

**So long, and thanks for all the honey:
Honey Bee Colony Collapse Disorder:
Agency response and implications for the future**

Mike Sandler
UP239: Disaster Prevention and Response
June 3, 2008



A bee smiling...or angry?

Abstract

Honey Bee Colony Collapse Disorder may become a slow-onset disaster due the pollinator's role in national food security. Honey bees are major pollinators of important food crops including almonds, apples, oranges, and blueberries. The loss of honey bees may result in future crops losses of billions of dollars. This paper presents a summary of the current knowledge about Colony Collapse Disorder, and a summary of government agency responses to this crisis. The response by government and others to Honey Bee Colony Collapse Disorder is compared with the responses to other species declines, including amphibian declines, sudden oak death, Mad cow disease (BSE), and posits reasons for differences between levels of response. The paper concludes by considering the implications of the crisis in an era of climate change and mass extinction.

Outline

- I. Honey Bee Colony Collapse Disorder - An Introduction
 - A. Crops Affected and Economic Impacts
 - B. Four Threats to Honey bees
 - C. Other theories: cell phones, climate change, and more

 - II. Other species' problems and comparisons
 - A. Frogs and amphibians
 - B. Sudden oak death
 - C. Mad cow disease

 - III. Responses to CCD
 - A. Government: Research, Regulatory, and Congressional
 - B. Other institutional responses
 - C. Contingencies

 - IV. Implications of this disaster
 - A. CCD: A slow onset disaster
 - B. Response in an era of mass extinction and climate change
 - C. Government responses and conclusion
-

I. HONEY BEE COLONY COLLAPSE DISORDER - AN INTRODUCTION

Honey bees (*Apis mellifera*, the western or European honey bee) are major pollinators of important food crops including almonds, apples, oranges, and blueberries. Close to 100 crop species in the U.S. rely to some degree on pollination services provided by this one species. Although grains would not be affected, fruits, nuts, and vegetables, which provide vitamins, require pollinators. Collectively, these crops make up approximately one-third of the U.S. diet, and include crops with an estimated value of \$15 billion per year, representing the healthiest part of the American diet. This paper describes the response to Honey Bee Colony Collapse Disorder, compares it to responses to other species declines, and discusses the implications of this slow onset disaster.

Over the past 50 years, many diseases and pests have diminished the U.S. honey bee population. Introduced pests and parasites, microbial diseases, pesticide drift, and competition with Africanized bees have all contributed to a population decline from 5.9 million colonies of honey bees in 1947 to 2.4 million colonies in 2005 (a typical bee colony contains 15,000 to 30,000 bees).

Colony collapse disorder (CCD) is the latest malady facing the honey bee. Beginning in 2007, American beekeepers began to notice the following phenomenon: 1) over about a week, bees leave the hive and fly away to die elsewhere; 2) the few bees left inside the hive carry multiple bee viruses and fungal infections. CCD is thought to be the cause of the loss of 60-70% of the U.S. commercial bee population over the winter of 2006-7. Europe's honey bees have also suffered. According to press reports, 20% of British bees died in the winter 2007-2008.

This paper will discuss the potential impact of CCD, the government's response to the crisis, and comparisons to other species die-offs.

Crops that require the honey bee for pollination include:

Soybeans, Cotton, Grapes, Almonds, Apples, Peanuts, Peaches, and Blueberries

Crops that benefit from honey bee pollinators include:¹

Asparagus, Apricots, Broadbeans, Caraway, Cherimoya, Chestnut, Chives, Citrus, Grapefruit, Lemon, Mandarin, Orange, Clove, Clovers, Coconut, Coffee, Cotton, Cowpeas, Cut flower seeds, Drug plants, Feijoa, Flax, Guava, Herbs (spices), Lima beans, Loquat, Mangosteen, Nectarines, Oil palm, Okra, Onion and Leek, Opium poppy, Papaya, Pears, Peppers, Pyrethrum, Safflower, Scarlet runner beans, Strawberry, Tephrosia, Tomatoes, Vanilla, Vegetable seeds, Anise, Chervil, and Endive

According to USDA study, symptoms of CCD include: 1) sudden loss of the colony's adult bee population with very few bees found near the dead colonies; 2) several frames with healthy, capped brood with low levels of parasitic mites, indicating that colonies were relatively strong shortly before the loss of adult bees and that the losses cannot be attributed to a recent infestation of mites; 3) food reserves that have not been robbed, despite active colonies in the same area, suggesting avoidance of the dead colony by other bees; 4) the weakened or abandoned hive is not taken over by other insects such as wax moths or hive beetle that usually take over hives; and 5) a laying queen often present with a small cluster of newly emerged attendants.¹

¹ USDA, Colony Collapse Disorder Action Plan, CCD Steering Committee
June 20, 2007 http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf

A. Economic Impacts of CCD

The value of the top 15 crops dependent on the honey bee as a primary pollinator was estimated at about \$5.7 billion in 1998. By dollar value, the major crops included apples at \$1.5 billion, almonds at \$959 million, melons at \$773 million, cucumbers and pears at just under \$300 million, and cherries at \$285 million.² Crops that are dependent on honey bees for 90% or more of their propagation include almonds, apples, avocados, blueberries, cherries, grapefruit and many types of citrus, pears, asparagus, broccoli, cucumber, onion, and more. Many types of field crops depend on the honey bee for 60% or more of their pollination, including alfalfa, cotton, and sunflowers.

Regarding state level economic impacts, a few examples show the importance of honey bee production to the agricultural economy. Alfalfa hay production in the state of Arizona was valued at \$307 million in 2007.³ The honey bee industry's products, including honey, beeswax, and pollinator services in Georgia generate an estimated \$70 million per year.⁴ South Dakota produces 30 million pounds of honey every year. Pennsylvania's \$61 million apple industry is heavily dependent on honey bees.

Substitutes for honey bees

According to the National Research Council, in order to bear fruit, three-quarters of all flowering plants, including most food crops, rely on pollinators for fertilization. Other native pollinators such as butterflies, bats, and some birds also face threats to their population. In decades past, desperate farmers have tried to approximate the services of honey bees by using giant blowers, helicopters, or mortar shells to try to spread pollen across the plants.⁵ Clearly, the best alternative is to save the honey bee.

B. Four Threats to Honey bees

Scientists have not yet determined the cause of CCD. Honey bee disappearances were also documented in the 1880s, the 1920s and the 1960s, but it is unclear how similar those instances were to the present. They are currently focusing on four potential categories of causes: pathogens, pests, stress, and pesticides. The true cause may be a combination of these factors, or it could be something else.

² Morse, R. A., and N. W. Calderone. 2000. "The value of honey bees as pollinators of U.S. crops in 2000." *Bee Culture* March 2000: 2-15. <http://www.masterbeekeeper.org/pdf/pollination.pdf>

³ USDA Agricultural Research Service. <http://www.ars.usda.gov/Research/docs.htm?docid=11059&page=1>

⁴ University of Georgia, College of Agricultural and Environmental Sciences. <http://interests.caes.uga.edu/insectlab/agimpact.html>

⁵ Barrionuevo, Alexei. "Honey bees Vanish, Leaving Keepers in Peril," *New York Times*, Feb. 27, 2007. <http://www.nytimes.com/2007/02/27/business/27bees.html?pagewanted=2&ei=5088&en=3aaa0148837b8977&ex=1330232400>

1. Pathogens

Throughout the 20th century, bacterial diseases, including European Foul Brood and American Foul Brood, have beset honey bees. American Foul Brood has become resistant to the antibiotics used against it. However, these Brood diseases only affect larvae and pupae, and do not affect grown honey bees, according to Benjamin Oldroyd of the University of Sydney, Australia.⁶ Oldroyd also describes a Protozoan, *Nosema apis*, that infests bees, and causes dysentery. However, Oldroyd says no signs of dysentery are present in CCD colonies. Oldroyd acknowledges that a new type of this Protozoa has been found in Europe, and could have contributed to CCD, but believes other explanations may have more merit.

Among viruses, the Israeli acute paralysis virus (IAPV) of bees, has been strongly correlated with CCD, and a second virus Kashmir bee virus (KBV) was found in three out of four colonies examined.⁷ An article published in *Science* by Diana Cox-Foster of Pennsylvania State University's Department of Entomology and others linked those viruses with Australian bees, stating, "Importation to the United States of bees from Australia began in 2004, coinciding with early reports of unusual colony declines."⁸

However, several Australian scientists disagreed, saying CCD has not occurred in Australia's bee population, and other countries reporting CCD (such as Greece, Poland, and Spain) have not imported bees from Australia.⁹ This debate is ongoing.

2. Pests

The Varroa mite (*Varroa destructor*) has been the major cause of the loss of most feral bee populations in the US. Major infestations in 1995-1996, and 2000-2001 caused losses of over 50% of bee colony populations in the northern U.S. American beekeepers are aware of the dangers of mite infestation, but according to the USDA, mites still pose a threat to honey bees, and they are developing a stronger immunity to miticides over time. Oldroyd states that mite infestations are obvious to beekeepers, and although they may contribute to colony decline in general, mite infestation alone would not lead to CCD symptoms.

3. Stress

Stress comprises a broad category as a potential cause of CCD. Stress could lower the bees' immune system, making them more susceptible to the pests or pathogens listed above. One source of stress on honey bees could be a result of the industrial agricultural

⁶ Oldroyd, Benjamin. (2007) What's Killing American Honey Bees? PLoS Biol 5(6): e168, June 12, 2007 <http://biology.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pbio.0050168>

⁷ Cox-Foster, Diana L. et al. "A Metagenomic Survey of Microbes in Honey Bee Colony Collapse Disorder," *Science* 12 October 2007: Vol. 318, No. 5848, pp. 283-287 <http://www.sciencemag.org/cgi/content/full/318/5848/283>

⁸ Ibid.

⁹ Anderson, Denis and Iain J. East. "The latest buzz about Colony Collapse Disorder" *Science* 8 February 2008: Vol. 319, No. 5864, pp. 724 - 725 <http://www.sciencemag.org/cgi/content/full/319/5864/724c>

model, whereby honey bee colonies are trucked to industrial farms during pollination season. Like an accountant during tax time, the bees become tired and more susceptible to health problems. The almond crop, in particular, utilizes 1.3 million of the 2.4 million U.S. colonies, and due to its concentrated and industrialized nature could lead to stress among bees during its short pollination season. According to Oldroyd, "Anecdotal evidence suggests that CCD is more common in businesses in which bees are trucked large distances and rented for pollination."¹⁰ Stress may come from other sources below as well.

4. Pesticides

Many beekeepers use chemicals to reduce losses from pests and pathogens. As noted above, the Varroa mite has become resistant to many of these chemicals, and beekeepers have had to increase doses, or change to stronger chemicals. Some of the newest pesticides are "systemic" meaning they are taken up through the plant's roots, and may concentrate in the nectar. Although these pesticides are tested to ensure they are nontoxic to humans, they are not tested for toxicity to beneficial insects, and many scientists believe that systemic pesticides disrupt insect neurology.

C. Other Theories

Cell phones

An article in the UK's *Independent* newspaper, provocatively titled, "Are mobile phones wiping out our bees?" refers to a study by scientists at Germany's University of Landau showing that bees react to electromagnetic radiation by refusing to return to their hive.¹¹ However, the study itself does not claim to have found the cause of CCD, CCD is not mentioned in the study, and the scientists involved have distanced themselves from newspaper articles that made any connection to CCD.^{12,13}

Climate change

Oldroyd notes that bees maintain a brood temperature between 34 and 35 C, regardless of ambient temperature outside. In experiments where the brood temperature fluctuates outside of this range, the bees exhibit deficiencies in learning and memory.¹⁴ Oldroyd

¹⁰ See citation 2.

¹¹ Lean, Geoffrey and Harriet Shawcross. "Are mobile phones wiping out our bees? Scientists claim radiation from handsets are to blame for mysterious 'colony collapse' of bees", *Independent UK*, Sunday, 15 April 2007

<http://www.independent.co.uk/environment/nature/are-mobile-phones-wiping-out-our-bees-444768.html>

¹² Kimmel, Stefan and Kuhn, Jochen et al. "Electromagnetic Radiation: Influences on Honey bees (*Apis mellifera*)" http://agbi.uni-landau.de/material_download/preprint_IAAS_2007.pdf

¹³ USDA Agricultural Research Service. Questions and Answers: Colony Collapse Disorder. <http://www.ars.usda.gov/News/docs.htm?docid=15572>

¹⁴ Tautz J, Maier S, Groh C, Rossler W, Brockmann A (2003) Behavioral performance in adult honey bees is influenced by the temperature experienced during their larval development. *Proc Nat Acad Sci U S A* 100: 7343–7347 <http://www.pnas.org/cgi/content/abstract/100/12/7343>

believes this is an area for further CCD research. If CCD is shown to have been caused by a new bacteria or fungus, climate change could potentially be a cause. It is possible that the emergence of such vectors could be facilitated by milder winters, which if they were colder could otherwise kill them back.

Perhaps the biggest threat from climate change is the potential to disrupt the overlap in seasonal timing (i.e. phenology) of flower production and of pollinator flight activity.¹⁵ Simply put, if the flowers begin blooming at different times, and the bees aren't in the air at the time, pollination will not occur, bees won't get fed, and the ecological system will collapse. Scientists are already documenting shifts in vegetation blooming patterns, but it is unclear whether this is playing any part in CCD.

Industrial agriculture

As noted above, industrial agricultural practices may play a role in increasing stress on honey bees when bees are transported long distances to pollinate large areas of a single crop. The monoculture may play an additional role in weakening the honey bee by causing nutritional deficits. Wild or feral bees often pollinate multiple types of flowers, and benefit from a more diverse diet. By contrast, bees that subsist on monocultural crops have poorer nutrition. As with other theories above, these are elements that may contribute to a weakened bee population that is more susceptible to CCD, but not sole or even primary factors.

Since the exact cause of CCD is currently unknown, most research agrees that the best current response is improving bee health and habitat and countering known mortality factors.

II. OTHER SPECIES' PROBLEMS AND COMPARISONS

The loss of a pollinator such as the honey bee can lead to many other species extinctions. Pollinators are necessary to the food supply. This raises the question of whether one would expect the government response to pollinator population collapse to be faster and bring with it more resources than they would to a species population that was less important to the human food supply. A brief synopsis of the loss of other species, and government response provides insight into governmental priorities, and also provides context for Colony Collapse Disorder as the latest in what biologists call "the Sixth Extinction."

¹⁵ Memmott, Jane et al. "Global warming and the disruption of plant–pollinator interactions" *Ecology Letters*, Volume 10, Issue 8, Page 710-717, Aug 2007. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1461-0248.2007.01110.x>

A. Frogs

A study of amphibian populations, led by Jeff Houlahan, of the University of Ottawa in Canada, showed worldwide declines over the past four decades.¹⁶ An estimated 170 species of frogs have gone extinct in the last 10 years, and an additional 1,900 out of 6,000 are threatened. Threats include habitat destruction as the number one cause, but an emerging disease called chytridiomycosis caused by the chytrid fungus and global climate change are thought to be the biggest threats to amphibians. Scientists have tied climate change to some extinctions, saying it can encourage pathogen growth, and it is highly likely that it led to amphibian extinctions in Costa Rica.¹⁷

Regarding government response, the US Geological Survey, a part of the Department of the Interior, runs the Amphibian Research and Monitoring Initiative.¹⁸ The USGS also oversees several amphibian research initiatives, including the North American Amphibian Monitoring Program (NAAMP), the Amphibian Research and Monitoring Initiative, the Taskforce on Amphibian Declines and Deformities, and Frogwatch USA in collaboration with the National Wildlife Federation. However, according to the American Institute of Biological Sciences, "no federal government policy specifically targets amphibian population declines."¹⁹ Federal policy seems to be to monitor the declines, and then, if forced to, and if there is still time, listing each amphibian species as threatened or endangered.

B. Sudden oak death

Sudden oak death is a disease found in oak trees, but can be carried by numerous other native plants and trees. It has mostly been found north and south of San Francisco along the California coast, but more recently in coastal Oregon. The cause of outbreaks of Sudden Oak Death is a fungus-like organism, *Phytophthora ramorum*, which has killed over a million native oak and tanoak trees since 1995.

The USDA's Animal and Plant Health Inspection Service has been in charge of quarantining the infected plants, and coordinating at the national level.²⁰ The California Oak Mortality Task Force was created in August 2000 to bring together public agencies, other nonprofit organizations and private interests to address the issue of elevated levels of oak mortality.²¹

¹⁶ Houlahan, J. E., et al. "Quantitative evidence for global amphibian population declines." *Nature* 404:752-755. 2000. <http://www.ncbi.nlm.nih.gov/pubmed/10783886>

¹⁷ Pounds, Alan J. "Widespread amphibian extinctions from epidemic disease driven by global warming" *Nature* 439, 161-167. 12 January 2006

AmphibiaWeb. <http://amphibiaweb.org/declines/declines.html>

¹⁸ <http://armi.usgs.gov/>

¹⁹ American Institute of Biological Sciences, Washington Watch http://www.aibs.org/washington-watch/washington_watch_2007_02.html

²⁰ USDA, APHIS website. http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/regulations.shtml

²¹ California Oak Mortality Task Force <http://www.suddenoakdeath.org/>

C. Mad Cow (BSE)

Bovine spongiform encephalopathy (BSE), widely referred to as "mad cow disease," is a degenerative disease affecting the central nervous system of cattle. The primary source of BSE infection in cattle is commercial feed contaminated with the infectious agent from rendered infected cattle. In 1996, scientists in the United Kingdom discovered a new variant of Creutzfeld–Jakob disease, a human degenerative brain disease that infects humans as a result of eating BSE-infected beef. The first BSE-infected cow found in the U.S. was in 2003 (it had been imported from Canada, where a few cows had been infected), and inspectors have found two other infected U.S. cows since. There are 96.7 million cattle in the United States.²² The beef industry is valued at an estimated \$74 billion in 2007.

The U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS),²³ in cooperation with the Food and Drug Administration (FDA) and USDA's Food Safety and Inspection Service (FSIS), has taken aggressive measures to prevent the introduction and potential spread of BSE in the United States. The Center for Disease Control (CDC) and the National Center for Infectious Diseases monitor cases of BSE.²⁴ The U.S. Department of Health and Human Services' Food and Drug Administration (FDA) enforces the feed ban regulations adopted since the identification of BSE.²⁵ The World Organization for Animal Health also monitors BSE outbreaks internationally.

Comparing Responses

If we were to rank the governmental responses in order of resources and strength of actions taken, they would be in the following order:

- 1) High- BSE
- 2) Medium- Sudden Oak Death
- 3) Low- Frogs and amphibians

The loss of frogs and amphibians lacks the level of institutional motivation of honey bees and CCD. The loss of frogs and amphibians may not be classified as a "disaster," yet biologists often refer to amphibians as an indicator species, since they are most receptive to water pollution or other environmental contamination. From an ethical perspective, the loss of frogs is equal to that of honey bees. However, in an era of mass extinction, resources must be put towards their best uses, and pollinators play a larger role in the human food supply and in the plant kingdom. On the other hand, resources currently being used to wage war over oil could be better used to preserve the biological wealth of

²² National Agriculture Statistics Service

<http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1017>

²³ USDA Animal and Plant Health Inspection Service, BSE webpage.

http://www.aphis.usda.gov/newsroom/hot_issues/bse/index.shtml

²⁴ Center for Disease Control (CDC), BSE webpage. <http://www.cdc.gov/ncidod/dvrd/bse/>

²⁵ Food and Drug Administration (FDA) BSE webpage. <http://www.fda.gov/oc/opacom/hottopics/bse.html>

the natural world that we inherited and that we should, morally, pass on to future generations.

The governmental response to BSE was rapid, and continues to carry significant resources in research, education, regulatory action, monitoring, enforcement, and funding. Factors for its high response are: 1) the economic importance of the beef industry (including trade implications for imports and exports), 2) the dietary importance of beef to our "Fast Food Nation" country, 3) the human public health component due to vCJD. Regulations have phased out feeding sick animals to other animals used as food, and in some ways have improved the food supply. Of course, the type of governmental response has not included such broad approaches such as encouraging vegetarianism, or organic agricultural practices nationwide. They have been more focused on the "emergency" measures of culling herds, quarantining sick animals, and checking for new cases. Still, the BSE response involves a variety of government agencies that seem well coordinated and well funded compared to the other species losses surveyed.

The governmental response to Sudden Oak Death is in between the high level of response to BSE and the relatively low level to amphibians. Like frogs, oaks lack the human interaction, connection to food supply, and the public health aspect of BSE. However, because the problem has thus far been limited geographically, the government response has been focused, and the government has taken strong actions such as quarantines. Whether or not they will be successful is another story, but the governmental response shows the importance of oak trees.

The next section describes the government response to CCD.

III. RESPONSES TO CCD

A. Government Response

The government's response to CCD can be divided into three parts: research, regulatory, and congressional (oversight and funding).

Research

The research component is the most developed and seems to have the most resources. The National Research Council's Board on Life Sciences and Board on Agriculture and Natural Resources have convened an ad hoc committee to document the status of pollinating animals in North America, funded by the US Department of Agriculture, the US Geological Survey, and The National Academy of Sciences. The USDA's Agriculture Research Service and the National Agricultural Library have active research programs and provide educational resources related to CCD, including the CCD Action Plan (see citation 2), which were useful in conducting research for this paper. The CCD Action Plan is mostly research oriented, since without knowing the cause of CCD, the actions recommended are mostly geared toward general colony health. However, this seems to be the area of greatest activity.

Regulatory

From a regulatory perspective, the USDA has a registration process for insecticides, which must specify the impact on nontarget species. Advocacy groups such as Beyond Pesticides have been disappointed by the lack of regulatory action by USDA on CCD, and are encouraging the USDA and the Environmental Protection Agency (EPA) to do more. An example of USDA's lack of leadership in tackling CCD is a recent interview with U.S. News and World Report, where Ed Shafer, the US Secretary of Agriculture, referred to \$20 million proposed for additional research funding from Congress in the new Farm Bill as "wasting money."²⁶

Environmental toxics campaigners have long considered USDA to be too permissive towards pesticides. According to Beyond Pesticides, the German Office for Consumer Protection and Food Safety has suspended the approval of eight toxic insecticides, including imidacloprid and clothianidin, agents that target an insect's nerve cells in a similar way to nicotine.²⁷ Clothianidin was approved for use in the U.S. in 2003 as a seed treatment for corn and canola, although Beyond Pesticides claims the EPA acknowledges it is "highly toxic to honey bees." Imidacloprid has been approved for use in the U.S. since 1994 and is commonly used on rice, cereal, maize, potatoes, vegetables, sugar beets, fruit, cotton, and hops. Beyond Pesticides has asked its members to ask the EPA to suspend the use of imidacloprid and clothianidin-containing chemicals as a precautionary measure until scientists prove the insecticides are not contributing to the die-off of bee populations.²⁸

Congressional oversight and funding

Congress has shown an interest in protecting the pollinators, including the honey bees from CCD. The Pollinator Protection Act of 2007 funded the research efforts mentioned above and boosted the previous research budget from \$1.7 million a year to \$7.4 million in 2007. The Pollinator Habitat Protection Act of 2007 introduced by Sen. Max Baucus of Montana would add pollinators to the Food Security Act of 1985, making research and educational programs eligible for additional USDA grant programs. Although this bill was never passed into law, parts of it were rolled into the 2008 Farm Bill, which was being debated in Congress as this paper was written. (Congress has passed the Farm Bill, but the President has threatened to veto, and Congress is expected to override the veto.)

The \$307 billion Farm Bill includes funding dedicated to Colony Collapse Disorder. The USDA's Agriculture Research Service has been appropriated total of about \$74 million over 5 years. Section 12102 of the Senate version of the Farm Bill would provide

²⁶ Bedard, Paul. "Washington Whispers: Feds Are Split on Funding for the Honey Bee Crisis" Posted April 29, 2008. <http://www.usnews.com/articles/news/politics/2008/04/29/washington-whispers-feds-are-split-on-funding-for-the-honey-bee-crisis.html>

²⁷ The full list of suspended products in Germany is: Antarc (ingredient: imidacloprid; produced by Bayer), Chinook (imidacloprid; Bayer), Cruiser (thiamethoxam; Syngenta), Elado (clothianidin; Bayer), Faibel (imidacloprid; Bayer), Mesurool (methiocarb; Bayer) and Poncho (clothianidin; Bayer).

²⁸ Beyond Pesticides Newsletter, May 23, 2008. <http://www.beyondpesticides.org/dailynewsblog/?p=355>

for supplemental agricultural disaster assistance to honey producers and others. Senator Barbara Boxer and Senator Hillary Clinton have been active proponents of an addition \$20 million in Farm Bill for research on CCD.²⁹

Proposed funding from the Farm Bill toward Colony Collapse Disorder includes the following:

- \$3 million for each of fiscal years 2008-2012 for personnel, facilities, and additional research at the bee labs.
- \$2.5 million for each of fiscal years 2008-2009 for other USDA labs in NY, FL, CA, UT and TX.
- \$1.75 million for each of fiscal years 2008-2010 to identify the causes of CCD.
- \$2.25 million for APHIS – The Animal, Plant Health and Inspection Service (the Regulators) – for each of fiscal years 2008-2012 to conduct a honey bee pest and pathogen surveillance program, and produce annual reports for the Secretary of Ag
- \$10 million for each of fiscal years 2008-2012 to CREES – Cooperative State Research, Education and Extension Service – for grants to investigate: honey bee biology honey bee bioinformatics, native bee crop pollination and habitat conservation, native bee taxonomy and ecology, pollination biology, sub-lethal effects of pesticides, effects of genetically modified crops, parasites and pathogens and their effects on pollinators

Based on the research shown here, the research agencies are working hard, given their resource and budgetary constraints. Congress has shown a willingness to support research and put some funding behind a stronger effort at understanding and responding to CCD. However, of the three, the regulatory agencies, including USDA and EPA, could be putting more resources and taking further action on CCD.

B. Other Institutional Responses to CCD

The American Beekeeping Federation advocates on behalf of beekeepers, and acts as an information clearinghouse to stakeholders in the bee keeping industry. The Federation advocated for increased funding in the Farm Bill, and offers research updates on its website. There are numerous state and regional bee associations. The Mid Atlantic Apiculture Research and Extension Consortium is a regional group focused on addressing the pest management crisis facing the beekeeping industry in the Mid-Atlantic Region.³⁰

Environmental groups have also been raising awareness about the issue, and lobbying for government action on CCD. For example, NRDC featured CCD in their February 2006 magazine.

²⁹ Senator Hillary Clinton's website. "Clinton Joins Boxer and Casey in Call for Action on Honey bee Crisis Threatening Agriculture"

<http://www.senate.gov/~clinton/news/statements/details.cfm?id=295017&&>

³⁰ MAAREC website, <http://maarec.cas.psu.edu/index.html>.

Some corporations have become involved in the fight against CCD. Häagen-Dazs announced a \$150,000 donation to Penn State's College of Agricultural Sciences, and a \$100,000 donation to the Harry H. Laidlaw Jr. Honey Bee Research Facility at the University of California, Davis to support honey-bee-related research programs. The company started a consumer education campaign called "Häagen-Dazs Loves Honey Bees," which aims to increase their customers' awareness about "the dire situation facing managed and wild pollinators and what can be done to help." On the press release announcing the research donations, Häagen-Dazs brand manager Josh Gellert stated, "...the plight of the honey bee could mean many of the ingredients used in our top flavors, like Vanilla Swiss Almond and Strawberry, would be difficult to source." Häagen-Dazs also announced that sales of a new flavor called Vanilla Honey Bee will donate a portion of proceeds, as well as from all honey bee-affected flavors in the brand's product line that carry a special label, towards helping honey bees.³¹ Several Whole Foods Markets offer honeybee donation coupons as a way for consumers to donate to CCD research efforts.

C. Contingencies

The genome of the honey bee has been sequenced, providing researchers with important information in their search for the culprit of CCD. If the cause of CCD is immune system suppression, scientists can use the genome to help pinpoint the source. However, if the cause is as multi-factorial as some researchers believe, the genome may not be as useful as it would if there were only a single factor.

The academic literature notes that native bees are a good backstop in case commercial bee populations plummet. Studies of simulations of farms without commercial bees show that native bees alone can provide sufficient pollination. However, the native bee population has been decimated by the Varroa mite, and so in many parts of the U.S. may not be able to play a backup role for the commercial honey bee.

One of the more positive policy prescriptions comes from Gary Nabhan of the Arizona Desert Museum near Tucson, Arizona. He has advocated for the creation of "pollinator corridors" that allow pollinators to traverse large distances along their usual migration routes.³²

Individual gardeners can plant pollinator friendly flowers, especially a variety that bloom in different seasons throughout the year. They can also leave a portion of the ground undisturbed. Honey bees nest in the ground, and over mulching, or covering all parts of the garden with black plastic leaves no place for beneficial insects. Of course, organic farming that omits the use of toxic insecticides and pesticides will benefit pollinators, and as consumers, purchasing organic fruits and vegetables encourages such agricultural practices.

³¹ Penn State Entomology Department, "Consumers Step up to help honeybees," June 3, 2008. <http://live.psu.edu/story/31200/nw4>

³² Nabhan, Gary. "Nectar Trails of Migratory Pollinators Restoring Corridors on Private Lands" Conservation in Practice, Vol 2, No. 1, January 2001. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1526-4629.2001.tb00002.x>

Sustainability measures can support the honey bee in many ways. The Häagen-Dazs funding mentioned above will also support Penn State's research efforts on "green roof" technology. Several students at UCLA's Urban Planning Department are actively promoting a green roof on the Public Affairs Building. Green roofs can help create rooftop bee habitat and provide benefits for energy efficiency and stormwater management as well.

V. IMPLICATIONS OF THIS DISASTER

Since honey bee Colony Collapse Disorder is still so new, its causes are still being studied, and no specific recommendations are yet available, this section will take a more theoretical and speculative posture, raising questions rather than answering them.

A. CCD: a potential slow-onset disaster

Honey bee Colony Collapse Disorder has the potential to become a slow-onset disaster. The characteristics that give CCD the potential to resemble a slow-onset disaster are 1) that it could result in irreparable losses of a major pollinator responsible for the production of major crops with the ability to affect American health and the agricultural economy, 2) similar to a famine, the change is initially triggered by a natural phenomenon, but the lack of capacity of social institutions including governments to quickly respond is what allows the situation to turn into a disaster, 3) CCD could overlap with or contribute to the current food shortages.

A slow-onset disaster describes famines or diseases that slowly build over several years before they are recognized as social crises. By contrast, sudden natural disasters such as hurricanes or earthquakes may occur without notice. In both cases, the social response can determine the magnitude of the impact on humans and the environment. For example, rapid response to a hurricane can prevent major damages from the ensuing floods, and reforestation after a landslide can prevent further erosion and impacts on the water supply.

B. Response in an era of mass extinction

Will honey bees be listed as a threatened or endangered species? Considering the reluctance of the current administration to extend listings to new species, a listing would probably require litigation from an advocacy group such as Center for Biological Diversity. This paper was not able to determine if CCD has progressed to the point where such a listing is necessary, but this could serve as a warning to slow-moving regulatory agencies that if they let CCD progress much further, the blunt hammer of the Endangered Species Act could be invoked at some point in the future. If such a listing were to occur, what would the honey bees' critical habitat be? Would it include all of the agricultural land in the U.S.? The recent listing of the polar bear caused some advocacy groups to declare that the listing would motivate U.S. climate policy, but the U.S. Secretary of the Interior Dirk Kempthorne denied that. Similarly, claims that a listing of

the honey bee could encourage a phase out of pesticides that are toxic to pollinators, and encourage organic farming practices, may be denied by the Secretary of Agriculture. These questions are speculative right now, but a few more years of losses due to CCD may make them more timely.

Climate adaptation

The problem of phenology, changes in timing of the blooming of plants in relation to pollinators or other complementary species, may grow more pronounced with climate change in the 21st century. This is a slow-onset disaster in the making, and should be the focus of additional governmental response, regardless of whether it is named as a cause of CCD. Of course, climate change adaptation is one half of the coin, but reducing greenhouse gas emissions that cause climate change (termed "mitigation") needs accompany all adaptation efforts. This consists of reducing the use of fossil fuels for transportation and electricity, and encouraging government policy that "caps" the total level of greenhouse gas emissions and reduces them over time.

C. Government Responses

As discussed in Part IV, governmental response to CCD has been strong on research, but weaker on regulatory action. Other species losses have inspired varied governmental responses. The importance of pollinators to the food supply makes it more likely that a governmental response will be strong. However, it is not a given. Food security does not have the same status as Homeland Security does. Online commentators to the U.S. News and World Report interview of the Secretary of Agriculture were worried about the government's view of the seriousness of the CCD crisis and its implications for American food security, writing:³³

"America is the bread basket of the world. We do export Billions of dollars of food products each year. With the demise of the primary pollinator, the Honey Bee, you will see America become dependent on others to supply our countries food needs."

"A robust and active Honey Bee Industry is vital to our National Security."

Conclusion

The second book in Douglas Adams' the Hitchhiker's Guide to the Galaxy series is titled *So long and thanks for all the fish*. The book's premise is that one man has, by accident, survived the destruction of the Earth by aliens, and he is now hitchhiking around the galaxy. He finds out that the only other survivors of Earth's destruction were the dolphins. While he is the only human left, all of the dolphins survived. It turns out that dolphins, not humans, were the most intelligent species on Earth. They had access to space travel, took care of each other, and treated other species with respect. As they left,

³³ Online comments at <http://www.usnews.com/articles/news/politics/2008/04/29/washington-whispers-feds-are-split-on-funding-for-the-honey-bee-crisis/comments/>, accessed on May 29, 2008.

the dolphins, aware of Earth's impending demise, left a note for the humans, "So long, and thanks for all the fish."

Let's hope that the honey bees' Colony Collapse Disorder does not leave us holding the note, "So long, and thanks for all the honey."

Additional sources consulted in writing this paper:

USDA Crop values:

<http://usda.mannlib.cornell.edu/usda/current/CropValuSu/CropValuSu-02-14-2008.pdf>

New York Times article:

<http://www.nytimes.com/2007/02/27/business/27bees.html?ex=1330232400&en=3aaa0148837b8977&ei=5088>

Washington Post article:

<http://www.washingtonpost.com/wp-dyn/content/article/2007/02/11/AR2007021100650.html>

San Francisco Chronicle <http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2007/07/06/MNG1VQRN6B1.DTL>

Guardian UK article: Vidal, John. "Fifth of UK bee colonies killed" May 9 2008

<http://www.guardian.co.uk/environment/2008/may/09/wildlife.endangeredspecies>

American Beekeeping Federation: <http://www.abfnet.org/>

USDA: About CCD:

http://riley.nal.usda.gov/nal_display/index.php?info_center=8&tax_level=2&tax_subject=10&want_id=1322&topic_id=1006&placement_default=0

National Academy of Sciences: "Status of Pollinators in North America,"

http://www.nap.edu/catalog.php?record_id=11761#toc

Testimony of May R. Berenbaum, Chair, Committee on the Status of Pollinators in North America before the Subcommittee on Horticulture and Organic Agriculture Committee on Agriculture, U.S. House of Representatives, March 29, 2007.

http://www7.nationalacademies.org/ocga/testimony/Colony_Collapse_Disorder_and_Pollinator_Decline.asp