



Recent Honey Bee Colony Declines

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Summary

Starting in late 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). Reports indicate that beekeepers in 35 states have been affected. Overall, bee colony losses averaged about 30% in 2007, with continued average annual losses of 35% nationwide in 2008. To date, the reasons for colony losses are not yet known.

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. 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.

During the 110th Congress there were three House subcommittee hearings on honey bee colony declines and concerns about CCD. The House Subcommittee on Horticulture and Organic Agriculture held two hearings: one in March 2007 and a second in June 2008. The Subcommittee on Fisheries, Wildlife, and Oceans of the House Committee on Natural Resources held a hearing in June 2007 on the role of pollinators in ecosystem health, which also addressed concerns about bee colony declines. In the Senate, in April 2008, Chairwoman Barbara Boxer and other members of the Senate Environment and Public Works Committee hosted a briefing on pollinators and their role in agricultural security.

The enacted 2008 farm bill (P.L. 110-246) contains provisions that would, among other things, provide additional funding for research and conservation programs addressing honey bees and pollinators.

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Starting 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). Overall, bee colony losses averaged about 30% in 2007, with continued average annual losses of 35% nationwide in 2008. Current reports indicate that beekeepers in 35 states have been affected. To date, the reasons for colony losses are not yet known.

This report provides an overview of the importance of honey bee pollination to U.S. agricultural production, especially specialty crops. It describes the extent and symptoms of CCD and how it differs from previous honey bee colony losses, describing some of the reasons why scientists believe honey bee colonies are being affected by CCD. Finally, this report discusses 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. In April 2008, Chairwoman Barbara Boxer and other members of the Senate Environment and Public Works Committee hosted a briefing on pollinators and their role in agricultural security. These hearings and briefings presented a range of policy options. The enacted 2008 farm bill (P.L. 110-246) contains provisions that would, among other things, provide additional funding for research and conservation programs addressing honey bees and pollinators.

Importance of Honey Bee Pollination

Honey bees (*Apis mellifera*) are the most economically valuable pollinators of agricultural crops worldwide and are the only bee species kept commercially in the United States.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

The monetary value of honey bees as commercial pollinators in the United States is estimated at about \$15 billion annually³ (**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

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

² M. R. Berenbaum, 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>; J. Pettis, 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 (wheat, corn, and rice) do not rely on insect pollination and are mostly wind pollinated.

³ R. A. Morse 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).

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.

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	—	—	14,564	—

Source: Compiled by CRS using values reported in R. A. Morse, 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>.

- 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).
- 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.
- Apricots, avocados, blueberries, brambleberries, cherries, cranberries, grapes, kiwi fruit, macadamia nuts, olives, peaches, pears, nectarines, plums, and strawberries.
- Asparagus, cauliflower, celery, cucumbers, pumpkins, squash, watermelon, and vegetable seeds.
- Peanuts, canola (rapeseed), and sugarbeets.

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 most recent U.S. Department of Agriculture (USDA) data indicate that there were about 17,000 operations with 2.4 million bee colonies in the United States.⁶ The majority of these, more than 2 million bee colonies, are reported to belong to commercial migratory beekeepers. About one-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%. Although 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.

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.⁷ 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 2005.⁸ 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.⁹

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

⁴ Ibid. Another study found that pollinators are essential for the production of some U.S.-grown crops, particularly macadamia nuts, squash, and pumpkins. A.-M. Klein, et. al, "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, *Honey*, February 2007, at <http://usda.mannlib.cornell.edu/usda/nass/Hone/2000s/2007/Hone-02-28-2007.pdf>; and 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.

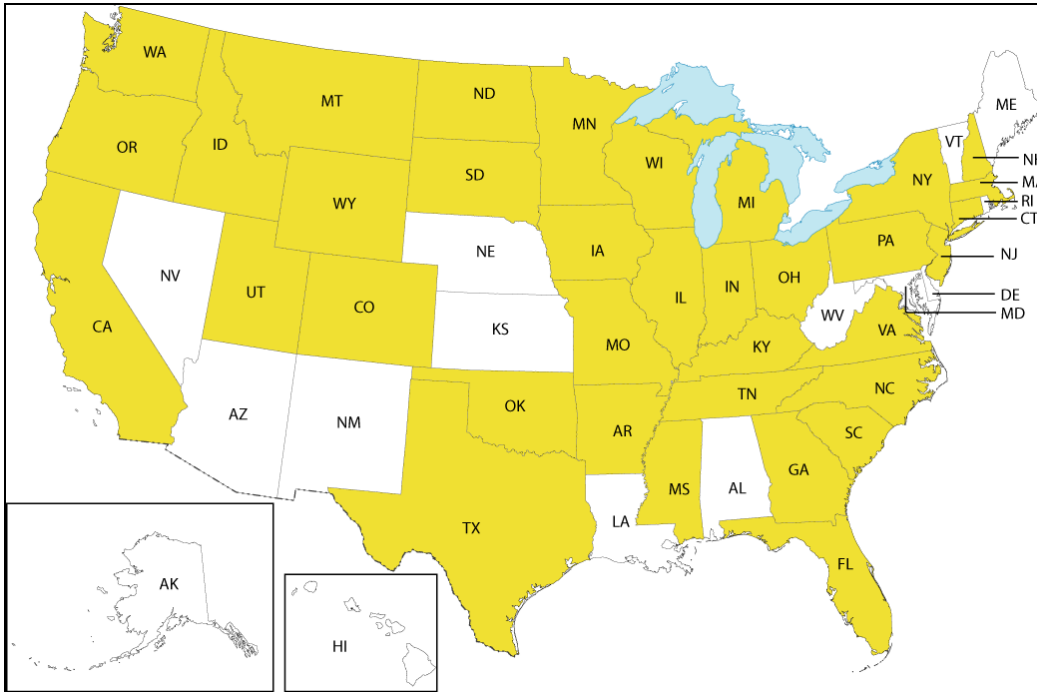
⁷ M. Burgett, *1999 Pacific Northwest Honey Bee Pollination Survey*, Oregon State University.

⁸ National Academy of Sciences, National Research Council, *Status of Pollinators in North America*, 2006.

⁹ USDA, CCD Steering Committee, "Colony Collapse Disorder Action Plan," June 20, 2007, at http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf.

end of 2006, beekeepers on the West Coast also began to report “unprecedented” losses.¹⁰ Current reports indicate that beekeepers in 35 states have been affected (**Figure 1**). Because of the severity and lack of precedent, scientists coined a new term, Colony Collapse Disorder (CCD), for this phenomenon.

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



Source: Bee Alert Inc., “Map of U.S. States Reporting Colony Collapse Disorder,” <http://beealert.blackfoot.net/~beealert/USshaded.pdf>. Shaded areas show reported affected states. This is the most recent update (as of January 2009).

Much of the current research on CCD is being conducted by scientists at USDA’s Agriculture Research Service (Beltsville bee laboratory), Pennsylvania State University, the University of Montana, and the Pennsylvania and Florida Departments of Agriculture, among others. 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.

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

¹⁰ D. 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.

declines due to the pathogen *Paenibacillus larvae*.¹¹ 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 1984.¹² *Varroa* mites are also said to have eliminated most feral bee colonies in the mid-1990s.¹³ *Varroa* 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.¹⁴ 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.

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. By comparison, bee colony losses for 2007 and 2008 have averaged about 30% and 35%, respectively, during the year.

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 varied widely, ranging from 30% to 90% of their bee colonies; in some cases beekeepers feared loss of nearly all of their colonies.¹⁵ Surviving colonies were reportedly weakened and might no longer be viable to

¹¹ National Academy of Sciences, National Research Council, *Status of Pollinators in North America*, 2006.

¹² 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>.

¹³ R. A. Morse 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>.

¹⁴ Similar conditions have been termed autumn collapse, May disease, spring dwindle, disappearing disease, and fall dwindle disease.

¹⁵ 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 (continued...)"

pollinate or produce honey. Losses were 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%.¹⁶ Bee colony losses also were reported in five Canadian provinces, several European countries, and countries in South and Central America and Asia.

In March 2007, the Apiary Inspectors of America (AIA) conducted a survey of its members in 15 states.¹⁷ 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 that winter.¹⁸ While a majority of losses were attributable to known causes, approximately 25% of beekeepers are believed to have suffered from CCD.¹⁹ The survey indicated 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.²⁰ 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 2007.²¹ 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) indicated 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.²²

Colony losses have reportedly continued during the winter 2007-2008 season. A recent USDA survey, along with even more recent survey information from AIA, indicates that overall average

(...continued)

of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006," December 15, 2006.

¹⁶ MAAREC, "Colony Collapse Disorder," at <http://maarec.cas.psu.edu/FAQ/FAQCCD.pdf>.

¹⁷ D. vanEngelsdorp, 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.

¹⁸ Estimated at the 95% confidence interval.

¹⁹ 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).

²⁰ Other reports indicate that the 2007 AIA survey found 30% colony losses.

²¹ C. Henderson, 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.bealert.info/>. More than 400 responses received.

²² E. Burdick and D. M. Caron, MAAREC Beekeeper Survey, University of Delaware, at <http://maarec.cas.psu.edu/pdfs/MAARECSurveyPub.pdf>.

loss across 21 states is 35%, with losses ranging widely depending on area from 7% to 80% loss at some surveyed operations.²³

How CCD Differs from Past Bee Colony Losses

Current bee colony losses seem to differ from past losses 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 why these losses are occurring remains still largely unknown.

The current phenomenon was first called “Fall-Dwindle Disease,” but was renamed because of the unusual characteristics of the colony declines. Moreover, the condition is not only seasonal but manifests itself throughout the year. The term “dwindle” implies a gradual loss, whereas CCD onset is sudden. Also, the term “disappearance” is 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.²⁴

Symptoms of Colony Collapse Disorder

The symptoms of CCD, based on the current research, include the following:²⁵

- rapid loss of adult worker bees,
- few or no dead bees found in the hive,
- presence of immature bees (brood),
- small cluster of bees with live queen present, and
- pollen and honey stores in hive.

Among the key symptoms of CCD in collapsed colonies is that the adult population is suddenly gone without any accumulation of dead bees. 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

²³ Jeff Pettis, “Colony Collapse Disorder Affecting Honey Bee (*Apis mellifera*) colonies,” October 2008 presentation <http://www.epa.gov/pesticides/ppdc/2008/oct2008/session7-ccd.pdf>. Survey based on 22 operations, managing 10% of U.S. colonies, and AIA surveys.

²⁴ D. vanEngelsdorp, D. Cox Foster, M. Frazier, N. Ostiguy, and J. Hayes, “Fall Dwindle Disease: Investigations into the Causes of Sudden and Alarming Colony Losses Experienced by Beekeepers in the Fall of 2006,” December 15, 2006.

²⁵ D. 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; published interview with Maryann Frazier, Penn State University, January 28, 2007, at <http://podcasts.psu.edu/taxonomy/term/62>; and Jeff Pettis, “Colony Collapse Disorder Affecting Honey Bee (*Apis mellifera*) colonies,” October 2008 presentation <http://www.epa.gov/pesticides/ppdc/2008/oct2008/session7-ccd.pdf>.

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.

Possible Causes of Colony Collapse Disorder

The current search for factors involved in CCD focuses on four areas:²⁶

- pathogens,
- parasites,
- environmental stresses, and
- bee management stresses such as poor nutrition.

Early on, researchers had tentatively removed some practices and conditions from the list of possible causes of CCD. These included feeding practices, chemicals used by beekeepers (such as antibiotics and miticides), use of bees (primarily for honey production versus pollination), and queen source.²⁷ However, the scientists researching this phenomenon note that 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.²⁸ Others note the possible role of miticide resistance in bees.

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.²⁹ A 10% die-off is not uncommon following transportation, with losses of 30% possible.

Parasites, Mites, and Disease

Initially, the potential causes of CCD, as reported by the scientists researching this phenomenon, were thought to include but not be limited to 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,

²⁶ USDA, ARS, "Questions and Answers: Colony Collapse Disorder," January 2008, at <http://www.ars.usda.gov/News/docs.htm?docid=15572>.

²⁷ Most queens are purchased from suppliers in Florida, California, Texas, Georgia, and Hawaii, or from suppliers in Canada, Australia, and New Zealand.

²⁸ D. Cox Foster, 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>.

²⁹ D. 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; C. Rexrod, 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>.

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.³⁰

In July 2007, USDA reported that theories about the causes of CCD were 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.³¹ In September 2007, a research team that included USDA published the results of a genetic screening of CCD-affected honey bee colonies and non-CCD-affected hives.³² The only pathogen found in nearly all samples (96.1%) from CCD-affected colonies, but not in non-CCD colonies, was the Israeli acute paralysis virus (IAPV), a dicistrovirus that can be transmitted by the *Varroa* mite.³³ USDA considers this research to have identified IAPV as a marker of CCD, since it is found in affected bees, but not to have identified IAPV as the cause of CCD; however, this research indicates there is a strong correlation of the appearance of IAPV and CCD together.³⁴

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 pathogen, given that some bee colonies have recovered once their bee boxes were irradiated.³⁵ Researchers have found the fungus *Nosema ceranae* and other pathogens such as chalkbrood in some affected hives throughout the country.³⁶ 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.³⁷

³⁰ 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>.

³¹ USDA, CCD Steering Committee, "Colony Collapse Disorder Action Plan," June 20, 2007, at http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf.

³² D. L. Cox-Foster et al., "A Metagenomic Survey of Microbes in Honey Bee Colony Collapse Disorder," *Science*, September 6, 2007, at <http://www.sciencemag.org/cgi/content/abstract/318/5848/283>.

³³ USDA, ARS, "Questions and Answers: Colony Collapse Disorder," January 2008, at <http://www.ars.usda.gov/News/docs.htm?docid=15572>. The study also found IAPV in honey bees from Australia that had been imported into the United States, as well as in royal jelly imported from China. Further studies challenge the idea that IAPV is a recent introduction from imported bees.

³⁴ USDA press release, "Genetic Survey Finds Association Between CCD and Virus," September 6, 2007, at <http://www.ars.usda.gov/is/pr/2007/070906.htm>; MAAREC statement, "Colony Collapse Disorder and Israeli Acute Paralysis Virus," <http://maarec.cas.psu.edu/CCDPpt/CCDbeekeepersStatementIAPV.pdf>.

³⁵ K. Ramanujan, "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.

³⁶ C. Henderson, 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/>.

³⁷ D. Cox Foster, Pennsylvania State University, and C. Rexrod, 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>.

Pesticides and Chemicals

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. Scientists have long been concerned that pesticides may have sub-lethal effects on bees, not killing them outright but instead impairing their development and behavior.³⁸

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 (which is the food for young, developing bees). The scientists studying CCD have tested samples of pollen and have indicated findings of a broad range of substances, including insecticides, fungicides, and herbicides.³⁹ These scientists 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.⁴⁰

Concerns about imidacloprid, as reported by beekeeping associations in the United Kingdom and France⁴¹ and by some U.S. beekeepers,⁴² 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,⁴³ and use of some of these pesticides has reportedly been discontinued in parts of Europe because of their potential effects on pollinators.⁴⁴ 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.⁴⁵

³⁸ Frazier, M., et. al, "What Have Pesticides Got To Do With It?" American Bee Journal, June 2008, <http://maarec.cas.psu.edu/CCDPpt/WhatPesticidesToDoWithItJune08ABJ.pdf>.

³⁹ S. Williams, "The Case of the Missing Bees," Penn State Agriculture Magazine, Winter/Spring 2008, available at <http://aginfo.psu.edu/psa/08WinSpr/bees.html>.

⁴⁰ National Academy of Sciences, NRC, *Status of Pollinators in North America*, 2006.

⁴¹ Northwest Coalition for Alternatives to Pesticides, "Imidacloprid, Fact Sheet," *Journal of Pesticide Reform*, Spring 2001, <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.

⁴² Joe Cummins, "Neonicotinoid insecticides used in seed dressing may be responsible for the collapse of honeybee colonies," April 24, 2007, at http://www.organicconsumers.org/articles/article_4972.cfm.

⁴³ For example, see EPA's fact sheet on clothianidin, issued May 3002, at <http://www.epa.gov/oppr001/factsheets/clothianidin.pdf>.

⁴⁴ D. 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; published interview with Jerry Hayes, Florida's Department of Agriculture, Apiary Section, March 2, 2007, at <http://www.loe.org>.

⁴⁵ Organic Consumers Association, "Honey Bee Health & Colony Collapse Disorder," at <http://www.organicconsumers.org/bees.cfm>.

Nevertheless, a number of environmental groups are taking legal action to highlight the possibility that pesticides and chemical loads may be contributing to colony declines. In August 2008, the Natural Resources Defense Council (NRDC) filed a lawsuit against the U.S. Environmental Protection Agency (EPA) to obtain information that they allege the U.S. government is withholding about the risks posed by pesticides to honey bees. NRDC claims EPA has evidence of connections between pesticides and CCD.⁴⁶ Also in August, a German coalition group brought legal charges against Bayer AG, accusing them of “marketing dangerous pesticides” and contributing to bee colony declines.⁴⁷ The coalition filed the charge in cooperation with German beekeepers who claim they lost hives because of the Bayer pesticide clothianidin dating back to May 2008.

Other Factors

Other reported theories include the effects of shifting spring blooms and earlier nectar flow associated with broader global climate and temperature changes,⁴⁸ the effects of feed supplements that are produced from transgenic or genetically modified crops, such as high-fructose corn syrup,⁴⁹ and also the effects of cell phone transmissions and radiation from power lines that may be interfering with a bee’s navigational capabilities.⁵⁰ The contributions of these possible factors have not been substantiated by evidence examined by the key researchers of this issue.⁵¹

USDA’s Action Plan and Progress Reports

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.⁵²

⁴⁶ NRDC press release, “EPA Buzz Kill: Is the Agency Hiding Colony Collapse Disorder Information?” August 18, 2008, <http://www.nrdc.org/media/2008/080818a.asp>.

⁴⁷ “German Coalition Sues Bayer Over Pesticide Honey Bee Deaths,” *Environmental News Service*, August 25, 2008, <http://www.ens-newswire.com/ens/aug2008/2008-08-25-01.asp>.

⁴⁸ W. Esaias, “Honey Bees, Satellites and Climate Change,” presentation at the Library of Congress, April 3, 2007.

⁴⁹ See, for example, Louise A. Malone and Minh-Hà Pham-Delègue, “Effects of transgene products on honey bees (*Apis mellifera*) and bumblebees (*Bombus* sp.),” *Apidologie*, 32, 2001, at <http://www.hortresearch.co.nz/files/science/gmimpacts/m1403malone.pdf>; also research conducted by Hans-Hinrich Kaatz, University of Halle, Germany, cited at <http://www.sierraclub.org/biotech/references.asp>.

⁵⁰ Reportedly, this theory originated with initial research conducted in 2003 by J. Khun and H. Stever of Landau University in Germany.

⁵¹ Statements and expert testimony at a public hearing of the U.S. House of Representatives, Subcommittee on Horticulture and Organic Agriculture, March 29, 2007.

⁵² R. Addee, 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>; D. Weaver, American Beekeeping Federation, Inc., Statement before the Subcommittee on Fisheries, Wildlife and Oceans, House Committee on Natural Resources, June 26th, 2007, at <http://resourcescommittee.house.gov/> (continued...)

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.⁵³ 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 2007.⁵⁴

Funding for honey bee and CCD research at USDA's ARS averaged more than \$7.7 million annually in FY2007 and FY2008. Proposed funding for FY2009 is \$8.6 million. ARS also has an "Area-wide Project on Bee Health," which consists of temporary funding of \$670,000 in FY2008 and will continue for at least four additional years at approximately \$1 million per year.⁵⁵ Additional funding is available to USDA's CSREES, and includes combined research on honey bees, funding specific to CCD and bee health, and funding for various research labs and grants. Recently, emerging issues grants were awarded to Penn State University and the University of Georgia to study the effects of pesticides, pathogens, and miticides on pollinator populations.⁵⁶

USDA will publish its 2007-2008 progress report on its ongoing and intended future research efforts related to honeybees and CCD in early 2009.⁵⁷

Other Related Events

In late 2008, beekeepers in some states began to raise concerns about live bee imports from Australia. Specifically, these concerns centered on reports that the Asian honey bee, *Apis cerana*, had been introduced to Australia. Asian honey bees, found in southeast Asia, are considered an invasive species of bees and are known to carry a mite (*tropilaelaps clarae*). Neither the Asian honey bee nor the mite are known to be present in the Western Hemisphere. However, U.S. beekeepers have expressed concerns that bee imports could result in the introduction of mites and other diseases and further contribute to stressors already facing domestic species.⁵⁸

(...continued)

images/Documents/20070626/testimony_weaver.pdf.

⁵³ USDA, CCD Steering Committee, "Colony Collapse Disorder Action Plan," June 20, 2007, at http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf.

⁵⁴ K. Hackett, USDA, Statement before the Subcommittee on Fisheries, Wildlife and Oceans, House Committee on Natural Resources, June 26th, 2007, at http://resourcescommittee.house.gov/images/Documents/20070626/testimony_hackett.pdf.

⁵⁵ CRS communication with USDA personnel, December 4, 2008; Jeff Pettis, "Colony Collapse Disorder Affecting Honey Bee (*Apis mellifera*) colonies," October 2008 presentation <http://www.epa.gov/pesticides/ppdc/2008/oct2008/session7-ccd.pdf>. The Conference Report of the 2008 Consolidated Appropriations Act (P.L. 110-161) identified CCD as an area that USDA is encouraged to take appropriate actions, using available resources.

⁵⁶ Statements by Jeff Pettis, USDA, to Senate Environment and Public Works committee staff, April 9, 2008.

⁵⁷ CRS communication with USDA personnel, December 4, 2008.

⁵⁸ CRS communications with USDA APHIS on December 23, 2008. Also see, e.g., Kim Flottum, "Why the U.S. Should Stop Importing Bees from Australia," December 15, 2008, at <http://www.thedailygreen.com/environmental-news/blogs/bees/australian-bee-imports-88121501?src=rss>.

In November 2008, Australia notified APHIS of an incursion of Asian honey bees in the Cairns, Queensland, area of northeastern Australia, and Australia voluntarily stopped issuing export certificates to ship honey bees to the United States. In response, APHIS required that all honeybee exports be derived from colonies 100 miles away from any find of Asian honey bees known to have occurred in the last two years. As of late December, Australian shipments of honey bees to the United States have resumed. APHIS's decision to resume trade was based on data provided by Australia indicating that the areas outside the quarantine zone in Cairns are free the Asian honey bee and of the mites of concern.⁵⁹

Live bees (only queens with attendants and package bees) are allowed for import into the United States from Canada, Australia, and New Zealand. Imports from other countries are restricted. Certain import requirements apply along with general restrictions regarding the transit of live honey bees, bee byproducts, and bee equipment.⁶⁰ Items that are not allowed for transit include imports of whole colonies in hives, used beekeeping equipment, and pollen. Restrictions apply on beeswax for beekeeping and honey for bee feed, and require special treatment.⁶¹

Issues for Congress

During the 110th Congress there were three House subcommittee hearings on honey bee colony declines and concerns about CCD. The House Subcommittee on Horticulture and Organic Agriculture held two hearings: one in March 2007 and a second in June 2008. The Subcommittee on Fisheries, Wildlife, and Oceans of the House Committee on Natural Resources held a hearing in June 2007 on the role of pollinators in ecosystem health, which also addressed concerns about bee colony declines. In the Senate, in April 2008, Chairwoman Barbara Boxer and other members of the Senate Environment and Public Works Committee hosted a briefing on pollinators and their role in agricultural security.

Policy options discussed at these congressional hearings and briefings 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.⁶² Other recommended options included 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.

⁵⁹ CRS communications with USDA APHIS on December 23, 2008.

⁶⁰ For information, see USDA APHIS import requirements: "Regulated Organism and Soil Permits, Honey Bees and Other Bees," at http://www.aphis.usda.gov/plant_health/permits/organism/bees/index.shtml.

⁶¹ See 7 CFR Part 322, Subpart E, "Importation and Transit of Restricted Articles."

⁶² There were reports in 2007 that the University of California at Davis was considering revitalizing its honey bee research program by hiring a bee breeder and geneticist and renovating the biology facility ("News Briefs," *AgriPulse*, Vol. 3, No. 20, May 16, 2007).

On May 22, 2008, Congress enacted the 2008 farm bill (P.L. 110-246). The enacted bill contains provisions that would, among other things, provide additional funding for research and conservation programs addressing honey bees and pollinators. The bill reflects provisions that were included in both the House- and Senate-passed versions of the farm bill, which provided for honey bees and pollinators as part of their conservation, specialty crop, research, and miscellaneous title provisions. Below is a summary of these provisions.

The conservation title of the 2008 farm bill includes language that broadly encourages habitat development and protection among the administrative requirements for native and managed pollinators under USDA's conservation programs (Section 2708) and ensures that USDA's conservation technical assistance includes standards that account for native and managed pollinators (Section 2706). The inclusion of these provisions could broaden the focus of USDA's farm conservation programs to include pollinator habitats and habitat improvement among the goals of these programs, as well as require USDA to review its conservation practice standards with respect to managed and native pollinators.

In addition, the research title of the 2008 farm bill identifies pollinator protection among its so-called high-priority research and extension areas (Section 7204). This provision provides for research and extension grants (1) to survey and collect data on bee colony production and health; (2) to investigate pollinator biology, immunology, ecology, genomics, and bioinformatics; (3) to conduct research on various factors that may be contributing to or associated with colony collapse disorder and other serious threats to the health of honey bees and other pollinators, including parasites and pathogens of pollinators, and the sublethal effects of insecticides, herbicides, and fungicides on honey bees and native and managed pollinators; (4) to develop mitigative and preventative measures to improve native and managed pollinator health; and (5) to promote the health of honey bees and native pollinators through habitat conservation and best management practices. For this provision, the 2008 farm bill authorizes appropriations for grants at \$10 million annually for FY2008-FY2012.

The research title provisions also directs USDA to increase its capacity and infrastructure to address colony collapse disorder and other long-term threats to pollinator health (including hiring additional personnel) and to conduct research on colony collapse disorder and other pollinator issues at USDA's facilities. Annual appropriations are authorized at \$7.25 million (FY2008-2012), with another \$2.75 million annually (FY2008-2012) for honey bee pest and pathogen surveillance. The 2008 farm bill also directs USDA to submit an annual report to Congress on its response to Colony Collapse Disorder, indicating that the report should investigate the cause(s) of honey bee colony collapse and recommend appropriate strategies to reduce colony loss.

Additional provisions in the 2008 farm bill supporting pollinators are provided for in the enacted bill's crop insurance and other disaster assistance provisions. One such provision identifies honey farms as possible beneficiaries of the bill's supplemental agricultural disaster assistance (Section 12033); another provision provides contracts for additional policies and studies to carry out research and development regarding insurance policies that cover loss of bees (Section 12023). The enacted bill also contains provisions that generally support honey production. These include, for example, provisions pertaining to the National Honey Board (Section 10401-10402); provisions covering rates for marketing assistance loans for certain commodities, including honey (Section 1202); and other provisions covering certain nutrition title provisions (such as Section 4231).

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