of CCD. These include feeding practices, chemicals used by beekeepers (such as antibiotics and miticides), use of bees (primarily for honey production versus pollination), and queen source.[29] However, the scientists who are researching this phenomenon note these could contribute to the risk of bee colonies developing CCD. Some scientists also wonder whether a combination of the stressors, including mites, disease, and nutritional stress, are interacting to weaken bee colonies and are allowing stress-related pathogens, such as fungi, thus causing a final collapse.[30] Others note the possible role of miticide resistance in bees.

High levels of bacteria, viruses, and fungi have been found in the guts of the recoverable dead bees. Early evidence does suggest the possible presence of a

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[27] Published interview with Maryann Frazier, Penn State University, January 28, 2007, at [http://podcasts.psu.edu/taxonomy/term/62]; and MAAREC, "Colony Collapse Disorder," at [http://maarec.cas.psu.edu/FAQ/FAQCCD.pdf].

[28] USDA, CCD Steering Committee, "Colony Collapse Disorder Action Plan," June 20, 2007, at [http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf].

[29] Most queens are purchased from suppliers in Florida, California, Texas, Georgia, and Hawaii, or from suppliers in Canada, Australia, and New Zealand.

[30] Cox Foster, D., Pennsylvania State University, Statement before the Subcommittee on Horticulture and Organic Agriculture, U.S. House of Representative, March 29, 2007, at [http://agriculture.house.gov/testimony/110/h70329/CoxFoster.pdf].

pathogen, given that some bee colonies have recovered once their bee boxes were irradiated.[31] Researchers have found the fungus, *Nosema ceranae,* and other pathogens such as chalkbrood in some affected hives throughout the country.[32] Some researchers have speculated that these high infection levels may be compromising the immune system of the honey bees, resulting in immune deficiencies in bees that may be among the possible causes for bee mortalities and disappearance.[33]

Others have speculated that because most of the reported colony losses are among large commercial migratory operations, which may move bees two to five times during a growing season, the current disorder may be the result of accumulated stress, and factors such as confinement and temperature fluctuations. These stresses may increase the colony's susceptibility to disease and may also increase its potential exposure to other diseases and parasites.[34] A 10% die-off is not uncommon following transportation, with losses of 30% possible.

Of the possible causes of CCD being examined, one that has become the subject of debate is whether certain chemicals or combinations of chemicals could be contributing to CCD, including some pesticides and possibly some fungicides. One class of insecticide being studied are neonicotinoids, which contain the active ingredient imidacloprid, and similar other chemicals, such as clothianidin and thiamethoxam. Honey bees are thought possibly to be affected by such chemicals, which are known to work their way through the plant up into the flowers and leave residues in the nectar and pollen. The scientists studying CCD note that the doses taken up by bees are not lethal, but they are concerned about possible chronic problems caused by long-term exposure. As noted by the NRC, some studies report sublethal effects of pesticides on bee foraging behavior that may impair the navigational and foraging abilities of honey bees.[35]

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[31] Ramanujan, K., "Parasites, pathogens and pesticides called possible suspects in honeybee decimation," *Cornell Chronicle*, Cornell University, May 17, 2007, at [http://www.news.cornell.edu/Chronicle/07/05_17_07.pdf].

[32] Henderson, C., L. Tarver, D. Plummer, R. Seccomb, S. Debnam, S. Rice, J. Bromenshenk, and J. Glassy, "U.S. National Bee Colony Loss Survey, Preliminary Findings with Respect to Colony Collapse Disorder (CCD)," March 26, 2007, at [http://www.beealert.info/].

[33] Cox Foster, D., Pennsylvania State University, and Rexrod, C., USDA's ARS, Statement before the Subcommittee on Horticulture and Organic Agriculture, U.S. House of Representatives, March 29, 2007, at [http://agriculture.house.gov/testimony/110/h70329/CoxFoster.pdf] and [http://agriculture.house.gov/testimony/110/h70329/Rexroad.pdf]; and published interview with Jerry Hayes, Florida's Department of Agriculture, Apiary Section, March 2, 2007, at [http://www.loe.org].

[34] vanEngelsdorp, D. et al., "Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006; Rexrod, C., USDA's ARS, Statement before the Subcommittee on Horticulture and Organic Agriculture, U.S. House of Representative, March 29, 2007, at [http://agriculture.house.gov/testimony/110/h70329/Rexroad.pdf].

[35] National Academy of Sciences, National Research Council, *Status of Pollinators in North America*, 2006.

Concerns about imidacloprid, as reported by beekeeping associations in the United Kingdom and France[36] and by some U.S. beekeepers,[37] have focused on its potential to affect complex behaviors in insects, including flight, navigation, olfactory memory, recruitment, foraging, and coordination. However, the NRC and some scientists who study CCD note there is conflicting information about the effect of these pesticides on honey bees. Still, the U.S. Environmental Protection Agency has identified some of these chemicals as highly toxic to honey bees,[38] and use of some of these pesticides has reportedly been discontinued in parts of Europe because of their potential effects on pollinators.[39] However, bee colony losses are also occurring in Europe, where these chemicals are reportedly no longer used. In the United States, the Organic Consumers Association reports that bee colony losses are not occurring at organic beekeeping operations.[40]

Other reported theories include the effects of shifting spring blooms and earlier nectar flow associated with broader global climate and temperature changes,[41] the effects of feed supplements that are produced from transgenic or genetically modified crops, such as high-fructose corn syrup,[42] and also the effects of cell phone transmissions and radiation from power lines that may be interfering with a bee's navigational capabilities.[43] The contributions of these possible factors have not been substantiated by evidence examined by the key researchers of this issue.[44]

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[36] Northwest Coalition for Alternatives to Pesticides, "Imidacloprid, Fact Sheet," *Journal of Pesticide Reform*, Spring 2001, at [http://www.pesticide.org/imidacloprid.pdf]; Apiculteurs de France, "Composite Document of Present Position Relating to Gaucho, Sunflower and Bees, at [http://www.beekeeping.com/articles/us/gaucho/manifestation_paris_us.htm].

[37] Pastis, S., "Mysterious Bee Deaths Strike Central Valley," *Valley Voice*, [no date], at [http://www.valleyvoicenewspaper.com/vv/stories/beedeaths.htm].

[38] For example, see EPA's fact sheet on clothianiden, issued May 3002, at [http://www.epa.gov/opprd001/factsheets/clothianidin.pdf].

[39] vanEngelsdorp, D. et al., "Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006; published interview with Jerry Hayes, Florida's Department of Agriculture, Apiary Section, March 2, 2007, at [http://www.loe.org].

[40] Organic Consumers Association, "Honey Bee Health & Colony Collapse Disorder,"at [http://www.organicconsumers.org/bees.cfm].

[41] Esaias, W., "Honey Bees, Satellites and Climate Change," presentation at the Library of Congress, April 3, 2007.

[42] See, for example, research conducted by Hans-Hinrich Kaatz, University of Halle, Germany, cited at [http://www.sierraclub.org/biotech/references.asp] and also research cited at [http://www.moraybeekeepers.co.uk/gmbees.htm].

[43] Reportedly, this theory originated with initial research conducted in 2003 by J. Khun and H. Stever of Landau University in Germany.

[44] Statements and expert testimony at a public hearing of the U.S. House of Representatives, Subcommittee on Horticulture and Organic Agriculture, March 29, 2007.

USDA's CCD Action Plan

USDA released its action plan for addressing CDC in July 2007. USDA's action plan focuses on improving coordination and redirecting existing resources and research for mitigation and prevention, including education and outreach, as well as expanding research and diagnostic resources to prevent future losses, working with the land grant universities. It also coordinates activities across three USDA agencies: Agricultural Research Service (ARS), Animal and Plant Health Inspection Service (APHIS), and Cooperative State Research, Education, and Extension Service (CSREES). USDA's focus on expanded research is consistent with the approach taken in the most recently introduced Congressional bills and with recommendations by the American Honey Producers Association and the American Beekeeping Federation.[45]

Under the plan, USDA will: (1) conduct surveys and collect data on bee health; (2) analyze bee samples for pests, disease-causing pathogens, pesticide exposure, and other factors; (3) conduct controlled experiments to identify factors affecting bee health, including potential causes of colony collapses; and (4) develop best management practices and guidelines to improve the general bee health and reduce their susceptibility to colony collapses and other disorders, among both honey bees and non-*Apis* bees.[46] Aspects of USDA's action plan were presented at a hearing before the Subcommittee on Fisheries, Wildlife, and Oceans of the House Committee on Natural Resources in June 2007.[47]

Issues for Congress

In March 2007, the House Subcommittee on Horticulture and Organic Agriculture held a hearing to review the recent honey bee colony declines reported throughout the United States. In June 2007, the Subcommittee on Fisheries, Wildlife, and Oceans of the House Committee on Natural Resources held a hearing on the role of pollinators in ecosystem health, which also addressed concerns about bee colony declines. Based on information presented to Congress, both by scientists researching recent bee colony declines and by agricultural producers who may be potentially affected by these losses, Congress could consider options for subsequent action in this area.

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[45] Addee, R., American Honey Producers Association, Statement before the Subcommittee on Horticulture and Organic Agriculture, House Committee on Agriculture, March 29, 2007, at [http://agriculture.house.gov/testimony/110/h70329/Adee.pdf]; Weaver, D., American Beekeeping Federation, Inc., Statement before the Subcommittee on Fisheries, Wildlife and Oceans, House Committee on Natural Resources, June 26th, 2007, at [http://resources committee.house.gov/images/Documents/20070626/testimony_weaver.pdf].

[46] USDA, CCD Steering Committee, "Colony Collapse Disorder Action Plan," June 20, 2007, at [http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf].

[47] Hackett, K., USDA, Statement before the Subcommittee on Fisheries, Wildlife and Oceans, House Committee on Natural Resources, June 26th, 2007, at [http://resources committee.house.gov/images/Documents/20070626/testimony_hackett.pdf].

Policy options that were discussed at these House subcommittee hearings focused on the need for increased federal funding for multi-disciplinary research and monitoring to document changes in pollination reserves, as well as additional technical support and assistance for beekeepers. Additional research funding would help support USDA's research efforts and those at its laboratories located in Arizona, Louisiana, Maryland, Texas, and Utah.[48] Other recommended options include expanding crop insurance to include beekeepers and honey producers; providing a one-time payment for incurred losses; improving existing USDA conservation programs to better prevent habitat loss and sustain wildlife populations; emphasizing the importance of pollinator diversity and sustaining wild and native pollinator species; developing or improving existing federal and state best management practices for beekeepers; improving regulatory enforcement to prevent misuse of agricultural chemicals; and continuing the current marketing loan program for honey.

A bill introduced by Congressman Hastings (H.R. 1709) would provide additional funding for bee and CCD-related research by increasing research at USDA. Specifically, the bill would authorize funding levels between $3 million and $7.25 million annually for apicultural research at USDA's ARS, and would also authorize funding for USDA research grants through USDA's CSREES at $10 million annually (FY2008-FY2012). Many of the provisions in H.R. 1709 were included in the House-passed farm bill (H.R. 2419, section 11315). A similar bill was introduced by Senator Boxer, S. 1694.

Other bills have been introduced that aim to protect the pollinator habitats. One bill introduced by Senator Baucus, S. 1496, would modify three of the major farm conservation programs — the Conservation Reserve Program, the Conservation Security Program, and the Environmental Quality Incentives Program — amending current law to broaden the focus of these programs to include pollinator habitats and pollinator habitat improvement, in addition to other program goals. Another bill, introduced by Congressman Blumenauer, H.R. 2913, would ensure a greater emphasis within USDA's farm conservation programs to increase habitat for native and managed pollinators and to establish cropping systems, integrated pest management regimes, and other practices that protect native and managed pollinators. Reportedly, the Xerces Society for Invertebrate Conservation has been working with USDA and with some states to better incorporate native pollinators into existing farm conservation programs in the farm bill and within state agencies.[49]

Prior and existing laws have been enacted to support the U.S. beekeeping sector and to ensure continued pollination for agricultural crops. For example, in 1970,

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[48] Recent reports suggest that University of California at Davis is revitalizing its honey bee research program by hiring a nee breeder and geneticist and renovating the biology facility. See "News Briefs," *AgriPulse*, Vol. 3, Number 20, May 16, 2007.

[49] Berenbaum, M.R., University of Illinois, Statement before the U.S. House of Representatives, Subcommittee on Horticulture and Organic Agriculture, March 29, 2007, at [http://www7.nationalacademies.org/ocga/testimony/Colony_Collapse_Disorder_and_Pollinator_Decline.asp]. Xerces is an international nonprofit organization dedicated to protecting biological diversity through invertebrate conservation [http://www.xerces.org/].

Congress authorized the Beekeeper Indemnity Program.[50] This program, administered by USDA, partially compensated beekeepers for colony losses due to exposure to agricultural pesticides that had been approved by the federal government. Beekeepers who exercised reasonable precautions to avoid pesticide damage but still lost bees were eligible to apply for indemnity payments after January 1, 1967. This program expired in 1977.

The existing federal Honeybee Act authorizes USDA's APHIS to regulate the importation of honey bees and related material to prevent the entry of honey bee diseases and parasites, as well as undesirable subspecies of honeybees.[51] Several states also have apiary inspection programs to prevent the spread of diseases such as American foulbrood and parasitic mites. Funding is provided for a range of pollinator and bee disease research programs within USDA, mainly within ARS and CSREES.

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[50] Section 804 of the 1970 Agricultural Act, P.L. 91-524. The program was extended in 1973, authorizing payments to eligible beekeepers through December 31, 1977.

[51] USDA, APHIS "Plant Protection and Honeybee Acts," at [http://www.aphis.usda.gov/plant_health/permits/organism/plant_protection_honeybee_acts.shtml]. Regulations on import permits for bees are at 7 CFR 322. The act was originally enacted August 31, 1922.