“Beepocalypse” Not

Alarmist Honeybee Claims Collapse Under Scrutiny

By Angela Logomasini

April 2015

ISSUE ANALYSIS 2015 NO. 1

COMPETITIVE ENTERPRISE INSTITUTE

"Beepocalypse" Not
Alarmist Honeybee Claims Collapse Under Scrutiny

by Angela Logomasini

Executive Summary

Concern about the survival of the European honeybee has blossomed into a media frenzy during the past several years, with activists declaring, "Beepocalypse"! Beekeepers have seen see some of their honeybee hives disappear in recent years, and concerned observers have blamed the losses on everything from cell phones to genetically modified crops. The most frequently alleged culprit, though, is a class of pesticides known as neonicotinoids. But such alarmism is not supported by the facts. This parade of alarming news stories has led the European Union to place a moratorium on neonicotinoids, and U.S. policymakers are considering similar options. Such bans and restrictions will do more harm than good as more toxic chemicals replace neonicotinoids. This paper aims to sort fact from fiction and promote a more balanced understanding that will facilitate rational solutions for helping honeybees.
It shows:

Colony Collapse Disorder is not the biggest threat facing honeybees. Lots of people blame hive losses in recent years on the so-called Colony Collapse Disorder (CCD), a phenomenon in which worker bees disappear, leaving behind the queen and honey. But according to a 2010 United Nations study, about 7 percent of hive losses are attributed to CCD, and the remaining 93 percent to other causes. In fact, the more significant problem is not really CCD, but instead compromised hive health, which is affected by a combination of factors, including: diseases and parasites, poor queen bee health, hive transport for pollination services, and nutritional issues. Pesticides are the least among these factors and neonicotinoids the least among those, if they have any impact at all.

CCD is not a new problem that can be easily attributed to modern pesticides. The mysterious disappearance of hives is not a new phenomenon. For example, the U. S. Department of Agriculture's (USDA) Agricultural Research Service, points out similarly curious honeybee disappearances in the 1880s, 1920s, and 1960s.

Honeybees are not even a "natural" part of any ecosystem in the United States. A narrative popular among environmentalists suggests that the problem is mankind's "tampering with nature," but honeybees are not even "native" to the United States. Instead, they are a farmed agricultural commodity, imported from Europe during the 17th century for honey production and crop pollination. Like cattle, they are largely an agricultural commodity that is farmed and managed by human hands, in this case beekeepers.

Honeybees are nowhere near going extinct. In fact, the number of hives has *increased* globally. Globally, far more honeybees are used for honey production than pollination services, and the amount of honey produced has increased. U.S. and European commercial hives have decreased because honey production simply moved to other nations, where the number of hives have grown substantially. According to United Nations Food Agricultural Organization (FAO) statistics, the number of beehives kept globally has grown from nearly 50 million in 1961 to more than 80 million in 2013.

Surveys in 2014 show that honeybee hives have improving survival rates. Hives kept for pollination services in the United States and Europe have shown better survival rates in recent years, much closer to what beekeepers consider normal. This occurred despite continued use of neonicotinoids.

Farming and food production is not about to collapse because of poor pollination. About one third of food production in the United States benefits from honey bee pollination, according to USDA. Poor hive health is unlikely to completely undermine production of these foods, but it could make them more expensive. Fortunately, improved hive survival can mitigate such issues.

There is no consistent correlation between neonicotinoids and hive losses. If neonicotinoids were a cause of significant hive losses, we would expect to see at least some correlation between their use and high hive losses, but no such pattern has been observed since their introduction in the 1990s. In many places where these chemicals are used widely, such as in Australia, CCD is not a problem. And in Europe during 2013-2014, hives survived well in many areas where neonicotinoids were used.

Field studies find no health effects from "sublethal exposures" to neonicotinoids. To date, there are no studies showing that honeybees have suffered ill effects from "field-relevant" neonicotinoid exposures. Only studies that feed the bees unrealistically high levels of the chemicals show adverse effects. Studies of bees in the field where neonicotinoids are used show no measurable effects.

Neonicotinoids do not present the most significant pesticide exposure to honeybees. While activists like to blame neonicotinoids for the disappearance of hibernating bees, little of these chemicals is actually found in the hives. Instead, most of the chemicals found in the hive are put there by beekeepers trying to fight various diseases carried by mites and other organisms. "It's like chemotherapy. They know it's bad, but it's a lot better than the alternative," says bee researcher Dennis vanEngelsdorp.

Alternative chemicals may prove more dangerous than neonicotinoids. The U.S. Agricultural Research Service notes on its website: "The neonicotinoids were developed in the mid-1990s in large part because they showed reduced toxicity to honey bees, compared with previously used organophosphate and carbamate insecticides." If farmers cannot use neonicotinoids, they will use other chemicals that are more toxic to bees.

Regulations will not solve the problem. Regulations are slow to develop, governed by political rather than practical and scientific goals, and hard to modify, even when they become counterproductive. In the case of honeybees, the best solutions will emerge with collaboration among the parties with an interest in protecting bees, including beekeepers, farmers and home gardeners.

Honeybee health issues are far broader than concerns raised by CCD alone and the solutions require a better understanding of the issue. Shortsighted pesticide bans will prove counterproductive, undermining food production and harming both honeybees and native pollinators because replacement products are likely to prove more dangerous. The best solution will strike a balance that recognizes the value of targeted and managed use of agrochemicals while minimizing risks.

Introduction

"Honey bees are disappearing across the country, putting $15 billion worth of fruits, nuts and vegetables at risk," laments the Natural Resources Defense Council.[1] They are joined by a chorus of activist, media and others who fear that mankind's intrusions on nature threaten not only the bees but the livelihood of beekeepers and our food supply. "For them [beekeeepers], catastrophe could be just one harvest away," notes one Minneapolis *Star Tribune* writer.[2] Media headlines have even declared this a crisis worthy of the name "Beepocalypse."[3]

Allegedly, the problem stems largely from our naïve trust in agro-technologies, particularly pesticides. One journalist writing in *Time* magazine claims: "Honeybees are suffering because we've created a world that is increasingly inhospitable to them." Specifically, Greenpeace and myriad others blame a class of pesticides called neonicotinoids, claiming that these chemicals "might just be the prime culprit in the honeybee plague known as Colony Collapse Disorder (CCD)."[4]

Beekeepers do face some significant challenges concerning the health of commercially farmed honeybee hives—but these problems are not primarily driven by Colony Collapse Disorder, a phenomenon in which bees leave the hive and honey behind for no apparent reason. Rather, beekeepers have suffered losses mostly due to other challenges to the health of the honeybee hives, mainly driven by natural forces such as the emergence and spread of diseases and parasites that affect honeybees and the need for a more diverse diet. These are issues that can and will be managed largely by beekeepers themselves along with some collaboration with farmers and even home gardeners. But we won't reach such solutions if we focus on the wrong issues.

The parade of lopsided and alarming news stories on CCD and the so-called Beepocalypse has led the European Union to place a moratorium on neonicotinoids, which has caused serious crop damage without helping honeybees. Policy in the United States has been more measured, but is moving in the wrong direction as well. Should U.S. policymakers turn to bans and restrictions, they will do more harm than good. Restrictions on neonicotinoids will likely harm honeybees as farmers are forced to use more environmental damaging replacement chemicals, and such policies will undermine farmers' ability to provide an affordable food supply to feed a growing world population.

The causes of, and solutions to, these challenges are far more multifaceted and complex than headlines suggest. This paper aims to sort fact from fiction and promote a more balanced understanding that will facilitate rational

Restrictions on neonicotinoids will likely harm honeybees as farmers are forced to use more environmental damaging replacement chemicals.

CCD is really not the main challenge facing honeybees.

public policies. Accordingly, it examines the most common misperceptions and faulty claims related to honeybee health.

It shows that CCD is not as significant a problem as the headlines suggest; honeybees are not going extinct; pesticides are not the main challenge to hive health; the food supply is not about to collapse; and proposed pesticide bans will likely do more harm than good to honeybees.

The Charges: Claims vs. Reality

Claim: Colony Collapse Disorder is the biggest threat to honeybees.

Reality: CCD is a relatively small threat to honeybees compared to other well-known challenges.

"With a third of honeybee colonies disappearing due to 'colony collapse disorder,' it's time to move into high gear to find a solution," claims one recent *Mother Jones* article on the topic.[5] But to find a solution, we need to understand the problem, and CCD is really not the main challenge facing honeybees.

Not all honeybee losses are related to CCD. Honeybees die and disappear for many different reasons. The phrase "colony collapse disorder" refers to losses that occur along a very specific set of circumstances. Researchers attribute hive losses to CCD when most or all adult honeybees disappear from the hive, leaving behind honey, a live queen, and immature bees. According to a 2010 United Nations Environment Programme study, about 7 percent of hive losses are attributed to CCD, and the remaining 93 percent to other causes.[6]

In fact, the real issue is not so much CCD, but instead hive health, which is affected by a number of factors. While each factor alone might not present much of an issue, it is the combination of such stressors that lead to poor hive health and periodic annual declines. Such stressors include diseases and parasites, poor queen bee health and limited generic diversity, hive transport for pollination services, nutritional issues, and a number of different pesticides.

Diseases and Parasites. Of all the factors impacting bee hive health, natural pests and diseases is quite significant. A 2009 study on hive health by Dennis vanEngelsdorp of the University of Maryland and other researchers underscores the significant role that pathogens play in hive health.[7] In January and February 2007, the authors examined 13 apiaries owned by 11 beekeepers with a total of 91 bee colonies.[58] They divided up the apiaries into one of two groups: a control group for those lacking CCD and another for apiaries that experienced CCD. They found that colonies affected by CCD had more pathogens—bacteria, viruses, and parasites—in the hive, and therefore a higher "pathogen load" than did the healthy hives, although no single pathogen or other variable was found to be more prevalent than others.

Some of these pathogens and parasites originate domestically but as beekeeping has become a global industry, different diseases have spread around the world through increased trade. These diseases may contribute to, or cause, some CCD cases. One researcher at the Department of Agriculture's (USDA) Agricultural Research Service (ARS) says the first two of these diseases listed below are recognized as "probable" contributing factors.[9] In any case, the diseases affecting honeybees are many.[10]
A few examples include:

- **Varroa destructor mites.** Accidentally imported into the United States in the late 1980s, the Varroa destructor mite is "the most detrimental honey bee parasite in the world today," according to honeybee researchers.[11] It has already nearly eliminated wild honeybee populations in the United States. These mites feed on honeybees and larvae. That is bad enough, but they also transmit secondary diseases, such as a virus called "deformed wing disease," that can decimate hives if left uncontrolled. These mites have not destroyed commercial beekeeping, but they have increased annual hive losses and raised beekeeping costs. That appears to have reduced the number of small beekeeping operations and increased larger scale commercial beekeeping.[12]

- **Nosema.** Nosema is a disease transmitted by microsporidian parasites that enter honeybees as spores and then develop in the honeybee gut, where they weaken the bee and lead to premature death of adult bees and queens. Bees pass the spores via excrement, which builds up in the hive, particularly during the winter. Symptoms are hard to detect and beehives may recover, but only after many bees are lost.

- **Tracheal mites.** First discovered in 1984 in Texas, these microscopic sized vermin inhabit the trachea of young adult honeybees, where they feed on the bees' blood, affecting the bees' development, ability to fly, and overall health. The mites easily spread from one bee to the next, with many infections occurring during winter hibernation and into the spring. Tracheal mites are controlled with Menthol crystals, which is a registered pesticide with the U.S. Environmental Protection Agency.[13]

- **American and European foulbrood.** American foulbrood is a bacterial disease that kills bee

A United Nations Environment Program report notes: "CCD only accounts for about 7% of losses in the USA, and even less in Europe."

larvae in the honeycomb. The larvae first eat the bacteria's spores that have contaminated their food. The spores then develop in the larvae gut, consuming its food, releasing more spores into the hive, and spreading the disease. The disease is hard to control because spores can remain viable up to 40 years and because each attached bee larvae can release up to a million spores. Burning the hive and related equipment, and then starting a new hive with sanitary controls may be the only option in some cases. Antibiotics may help treat infection, but cannot eliminate the spores, and the bacteria are growing resistant. Fortunately, researchers are making headway in finding a cure.[14] European Foulbrood is similar, but not as dangerous, and some hives recover from it.

Queen Bee Health. In a healthy hive, queen bees usually lay eggs for about two years, populating the hive with worker bees as well as with the male drones that mate with the queen. But sometimes queen bees fail to produce enough offspring or mysteriously die, undermining hive health. In some cases worker bees will even kill off their own queens early if there is a health problem. Limited genetic diversity among the commercially farmed bees may contribute to poor quality queens, but the causes are not fully understood.[15]

A United Nations Environment Program report highlights the fact that poor quality queens is an even more significant problem. The report notes: "CCD only accounts for about 7% of losses in the USA, and even less in Europe. The loss of queen bees seems to be a much more common cause at about 25%."[16] In the United States, beekeepers reported premature death of queen bees in 32 percent of their hives.[17]

Hive Transport and Pollination Services. Honeybee hives in the United States are farmed at various locations around the nation and then trucked to farms in the spring and summer to pollinate crops, with many hives visiting more than one farm every growing season. Such movements, although necessary, represent yet another stress that affects hive health. A report in *Agricultural Research Magazine* notes: "At the same time [as honey production moved overseas], the call for hives to supply pollination services has continued to climb. This means honey bee colonies are trucked farther and more often than ever before, which also stresses the bees."[18] In addition, the movement of hives aggregates bees and diseases they carry, increasing transmission, as the bees move from one region to the next.[19]

Nutritional issues. Farmed honeybees spend much of their time pollinating a limited number of crops, which means their nutritional sources may be too one dimensional. And many times beekeepers supplement the hive diet with are fed high-fructose corn syrup, which offers limited nutritional value. Bees achieve better health when they can forage among a wider range of pollen and nectar sources. "Although honey bees may store food (in the form of honey and packed pollen) for times of dearth, lack of diverse floral resources is now demonstrated to diminish their immune response," explain researchers in *Environmental Science and Technology*.[20]

Pesticides. Ironically, the pesticides that pose the greatest exposure and risk to honeybees are also necessary to control some of the diseases that would otherwise destroy hives: fungicides and mitocides used directly inside the hives. These products pose risks to hive health, but they are necessary for survival. Of all the causes discussed here, agricultural pesticides appear to play one of the smaller roles, yet headlines focus on them. This is in part because they are the subject of regulation in Europe that warrants news coverage. But much of the news coverage derives from misinformed alarmism about these chemicals.

Claim: CCD is a new threat, which indicates it is linked to modern technologies such as pesticides.

Realty: CCD does not appear to be a new phenomenon as there are reported cases of similar disappearances of colonies going back decades even before we employed modern pesticides.

The mysterious disappearance of hives is not a completely new phenomenon. University of Florida entomologist Jamie Ellis explains:

> In fact, many colonies have died over the past 50-60 years displaying symptoms similar to those of CCD. The disorder as described in older literature has been called spring dwindle disease, fall dwindle disease, autumn collapse, May disease, and disappearing disease. We may never know if these historic occurrences share a common cause with modern-day CCD. They do, however, share the symptoms.[21]

The Agricultural Research Service, points out similarly curious honeybee disappearances in the 1880s, 1920s, and 1960s. On its website, ARS notes several cases, including the disappearance of 2,000 colonies in Cache Valley in Utah during 1903, "after a 'hard winter and a cold spring,'" as well as a the disappearance of 53 percent of the hives in Pennsylvania following the winter of 1995-1996.[22] We cannot be sure these disappearances happened for the same reason they do today, but they are reason to doubt that this is a new problem caused by modern pesticides.

Ironically, the pesticides that pose the greatest exposure and risk to honeybees are also necessary to control some of the diseases that would otherwise destroy hives.

Honeybees are not even a "natural" part of the ecosystem in the United States. They were imported from Europe during the 17th century.

Claim: Mankind's tampering with nature threatens the survival of the honeybee and the "balance of nature."

Reality: Honeybees in the United States are not natural; they are a non-native farmed species imported to provide honey production and pollination services.

A narrative popular among environmentalists suggests that the problem is mankind's "tampering with nature," which can only be solved by reducing our "footprint" on the planet by using fewer agro-technologies and less intensive farming. "Humanity is the perpetrator" of CCD, says Greenpeace activist Rex Weyler, and the "two most prominent causes appear to be pesticides and habitat loss."[23]

In fact, honeybees are not even a "natural" part of the ecosystem in the United States. They were imported from Europe during the 17th century for honey production and crop pollination, although some colonies now live in the wild. Like cattle, they are an agricultural commodity that is farmed and managed by human hands, in this case beekeepers. And it has been this way for a long time. Bee expert Eva Crane explained in 1975, "Like the dog, the honeybee had accompanied man on most of his major migrations, and some of the early settlers in each part of the New World took hives of bees with them."[24] Thus, this debate is not about protection of a wild species we have somehow "disrupted," but about the management of a domesticated commodity.

Today, Americans continue to employ the European honeybee or honey production and pollination. Much honey is now produced overseas, while U.S. beekeepers farm the bees, which they rent out to farmers during spring and summer for pollination services. Beekeepers around the nation transport some 60 percent of all U.S. hives to pollinate California's almond farms in spring, and then move them throughout the spring into the summer to pollinate yet more crops around the nation.[25]

It is not surprising that honeybees in the Western Hemisphere generally do not survive as well as they do in Europe, where they have a longer history and greater genetic variability that makes them more resistant to disease.[26] In fact, in their recent survey on honeybee health, European researchers note annual honeybee losses due to natural factors are considered "acceptable" at a rate of 10 percent, while U.S. beekeepers report higher acceptable loss rates ranging from 15 to just more than 21 percent.[27] Even annual losses of nearly 20 percent in the United States are considered acceptable according to a recent survey conducted by the Bee Informed research initiative, a collaborative effort of several universities and research labs led by the U.S. Department of Agriculture and National Institute of Food and Agriculture.[28]

Accordingly, beekeepers must replace a number of colonies every year, which they replenish by splitting hives or purchasing new bees and queens.[29] This involves obvious increased costs and possible downtime while new hives get established. Nevertheless, large annual losses are far from unusual.

Claim: Honeybee populations are declining and creating a crisis situation for farmers who need their pollination services.

Reality: Globally, the number of hives have* increased *although their locations have shifted.

The news about honeybee populations can be very confusing. Some point out that there are more honeybee hives today than there were several decades ago, while others claim the opposite. The Hoover institution's Dr. Henry Miller points out in *The Wall Street Journal* that U.N. Food and Agriculture Organization (FAO) data show that "honeybee populations are not declining."[30] In fact, FAO data show that the number of bee hives kept globally has grown from nearly 50 million in 1961 to more than 80 million in 2013.[31] Jennifer Sass of the Natural Resources Defense Council responds in a letter to the editor: "The number of managed honeybee colonies in the U.S. has dropped from four million hives in 1970 to 2.5 million today, according to White House statistics."[32]

Both of these claims may be technically correct, but Miller's data is more relevant, while Sass's data shows only part of the picture. Miller points to the "global" commercial honeybee hive count, which has grown considerably. Sass points to domestic colony numbers only, which have in fact declined for economic, not environmental reasons. Miller points out that U.S. and European hive numbers are relatively stable, and the Canadian numbers have actually increased. Miller is certainly correct to point out that honeybees are not about to disappear from the face of the Earth.

Honeybees are not about to disappear from the face of the Earth.

The FAO data Miller cites were analyzed by biologists Marcelo A. Aizen of Universidad Nacional del Comahue in Argentina and Lawrence D. Harder of the University of Calgary in a 2009 *Current Biology* journal article. They explain that economic rather than ecological forces have determined where and how many hives are commercially kept.[33]

Globally, far more honeybees are used for honey production than pollination services, and the amount of honey produced has increased with world population growth. U.S. and European commercial hives have decreased because honey production simply moved to other nations, where the number of hives have grown substantially. Aizen and Harder explain:

> The FAO data also clarify that national or even regional declines

As a farmed commodity, the number of colonies and their locations will ebb and flow with the market.

> in the health and/or size of the managed honey-bee population cannot substantiate claims of a global pollinator decline or an attendant pollination crisis. … Until relevant data become available and clear patterns emerge, any claim of a global pollinator decline and associated pollination crisis must be considered as a matter of debate, rather than as fact. This conclusion does not detract from real biological problems in the honey-bee populations of some countries; however, it emphasizes that solutions to those problems must be motivated locally, rather than globally, and must acknowledge the dominant influence of economics in the pollination represented by every spoonful of honey.[34]

In the final analysis, we see that whether there were more or less commercial bee colonies in 1960 than there are today in one nation or region is not clearly a matter for concern. As a farmed commodity, the number of colonies and their locations will ebb and flow with the market. Annual losses represent an important concern and economic challenge for beekeepers in the regions where they occur, but they should not be confused with the global supply of honeybees.

Claim: Regional losses of honeybees in Europe and the United States continue unabated.

Reality: Surveys in 2014 showed improved survival rates, which may indicate that better hive management is reducing losses.

"Honeybees have been disappearing at an alarming rate since 2005 … if the bees die, the human race will not be far behind," laments a 2015 article in the online news site *Inquisitr*.[35] In reality, hives kept for pollination services in the United States and Europe have shown better survival rates in recent years, much closer to what beekeepers consider normal. This reality indicates that the high losses in recent years, do not necessarily represent an inevitable long-term trend.

In the United States, a survey on honeybee health conducted by Bee Informed shows that bees did much better during the winter of 2013-2014 than in prior years.[36] The annual losses reported after the winter of 2013-2014 came to 23.2 percent, while the past eight year average was 29.6 percent, with a high loss rate of 36 percent in 2007-2008, and a low of 21.9 percent in 2011-2012. While challenges remain, efforts to improve hive health may have made the difference and provide a roadmap for future efforts.

No one can point to a single reason for improved hive survival, but as Dennis vanEngelsdorp explains, improved beekeeping practices may be limiting the impact of the Varroa mite. “What is clear from all of our efforts is that Varroa is a persistent and often unexpected problem,” he said. “Even beekeepers who do treat for mites often don’t treat frequently enough or at the right time. If all beekeepers were to aggressively control mites, we would have many fewer losses.”[37]

CCD has not proven as much of a problem in Canada, but there are some isolated problems there as well. In 2014, beekeepers reported unusually high losses in Toronto, which experienced losses of 58 percent. But excluding Toronto, which appears to be a very unusual outlier, Canadian beekeepers report that winter mortality was just 19.2 percent that year. The report notes: “It is notable that the winter losses has been reduced by 25 per cent, going from as high as 35% from 2007-2008 down to on average 20 percent since 2009/10.”[38]

Similarly, a 2014 European Union study indicates that honeybees are doing better in Europe than it originally appeared.[39] The study covered 80 percent of all honeybee hives in Europe. According to the survey, member states that suffered hive losses of 10 percent or less housed 47 percent of the hives in this study. European states that experienced between 10 to 15 percent losses were home to 27 percent of the hives. In other words, nations that were home to nearly 75 percent of the hives experienced losses below 15 percent, which is a reasonably good honeybee hive survival rate for a large portion of the hives in Europe. In fact, the highest losses (those above 20 percent) occurred in nations that housed just 5 percent of the hives.[40] “It’s the first major study of pests and diseases that affect honeybees. A lot of it seems very encouraging,” said Tom Breeze, Research Fellow in the School of Agriculture, Policy and Development at the University of Reading in the United Kingdom.[41]

2014 European Union study indicates that honeybees are doing better in Europe than it originally appeared.

Another study conducted by an international group called COLOSS (Prevention of Honey Bee COlony LOSSes), collected and analyzed survey data from beekeepers in 19 European nations as well as Israel and Algeria. With more than 17,000 respondents managing more than 375,000 hives, this comprehensive study reported some very good preliminary results:

> A preliminary analysis of the data show that the mortality rate over the 2013 – 14 winter varied between countries, ranging from 6% in Norway to 14 % in Portugal, and there were also marked regional differences within most countries. The overall proportion of colonies lost was 9%, the lowest since the international working group started collecting data in 2007.[42]

With any luck, continued effort and research on causes and improvements to hive management will improve hive survival.

Another study by the British Beekeepers Association (BBKA) showed great improvements in the United Kingdom during the winter of 2013-3014, with a total loss reported of 9.6 percent.[43] Although BBKA representatives still consider a 9.6 loss too high, this level is far lower than the peak loss of 33 percent in 2012-2013. Prior years have shown losses ranging from a high of 30 percent in 2007-2008. In other years, the losses were much lower with a high of nearly 19 percent in 2008-2009 and a low of less than 14 percent in 2010-2011. The BBKA identifies the Varroa mite and limited foraging plants available to bees as major challenges in the UK, which it is addressing through education on hive management and via a National Pollinator Program that encourages planting of valuable flowers for honeybee foraging.

Challenges remain and no one knows for sure what next year or the following will bring in terms of hive losses. But with any luck, continued effort and research on causes and improvements to hive management will improve hive survival.

Claim: Honeybee losses are largely an environmental issue that threatens our food supply.

Reality: Honeybee losses are largely a manageable economic issue and the farming industry is not about to collapse.

A 2013 *Huffington Post* headline exclaimed: "Honey Bees Are Dying Putting America at Risk of a Food Disaster."[44] And the Natural Resources Defense Council claims: "Honey bees are disappearing across the country, putting $15 billion worth of fruits, nuts and vegetables at risk."[45] Another article maintains that 70 percent of our food supply is pollinated by honeybees.[46] These claims are all flat wrong. While they make great headlines, they create a misleading impression that periodic honeybee losses seriously threatens our food supply.

It is true that hive health issues are of concern because farmers rely on honeybees for the production of many fruits, nuts, and vegetables. About one third of food production in the United States benefits from honeybee pollination, according to USDA.[47] California almond growers depend on honeybees exclusively to pollinate crops, requiring 60 percent of the commercial honeybee hives in the country to produce 80 percent of the world's supply of almonds. Almonds constitute California's highest-valued agricultural export, according to agricultural economist Hoy Carman of the University of California-Davis.[48]

While poor hive health is unlikely to completely undermine production of these foods, it could make them more expensive. In fact, according Carman, fees for pollinating almonds have increased substantially.

> Average fees increased from $35.41 in 1995 to $53.67 [per hive rented] in 2004. The fees then increased to $72.58 in 2005 when CCD first became evident, and shot up $45.31 to $136.98 between 2005 and 2006. Almond pollination fees continued to increase and peaked at an average of $157.03 in 2009.[49]

A recent survey by the California State Beekeepers' Association reports that the fees have remained high: $151.26 for 2011, $154.74 for 2012, and $154.03 for 2013.[50] ARS researchers explain that continual losses at the 33 percent level would be costly for beekeepers. But they note further: "Honey bees would not disappear entirely, but the cost of honey bee pollination services would rise, and those increased costs would ultimately be passed on to consumers through higher food costs."[51]

High annual losses represent an expensive challenge for beekeepers and potentially consumers, but even then, we should not expect a catastrophe. Professor Jamie Ellis of the Institute of Food and Agricultural Sciences at the University of Florida notes:

> Yet, no one believes that honey bees will disappear altogether, even with the concerns over CCD. Instead, the average American may experience increased food prices and decreased food availability if honey bees continue to die at the current rate. The almond industry illustrates this point well.[52]

Not all food depends on honeybees, and essential grains, particularly corn, rice and wheat, constitute the largest part of our diets and these are pollinated by the wind. Researchers from the University of Minnesota and U.S. Geological Survey, writing in *Environmental Science and Technology*, point out: "Thus the prospect of human starvation in the absence of bees is remote, but crop declines in the most nutritious—and arguably, most interesting—parts of our diet like fruit, vegetables, and alfalfa hay for meat and dairy production, are possible."[53]

Other researchers have raised concerns that the amount of honeybee-dependent crops has increased globally and exceeds the number of honeybees produced for pollination. They concluded that one of two things must be happening: Either the current number of hives is sufficient for pollination or wild pollinators are providing an important contribution. In the latter case, they suggest that policy makers consider the impact of land use policies to ensure that wild pollinators continue to have sufficient nutrition and nesting habitat. Intensification of "monoculture" may reduce the habitat diversity these wild

If neonicotinoids were a cause of CCD, we would expect to see at least some correlation between their use and CCD, but no such pattern has been observed.

pollinators require. For example, government subsidies and policies that promote planting of corn for ethanol trigger land use changes that reduce diversity of crops around the nation.[54]

Claim: Outbreaks of CCD since the introduction of neonicotinoids indicate that these pesticides are a key cause of CCD.

Reality: There is no consistent correlation between neonicotinoids and hive losses related to CCD or other causes.

Environmentalists and many government officials have singled out crop protection chemicals called neonicotinoids as the potential cause of CCD. For example, Greenpeace claims that "neonicotinoids might just be the prime culprit in the honeybee plague known as Colony Collapse Disorder (CCD)" based largely on a single, flawed Harvard University study.[55] As a result of such claims, the European Union has even placed a temporary ban on the use of these chemicals based on largely speculative science about their possible link to CCD. But the data do not support such definitive claims or actions.

Neonicotinoids are a class of pesticide products that enhance a plant's ability to fight off pests. Specific chemicals include acetamiprid, clothianidin, dinotefuran, imidacloprid, and thiamethoxam. They are "systemic" treatments because they become part of the plant, making it unattractive to pests that chew on the plants. Neonicotinoids may be sprayed on the plants, applied on the ground near the plant's roots, or applied to seeds. But the overwhelming majority of uses are applications in which seeds are treated with the pesticide before planting, a practice that avoids broad environmental exposure.

Systemic pesticides have the benefit of limited environmental impact because little enters into the environment, especially when seeds are treated. However, minuscule amounts of the chemicals may appear in the pollen and nectar of these plants, and the question then is whether these levels have an impact on honeybees and other non-target insects.

If neonicotinoids were a cause of CCD, we would expect to see at least some correlation between their use and CCD, but no such pattern has been observed since their introduction in the 1990s. France banned Imidacloprid in 1999 and, along with Germany, banned clothianidin in 2008, yet those bans did not prevent the emergence of CCD in both of those nations.[56]

In Europe during 2013-2014, hives survived well in many areas where neonicotinoids were used. See the map for this distribution of losses from the recent EU survey on hive survival.[57] Ironically, Greek beekeepers complained in 2013 that the chemicals were wreaking havoc, yet Greece actually had a lower than acceptable hive loss that year. This situation underscores the fact that some beekeepers and environmental activists are jumping the gun, blaming neonicotinoids for colony collapse disorder even in regions and years where evidence of a problem is not at all clear.

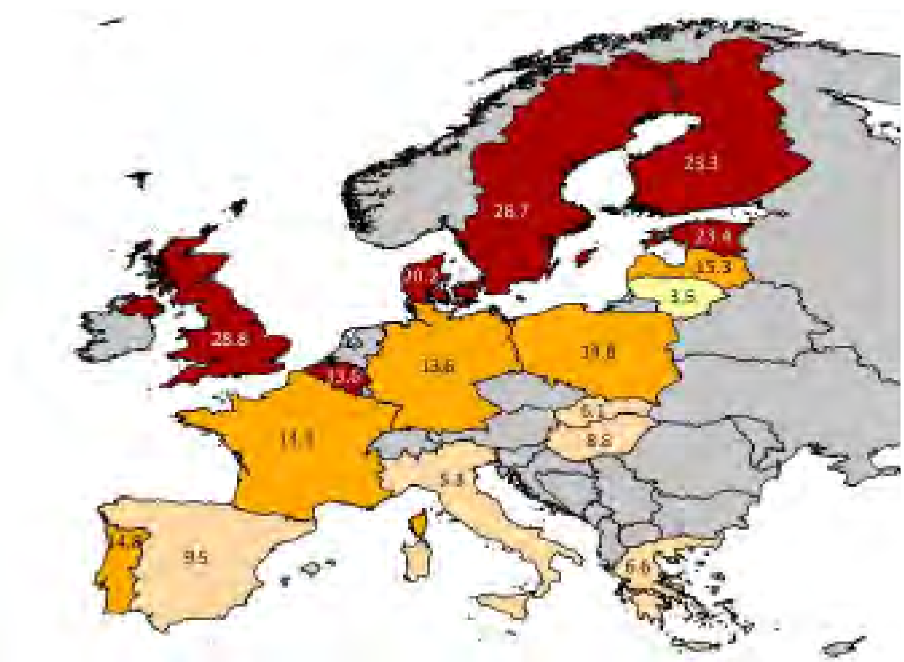
Conversely, in many places where these chemicals are used widely, such as in Australia, CCD is not a problem.[59] A 2014 Australian government report states: "Australian honeybee populations are not in decline, despite the increased use of this group of insecticides in agriculture and horticulture since the mid-1990s."[60] Similarly, in Canada, one beekeeper explains:

> [T]here are colonies in Ontario and Quebec that are exposed to neonics on both corn and soy, with zero problems. And look at Western Canada. On the Prairies, 70 percent of Canada's colonies forage canola without issue. We are even exposed to corn and soy, and except for four beekeepers in Manitoba in 2013, there have been no issues there either.[61]

Claim: Studies demonstrate that "sublethal" levels of neonicotinoid pesticides impact hive health.

Reality: Studies of honey bee exposures to chemicals in real-life settings have not found any such effects, and studies that find effects at unrealistically high exposure levels are not particularly relevant.

Some environmentalists suggest that relatively low exposures that do not immediately kill the bees (sublethal exposures) make them too weak to survive other stresses. The Pesticide



Source: Marie-Pierre Chauzat et al, "A pan-European epidemiological study on honeybee colony losses 2012-2013," European Union Reference Laboratory for Honeybee Health, http://ec.europa.eu/food/animals/live_animals/bees/docs/bee-report_en.pdf.

Over-reliance on studies that feed or otherwise dose bees with chemicals in a lab and then measure hive losses after the bees are allowed to forage in the field creates a misleading impression about the risks.

Action Network in the United Kingdom, for example, maintains: "Sub-lethal effects on individual bees can build up to colony-level harm, especially if exposure continues for several weeks."[62]

However, much of the research to date has not proven particularly relevant to real-life exposure to chemicals in the field. In fact, the Pesticide Action Network plays down the fact that field-relevant studies show no such effects, and that real-world scenarios tell us more about how these chemicals actually impact wildlife. Several studies, notes Kim Kaplan of the USDA's Agricultural Research Service, "relied on large, unrealistic doses and gave bees no other choice for pollen, and therefore did not reflect risk to honey bees under real world conditions. Nor have the studies demonstrated a direct connection or correlation to CCD."[63]

Over-reliance on studies that feed or otherwise dose bees with chemicals in a lab and then measure hive losses after the bees are allowed to forage in the field creates a misleading impression about the risks for many reasons. First, they ignore the fact that regular feeding or dosing of bees every day for a period of time is completely different than intermittent exposures from pollen in the field. As a result, even what some researchers maintain to be "field relevant" exposures in the lab are not relevant real-life exposures.

In fact, when researchers actually measure the chemicals in pollen, nectar, and bee products like wax and honey, the levels reported are largely insignificant. For example, Tjeerd Blacquière, of Wageningen University in The Netherlands, and his colleagues summarize the research on such exposures in an article for *Ecotoxicology*, published in 2012.[64] They explain that the current research indicates that the exposures in pollen, nectar, and bee products are below levels that would pose acute or chronic toxicity. They point out that no field-relevant studies to date have demonstrated any adverse sublethal effects from neonicotinoids.

In February 2014, other researchers reported similar findings. They measured neonicotinoids in several crops grown from seeds treated with the chemicals. They could not find any traces of the chemicals on soybean flowers or in cotton nectar. They found one neonicotinoid chemical in corn, but only in an insignificant amount. University of Arkansas entomologist Gus Lorenz, who participated in this study concluded, "It's not being expressed in the reproductive parts of the plants."[65]

Nonetheless, researchers at Harvard University produced a 2014 study[66] that some say finally proved that neonicotinoids are to blame for colony collapse disorder (CCD).[67] In this study, the researchers fed a handful of honeybee hives a diet of high fructose corn syrup containing pesticides and then waited to see how many would survive winter compared to control groups fed the syrup without pesticides. When the bees fed the neonicotinoids suffered more losses than did the control groups, the authors concluded: "[T]he findings in this study reinforce the conclusion that sub-lethal exposure to neonicotinoids is likely the main culprit for the occurrence of CCD."[68]

The Harvard researchers maintained that the exposure levels they used in their study were similar to those that honeybees experience in the field and that the neonicotinoid-treated bees suffered losses that resembled CCD. But both claims were not compelling to other researchers who reviewed the study.

A statement released by Bayer Crop-Science maintained that the bees were fed a diet of neonicotinoids for 13 weeks that exposed them to a pesticide level 10 times higher than what bees encounter in real-life scenarios, a practice Bayer described as "unrealistic" and "deceptive."[69] Activists and others dismiss Bayer's analysis because of the company's financial interest in the issue, but they have not been able to dispute the data. In fact, Dennis vanEngelsdorp basically agreed with Bayer CropScience's position. He remarked to the press that the study was of limited value because all it shows is that "high doses of 'neonics' kill bees—which is not surprising."

Entomologist Joe Ballenger, in an analysis of the Harvard study on the blog Biofortified, explains that the exposure in this study was likely five times what bees would experience in the field and 33 times higher than what is typically found in the hives of honeybee colonies. "Bottom line," says Ballenger, the study "appears to have overdosed the colonies compared to what they are encountering in the real world."[70]

Ballenger points to another problem: The honeybee losses the Harvard study describes do not constitute CCD. While some honeybees abandoned the hive, there were lots of dead bees present and some hives lost queens as well as their brood. This does not resemble CCD, which involves *disappearance* of nearly all worker bees with few dead bees present, with live queens and brood left behind.

A couple of other studies, led by USDA entomologist Jeff Pettis, raised concerns about neonicotinoids similar to those in the Harvard study, but these too have important limitations that have been largely overlooked by the press. In one study, Pettis et al dosed young worker bees with neonicotinoids as they emerged from the hive for the first time. These bees had very little time to develop immunity and died in large numbers. Pettis concluded that the pesticides appear to have weakened the bees and made them more susceptible to the Nosema parasites. While that may be true for this lab experiment, it appears to have little relevance to real-world scenarios.

In an article reviewing this and other research on neonicotinoids, the authors explain:

> Honeybees harbor a characteristic bacterial complex in the gut that plays an important role in nutrient processing, degradation of toxic compounds, and defending against pathogens. …The establishment of a normal microbiota requires contact with the colony and food exchange with older nestmates. The isolation of newly emerged workers in cages for testing may lead to increased susceptibility to pesticides and pathogens because of an impoverished gut microbiota. Differences in physiology, stress levels, and the bacterial complex of the gut may explain why the standard practice of collecting newly emerged workers from brood frames placed in incubators for use in laboratory pesticide tests may lead to misleading and/or inaccurate results."[71]

In another study Pettis et al., found that honeybees exposed to the same neonicotinoid, Imidacloprid, had a *lower* number of Nosema spores present in the hive than the honeybees without such exposure.[72] Rather than acknowledge that this study conflicts with earlier findings, the authors downplay the disparity noting: "Specific results vary, and may depend on the pesticide or dose used." More appropriately, in their review of this literature, Fairbrother et al., point out: "The studies by Pettis et al. illustrate the difficulty in extrapolating laboratory effects to field conditions when investigating susceptibility to gut pathogens."[73]

In yet another study, researchers dosed bumblebees in the lab with neonicotinoids and inserted tiny devices that allowed researchers to track the bees' behavior after the insects were set free to forage.[74] Not surprisingly, these lab exposures were relatively high and led to disoriented bees, affecting their ability to forage and find their way back to the hive. The authors called their dosing "field realistic," but the doses were still done in a lab and those feeding conditions and type of diet—sugar water rather than a diverse diet in the field—can also affect results.[75]

Such studies may well show that at some level and given limited diets, pesticides can place additional stresses on bees. But these studies do not show that pesticide risks cannot be managed and kept low enough to have insignificant impact on hive survival, which is the goal. Several other studies that dosed bees with "environmentally relevant" levels of neonicotinoids found no adverse effects.[76]

Perhaps most importantly, studies of bees in the field where neonicotinoids are used show no measurable effects. For example, one study conducted by researchers in the United Kingdom's Department for Environment, Food and Rural Affairs found no difference between bumble bees that visited areas treated with neonicotinoids and control bees. It reported:

> This study was not a formal statistical test of the hypothesis that neonicotinoid insecticides reduce the health of bumble bee colonies. Nevertheless, were neonicotinoids in pollen and nectar from treated oilseed rape to be a major source of field mortality and morbidity to bumblebee colonies, we would have expected to find a greater contribution of insecticide residues from nearby treated crops and for there to have been a clear relationship between observed neonicotinoid levels and measures of colony success. The absence of these effects is reassuring but not definitive. The study underlines the importance of taking care in extrapolating laboratory toxicology studies to the field, as well as the great need of further studies under natural conditions.[77]

More recently, a study that relies on data from actual field conditions confirms that farmers can protect their crops using these chemicals without harming honeybee hives.[78] The study, published in the online journal *PeerJ*, assessed the impact of neonicotinoid-treated canola crops on hives that foraged among these crops in 2012 in Ontario Canada. The researchers found no adverse impacts and very low exposure to the chemicals. The authors report:

> Overall, colonies were vigorous during and after the exposure period, and we found no effects of exposure to clothianidin seed-treated canola on any endpoint measures. Bees foraged heavily on the test fields during peak bloom and residue analysis indicated that honey bees were exposed to low levels (0.5–2 ppb) of clothianidin in pollen. Low levels of clothianidin were detected in a few pollen samples collected toward the end of the bloom from control hives, illustrating the difficulty of conducting a perfectly controlled field study with free-

Studies of bees in the field where neonicotinoids are used show no measurable effects.

While activists like to blame neonicotinoids for the disappearance of some the hibernating bees, little of these chemicals is actually found in the hives.

> ranging honey bees in agricultural landscapes. Overwintering success did not differ significantly between treatment and control hives, and was similar to overwintering colony loss rates reported for the winter of 2012–2013 for beekeepers in Ontario and Canada. Our results suggest that exposure to canola grown from seed treated with clothianidin poses low risk to honey bees.[79]

No one can completely dismiss the fact that agrochemicals can have an impact at some level to honeybees and non-target insects. The key is finding a level where risk is low-to-negligible in real-life settings, to allow beneficial uses of products necessary to grow food. That way we can have both effective pollination and agricultural productivity.

Claim: Neonicotinoids present the most significant pesticide exposure to honeybees.

Fact: Bees are exposed to much higher levels of other pesticides, including those that beekeepers use inside the hive to control mites and other disease-carrying vectors.

Worker honeybees are born in the early spring and pollinate crops for several weeks before they die. During their lifetime, they bring nectar and pollen to the hive to feed subsequent generations including the smaller number of bees that hibernate over the winter. Those wintering bees may be exposed to pesticides in the hive from pollen and nectar, which raises concerns about how those chemicals impact the hive's health. While activists like to blame neonicotinoids for the disappearance of some the hibernating bees, little of these chemicals is actually found in the hives. Rather, trace levels of many different chemicals appear in hives that may have some impact on hive health—to what extent is not fully clear.

For example, a 2010 study measured pesticide residues in 887 wax and pollen samples as well as bees themselves.[80] It found traces of 121 different pesticides and metabolites of pesticides in the samples, of which neonicotinoids were among the lowest present. No neonicotinoid residues were found in bees, while 49 detections were obtained from pollen and wax. Only one sample contained a notable amount of one neonicotinoid, Thaicloprid, but it only appeared in 3 percent of samples with the low average amount of 2.1 parts per billion. Compared to the other chemicals, the traces of neonicotinoids were largely insignificant. For example, the chemical Fluvalinate appeared in 98 percent of the bees wax samples with an average concentration of 7,472 parts per billion. It also appeared in 88 percent of pollen samples at levels of 40 parts per billion and in 83 percent of bees at 1 ppb. The chemical Coumaphos appeared at levels nearly as high.

The high levels for Fluvalinate and Coumaphos are to be expected, given that beekeepers apply these products directly to the hive to control mites, which pose even greater risks to the bees than do the traces of chemicals. Still, there is some evidence that these two chemicals have adverse effects on queen bees, with obvious implications for overall hive health.[81]

While beekeepers may often blame agricultural pesticides for annual hive losses, biologist and beekeeping blogger Randy Oliver calls on his colleagues to acknowledge "the elephant in the room" because they themselves use pesticides. "The plain truth is," notes Oliver, "a colony of bees does not differentiate between agricultural pesticides, and beekeeper-applied miticides. What actually affects the colony is the cumulative load of all toxins that the colony is exposed to, whether from smokestack pollution, dust drifted over from China, pesticides sprayed by farmers, or miticides applied by beekeepers with the best intentions."[82]

"I think we have known for a long time that miticides can adversely affect queens and kill drone sperm," says vanEngelsdorp, who was one of the first to identify colony collapse disorder. However, he does not blame beekeepers for using them. "It's like chemotherapy. They know it's bad, but it's a lot better than the alternative."[83]

Neonicotinoid exposure is far lower than that of those products used in the hive. There are periodically incidents where bees die in large numbers because mistakes made during application of chemicals, such as bee kills when chemicals are applied to the soil and sprayed. These isolated incidents are unlikely to be part of a trend related to substantial hive losses or CCD, and they can be reduced with careful management, such as proper timing of applications. Indeed, just as we do not ban airplanes or cars because of accidents, we need not ban chemicals that have valuable uses because a limited number of accidents. Fortunately, as highlighted in a recent study on such issues in Canada, these incidents are relatively few.[84]

Accordingly, chemicals need to be used strategically and carefully for both farming and pest control in hives. In both cases, the products yield important benefits in disease reduction and food production, which is why risk management rather than product elimination offers the best course of action.

Claim: Banning neonicotinoids and using other products to be on the "safe side" will help honeybees.

Isolated incidents are unlikely to be part of a trend related to substantial hive losses or CCD.

Despite much misleading and negative publicity, neonicotinoids strike a very good balance and have reduced risks associated with the pesticides they replaced.

Reality: Bans will promote the use of alternative chemicals that may prove more dangerous than neonicotinoids.

It is a given that farmers will look for products to protect their crops from damaging pests, so the only question is what products best meet their needs while keeping risks to non-target species low. Despite much misleading and negative publicity, neonicotinoids strike a very good balance and have reduced risks associated with the pesticides they replaced.

The U.S. Agricultural Research Service notes on its website:

> The neonicotinoids were developed in the mid-1990s in large part because they showed reduced toxicity to honey bees, compared with previously used organophosphate and carbamate insecticides.[85]

Similarly, in its review of the issue, the Australian government concluded:

> On the basis of information available to it, the APVMA [the Australian Pesticide and Veterinary Medicines Authority] is currently of the view that the introduction of the neonicotinoids has led to an overall reduction in the risks to the agricultural environment from the application of insecticides.[86]

One of the key benefits of neonicotinoids is that, although they can be applied as a spray, much of their uses involve seed applications. This approach greatly reduces environmental exposures to non-target species, as the insecticide is absorbed into the plant and mostly affects those pests that would bore into or chew on the plant.

A recent group of studies, produced by the agricultural consultancy AgInfomatics for several agrochemical companies, interviewed farmers to estimate impacts of potential bans on neonicotinoids. According to one of these studies, seed applications represent about 98 percent of neonicotinoid uses for corn, soybean, wheat, cotton, and sorghum crops.[87] These neonicotinoid applications are necessary to control 17 groups of pests affecting these crops. Based on the farmer interviews, the study estimates that about 77 percent would find alternative chemicals, which would lead to greater environmental damage. Specifically, it reports that if farmers cannot use neonicotinoids, they will:

- Turn to other insecticides and increase the number of acres where they apply such chemicals by 185 percent.
- Replace the 4 million pounds of neonicotinoids they use for these crops now with 19 million pounds of non-neonicotinoids chemicals,

a 116 percent increase of chemical use on a per-pound basis.

- Increase chemical applications to soil and direct foliar spraying of plants, increasing the relatively small current level of neonicotinoid spray applications of 4.5 million acres to spraying of 25 million acres of crops using replacement products.

The authors conclude:

> The non-neonicotinoid scenario implies greater reliance on fewer and older modes of action, such as pyrethroids and organophosphates, which raises concerns about problems with insect resistance. Increased use of these two broader-spectrum insecticide classes is also more likely to have negative impacts on non target insects and organisms, including beneficial insects that farmers using IPM rely on to contribute to lower pest populations. Furthermore, the projected shift also removes other benefits of seed treatments compared to foliar treatments, such as reduced potential for spray drift and field runoff as well as fewer passes through fields.[88]

Another AgInfomatics case study involved interviews with Florida citrus growers to address how neonicotinoids benefit these farms and their surrounding communities.[89] Citrus growers' very survival depends on having effective treatments for serious pests. In particular, they are plagued by a small insect called the Asian Citrus Psylid, which feeds on fruit trees and transmits a bacterial disease called Huanglongbing (HLB). If allowed to get out of control, HLB will undermine fruit productivity and eventually destroy citrus trees within a few years.

Such impacts are greatly minimized by the use of a number of pesticide products, key among them neonicotinoids. These are applied in liquid form at the roots of young trees as they mature, helping to produce trees that are more disease-resistant. The growers interviewed for the AgInfomatics study indicated that if they lose the ability to protect their crops using neonicotinoids, they may continue to harvest what they have until the trees are exhausted and then shut down their operations, ultimately leading to the Florida citrus industry's demise.

It is simply too difficult to survive without such valuable pest control technologies like neonicotinoids. "Losing viable citrus production in Florida would have a ripple effect on jobs in harvesting, processing and packing plants; transportation; and multiple agricultural services, including equipment sales and consulting," explain the researchers in this study.

Citrus growers' very survival depends on having effective treatments for serious pests.

Wouldn't it be wonderful if we could waive a magic regulatory wand and solve the world's problems?

"The further decline or loss of Florida citrus would have dramatic effects on communities throughout the citrus regions of Florida and would increase reliance on imported juice from other countries."[90]

In Europe, where neonicotinoids were banned starting in the 2014 planting season, farmers are already seeing serious crop damage and increased use of other chemicals that are likely more dangerous for bees. Rebecca Randall of the Genetic Literacy Project reports that damage to oilseed rape (canola) in England has increased because of a rise in beetle populations, whose larvae destroy plants by chewing on them.[91] The British government eventually allowed emergency spraying of neonicotinoids, but much damage is done and the emergency use is temporary.

In 2014, farmers in the UK reported losses of 20 to 50 percent of their crops and the government and in Germany some farmers have completely pulled up their crops and replaced them.[92] The only controls that farmers have left are potentially more damaging to honeybees than neonicotinoids. Randall reports:

> [C]anola farmers are spraying almost twice as much alternative chemicals from the class of pyrethroids, said Manuela Specht from the German oilseed trade group UFOP in Berlin. Last fall, UK farmer Peter Kendall said he sprayed his crop with pyrethroids three times last year before giving up, replanting and spraying again. This increased spraying with harsher chemicals may harm the honeybees, which the neonics ban intended to protect in the first place. A 2014 study by researchers at the University of London found that exposure to pyrethroids can reduce bee size. "There is a strong feeling among farmers that we are worse off and the environment is worse off," said Kendall.[93]

This situation illustrates the importance of considering the complete consequences of public policies. In this case, a shortsighted ban intended to protect the bees and their ability to pollinate crops will likely harm both honeybees and agricultural productivity in general.

Claim: We need regulations to address honeybee survival challenges.

Reality: Technological development, improved hive management, and private collaboration offer the best solutions.

Wouldn't it be wonderful if we could waive a magic regulatory wand and solve the world's problems? New regulations are often sold that way. Yet regulations are often slow to develop, governed by political rather than practical and scientific goals, and hard to repeal, improve, or modify, even when they become counterproductive. Indeed, while environmental activists may press for regulations, the resulting rules may serve other interest groups—including industry and agricultural interests—with whom the activists are not ideologically aligned.

In the case of honeybees, the best solutions will emerge with collaboration among the parties with an interest in protecting bees—beekeepers, farmers, conservationists, entomologists and other researchers, consumers, and even chemical companies. A balanced, proactive approach that recognizes both the need for food production and wildlife conservation will leverage current knowledge and technological advancements to address ongoing problems.

Ultimately, the survival of honeybees will result from careful hive management in the commercial bee industry. That means beekeepers need to continue to research and follow the best available science in beekeeping husbandry, just as farmers who care for cattle and other animals do. And they can work with other parties to achieve those ends.

Such improved hive management is already ongoing and progress is evident. For example, as noted, during 2013-2014 hive losses were lower and at manageable levels after several years of relatively high losses. What explains the improvement? Beekeeper and policy scholar Todd Myers of the Washington Policy Center explains: "Such a significant decline in winter mortality indicates beekeepers are effectively changing their management techniques in response to losing hives. It also shows how hyperbole about honeybees is harming thoughtful discussion about the causes of CCD."[94]

Dennis vanEngelsdorp noted that losses could have been much lower if beekeepers better managed varroa mites, which present a major challenge to honeybee health. And *pesticides*—which beekeepers use in hive to fight mites and other insects that harm honeybees—are part of the solution. A press statement on the study explains:

> Every beekeeper needs to have an aggressive varroa management plan in place. Without one, they should not be surprised if they suffer large losses every other year or so. Unfortunately, many small-scale beekeepers are not treating and are losing many colonies. Even beekeepers who do treat for mites often don't treat frequently enough or at the right time. If all beekeepers were to aggressively control mites, we would have many fewer losses.[95]

In the case of honeybees, the best solutions will emerge with collaboration among the parties with an interest in protecting bees—beekeepers, farmers, conservationists, entomologists and other researchers, consumers, and even chemical companies.

Homeowners and anyone with a piece of land or flower box can contribute by planting certain wild flowers that are of particular value to bees and other wildlife.

In addition to providing a better understanding about hive survival, recent studies on hive health provide insights on some of the solutions. For example, studies have found that some bees have a propensity to basically isolate and essentially quarantine diseases and contaminants that enter hives, such as mites. This "hygienic behavior" is a genetic trait.[96] Therefore, beekeepers can breed larger numbers of these hygienic bees into hives to reduce risks and produce healthier, stronger hives.

Farmers and chemical companies are also part of the solution. They can work with beekeepers to ensure the careful and strategic use of neonicotinoids and other chemical products necessary to control pests. For example, Florida citrus growers have negotiated a deal with beekeepers to continue neonicotinoid use but are employing measures to limit impact on bees, such as timing the spraying so that beekeepers can temporarily relocate nearby hives to prevent exposure.[97]

Other assistance can come from environmental groups that can help promote private conservation efforts to improve and diversify the food available to honeybees. Simply planting wildflowers near farms and even in residential settings will not only help honeybees, it will help other pollinators and nectar-feeding creatures, such as hummingbirds. Creating such habitat in and around farms that otherwise plant single species of crops can be particularly helpful in providing a diverse diet for both honeybees and native bees that also play a role in pollination. In addition, homeowners and anyone with a piece of land or flower box can contribute by planting certain wild flowers that are of particular value to bees and other wildlife. Such activities may play an important role in helping not only wild honey bee populations but also native bees, which may play a larger role in pollination than originally believed.[98]

Collaboration on habitat cultivation and research efforts are already being promoted by public, non-profit and industry players. To that end, there is the Bee Informed Partnership between federal agencies and academic researchers, Operation Pollinator to advance pollinator habitat organized by Syngenta,[99] the Bayer Bee Care Program[100] to support research, and the nonprofit group the Keystone Center has established the Honeybee Health Coalition[101] to bring together farmers, chemical companies, nonprofits, beekeepers, and other stakeholders. But more importantly are the many local collaborative efforts between beekeepers, farmers, and communities.

Conclusion

Honeybee health issues are far broader than concerns raised by CCD alone and the solutions require a more comprehensive understanding of issues affecting honeybees. A primary concern related to honeybee health is their value in promoting agricultural productivity. Shortsighted pesticide bans allegedly designed to help the situation are likely to prove counter-productive since these products are necessary to control pests that threaten our food supply. Such bans may also harm commercially farmed honeybees as well as wildlife, including native pollinators, because replacement products are likely to prove more dangerous.

The best solutions will strike a balance that recognizes the value of targeted and managed use of agrochemicals and minimizes any impact on commercially farmed honeybees and wildlife. Such policies can only be pursued when we dispense with misinformed alarmism and focus on science-based solutions and productive collaboration.

NOTES

1 "Vanishing Bees," Natural Resources Defense Council, undated, http://www.nrdc.org/wildlife/animals/bees.asp.
2 Josephine Marcottym, "Nature's Dying Migrant Worker," *Minneapolis Star Tribune*, September 6, 2014, http://www.startribune.com/local/264929101.html.
3 Kathryn Jackson Fallon, "The Harsh Economic Sting of the Beepocalypse," *Fiscal Times*, August 16, 2013, http://www.thefiscaltimes.com/Articles/2013/08/16/The-Harsh-Economic-Sting-of-the-Beepocalypse.
4 Jason Schwartz, "Bees: Study Points to Key Cause of Colony Collapse, Disorder," Greenpeace blog, May 23, 2014, http://greenpeaceblogs.org/2014/05/23/bees-study-points-key-cause-colony-collapse-disorder.
5 Amanda Kimble-Evans, "Colony Collapse Disorder: Are Potent Pesticides Killing Honeybees?" *Mother Jones*, October/November 2009, http://www.motherearthnews.com/nature-and-environment/colony-collapse-disorder-zmaz09onzraw.aspx#axzz3Q9fKwT9T.
6 *Global Honey Bee Colony Disorders and other Threats to Insect Pollinators*, United Nations Environment Programme, 2010, p. 4, http://www.unep.org/dewa/Portals/67/pdf/Global_Bee_Colony_Disorder_and_Threats_insect_pollinators.pdf.
7 Dennis vanEngelsdorp, Jay D. Evans, et al, "Colony Collapse Disorder: A Descriptive Study," PLoS ONE, Vol. 4, No. 8, March 6, 2009, http://www.plosone.org/article/info:doi/10.1371/journal.pone.0006481.
8 For a helpful summary of the study see Kim Kaplan, "Pathogen Loads Higher in Bee Colonies Suffering from Colony Collapse Disorder," Agricultural Research Service, U.S. Department of Agriculture, August 12, 2009, http://www.ars.usda.gov/is/pr/2009/090812.htm.
9 J. Kim Kaplan, "Colony Collapse Disorder: An Incomplete Puzzle", *Agricultural Research Magazine*, July 2012, Vol. 60, No. 6, http://www.ars.usda.gov/is/AR/archive/jul12/July2012.pdf.
10 Hachiro Shimanuki and David A. Knox, *Diagnosis of Honey Bee Diseases United States, Department of Agriculture Agricultural Research Service, Agriculture Handbook*, No. 690, undated, http://www.ars.usda.gov/is/np/honeybeediseases/honeybeediseases.pdf.
11 As cited by Dennis vanEngelsdorp, Marina Doris Meixner, et al in "A Historical Review of Managed Honey Bee Populations in Europe and the United States and the Factors that May Affect Them," *Journal of Invertebrate Pathology,* Vol. 103, suppl. (January 2010), pp. S80–S95.
12 Ibid.
13 "The Honey Bee Tracheal Mite," *Insect Information Series, Department of Entomology, Soils, and Plant Sciences, Clemson Cooperative Extension*, undated fact sheet, http://www.clemson.edu/extension/beekeepers/factsheets/honey_bee_tracheal_mite.html.
14 "Discovery Aims to Fight Destructive Bee Disease," News Release, University of Guelph, December 16, 2014, https://www.uoguelph.ca/cpa/wp/2014/12/discovery-aims-to-fight-destructive-bee-disease.
15 Matt Shipman, "Researchers Find Genetic Diversity Key to Survival of Honey Bee Colonies," *NC State News*, June 17, 2013, https://news.ncsu.edu/2013/06/wms-tarpy-diversity2013.
16 *Global Honey Bee Colony Disorders and other Threats to Insect Pollinators*, p. 4.
17 Francie Diep, "Royal Pains: Why Queen Honeybees Are Living Shorter, Less Productive Lives Plus, Why Colony Collapse Disorder is Not that Big a Deal Anymore," *Scientific American*, September 16, 2012, http://www.scientificamerican.com/article/royal-pains-why-queen-honeybees-are-living-shorter-less-productive-lives.
18 "Colony Collapse Disorder: A Complex Buzz," Agricultural Research Service, May/June 2008, http://www.ars.usda.gov/is/AR/archive/may08/colony0508.htm.
19 Anne Fairbrother, John Purdy, Troy Anderson, and Richard Fell, "Risks of Neonicotinoid Insecticides to Honeybees," *Environmental Toxicology and Chemistry*, Vol. 33, No. 4 (April, 2014), pp. 719-731.
20 Marla Spivak, Eric Mader, and Mace Vaughan, and Ned H. Euliss, Jr. "The Plight of the Bees," *Environmental Science and Technology*, Vol. 45, No. 1 (2011), pp. 34–38, http://pubs.acs.org/doi/full/10.1021/es101468w.
21 Jamie Ellis, "Colony Collapse Disorder (CCD) in Honey Bees," IFAS Extension, University of Florida, revised September 2013, http://edis.ifas.ufl.edu/pdffiles/IN/IN72000.pdf.
22 Agricultural Research Service, "Honey Bee Health and Colony Collapse Disorder."
23 Rex Weyler, "Worldwide Honey Bee Collapse: A Lesson in Ecology," EcoWatch, June 11, 2013, http://ecowatch.com/2013/06/11/worldwide-honey-bee-collapse-a-lesson-in-ecology.
24 vanEngelsdorp and Meixner, "A Historical Review of Managed Honey Bee Populations."
25 Agricultural Research Service, "Honey Bees and Colony Collapse Disorder."
26 vanEngelsdorp and Meixner, "A Historical Review of Managed Honey Bee Populations," p. 588.
27 Pierre Chauzat et al., *A Pan-European Epidemiological Study on Honey Bee Colony Losses 2012-2013*, European Union Reference Laboratory for Honeybee Health, April 2014, http://ec.europa.eu/food/animals/live_animals/bees/docs/bee-report_en.pdf.
28 Dennis vanEngelsdorp,et al., "Preliminary Results: Honey Bee Colony Losses in the United States, 2013-2014," May 6, 2014, http://beeinformed.org/2014/05/colony-loss-2013-2014.
29 For an excellent analysis of how market forces facilitate hive replacement, see Randal Rucker and Walter Thurman, "Colony Collapse Disorder: The Market Response to Bee Disease," Property and Environment Research Center (Bozeman MT: 2012), http://perc.org/sites/default/files/ps50.pdf.
30 Henry I. Miller, "Why the Buzz About a Bee-pocalypse Is a Honey Trap," *Wall Street Journal*, July 22, 2014, http://online.wsj.com/articles/henry-i-miller-why-the-buzz-about-a-bee-pocalypse-is-a-honey-trap-1406071612.

31 Food and Agriculture Organization of The United Nations, Statistics Division, FAOSTAT Database, accessed online on March 24, 2015, http://faostat3.fao.org.

32 Jennifer Sass, "No Fable of the Bees Here; The Critters Are in Trouble" (letter to editor), *Wall Street Journal*, August 6, 2014, http://online.wsj.com/news/articles/SB20001424052702303635604580065412952517120.

33 Marcelo A. Aizen and Lawrence D. Harder, "The Global Stock of Domesticated Honey Bees Is Growing Slower than Agricultural Demand for Pollination," *Current Biology,* Vol. 19 (June 9, 2009): pp. 1-4, http://www.cell.com/current-biology/abstract/S0960-9822%2809%2900982-8.

34 Ibid. They also note that global data is insufficient to gage the ecological well-being of wild pollinators, but that, although worthy of consideration, is a separate issue.

35 "Honeybees: Population Declines Continue, Is the American Food Supply in Jeopardy?" *Inquisitr*, January 3, 2015, http://www.inquisitr.com/1724473/honeybees-population-declines-continue-is-the-american-food-supply-in-jeopardy.

36 Kim, Kaplan, "Survey Reports Fewer Winter Honey Bee Losses," press release, U.S. Department of Agriculture, May 15, 2014, http://www.ars.usda.gov/is/pr/2014/140515.htm; Kim Kaplan, "Fact Sheet: Survey of Bee Losses During Winter of 2012/2013," May 12, 2014, http://www.ars.usda.gov/is/br/beelosses; and Winter Loss Survey 2012 – 2013: Preliminary Results, Bee Informed, May 2nd, 2013, http://beeinformed.org/results/winter-loss-survey-2012-2013-2.

37 Kim Kaplan, "Survey Reports Fewer Winter Honey Bee Losses."

38 Canadian Association of Professional Apiculturists, "CAPA Statement on Honey Bee Wintering Losses in Canada (2014)," July 2014, http://www.capabees.com/content/uploads/2013/07/2014-CAPA-Statement-on-Honey-Bee-Wintering-Losses-in-Canada.pdf.

39 Chauzat.

40 Ibid.

41 Barbara Lewis, "EU Study Finds Honey Bees Death Rates are Lower than Feared," Reuters, April 07, 2014, http://www.reuters.com/article/2014/04/07/eu-bees-idUKL6N0MZ4P920140407?irpc=932.

42 "Losses of honey bee colonies over the 2013/14 winter, Preliminary Results from an International Study," news release, COLOSS, Bern Switzerland, July 18, 2014, http://www.coloss.org/announcements/coloss-press-release-colony-losses-july-14.

43 "Honey Bee Colony Winter Survival Rate Greatly Improves: The 2013/14 Winter Was Kinder to Bees but Losses at 10 Percent Were still Double what they Should Be," news release, British Beekeepers Association, June 18, 2014, http://www.bbka.org.uk/files/pressreleases/bbka_winter_survival_release_18_june_2014_1403026705.pdf.

44 Todd Woody, "Honey Bees Are Dying Putting America At Risk Of A Food Disaster," *Huffington Post*, May 6, 2013, http://www.huffingtonpost.com/2013/05/06/honey-bees-dying-food-disaster_n_3225599.html.

45 "Vanishing Bees," Natural Resources Defense Council, undated, http://www.nrdc.org/wildlife/animals/bees.asp.

46 Inquisitr.

47 Agricultural Research Service, "Honey Bees and Colony Collapse Disorder."

48 Hoy Carman, "The Estimated Impact of Bee Colony Collapse Disorder on Almond Pollination Fees," *Agricultural and Resource Economics Update*. Vol. 14, No. 5 (June 2011): pp. 9-11, http://giannini.ucop.edu/media/are-update/files/articles/V14N5_4.pdf.

49 Ibid.

50 "CSBA 2013 Pollination survey Results," California State Beekeepers Association, undated, http://www.californiastatebeekeepers.com/resources/2013-Pollination-Survey%20.pdf.

51 Agricultural Research Service, "Honey Bees and Colony Collapse Disorder."

52 Ellis.

53 Marla Spivak, Eric Mader, and Mace Vaughan, and Ned H. Euliss, Jr. "The Plight of the Bees," *Environmental Science and Technology*, Vol. 45, No. 1 (2011), pp. 34–38, http://pubs.acs.org/doi/abs/10.1021/es101468w.

54 Jonathan Foley, "It's Time to Rethink America's Corn System," *Scientific American*, March 5, 2013, http://www.scientificamerican.com/article/time-to-rethink-corn.

55 Schwartz. The Harvard study is discussed in a subsequent section of this paper.

56 Kaplan, "Colony Collapse Disorder: An Incomplete Puzzle."

57 Chauzat.

58 Anastasia Balezdrova, "The government does not support the Greek beekeepers in the fight against harmful pesticides," *GR Reporter*, April 30 2013, http://www.grreporter.info/en/government_does_not_support_greek_beekeepers_fight_against_harmful_pesticides/9259.

59 *Overview Report: Neonicotinoids and the Health of Honey Bees in Australia* (Kingston: Australian Government/ Australian Pesticides and Veterinary Medicines Authority, February 2104,), p. 2, http://archive.apvma.gov.au/news_media/docs/neonicotinoids_overview_report_february_2014.pdf.

60 Ibid.

61 Lee Townsend, "Canada's Bees are Thriving: Public Needs Facts, not Fear," *Guelph Mercury*, March 19, 2014, http://www.guelphmercury.com/opinion-story/4417531-canada-s-bees-are-thriving-public-needs-facts-not-fear.

62 Pesticide Action Network UK, "Sub-Lethal and Chronic Effects of Neonicotinoids on Bees and Other Pollinators," *Bee Declines and Pesticides Factsheet 2*, 2012, http://bees.pan-uk.org/assets/downloads/Bee_factsheet2.pdf.

63 Agricultural Research Service, "Honey Bees and Colony Collapse Disorder."
64 Tjeerd Blacquière et al., "Neonicotinoids in Bees: a Review on Concentrations, Side-Effects and Risk Assessment," *Ecotoxicology*, Vol. 21, No. 4, (May 2012): pp. 973–992, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3338325.
65 "Neonicotinoids Barely Found in Pollen of Seed-treated Plants," *Entomology Today*, February 6, 2014, http://entomologytoday.org/2014/02/06/neonicotinoids-barely-found-in-pollen-of-seed-treated-plants.
66 Lu Chensheng, Kenneth M. Warchol, and Richard A. Callahan, "Sub-lethal Exposure to Neonicotinoids Impaired Honey Bees Winterization before Proceeding to Colony Collapse Disorder," *Bulletin of Insectology*, Vol. 67, No. 1 (2014): pp. 125-130, http://www.bulletinofinsectology.org/pdfarticles/vol67-2014-125-130lu.pdf.
67 James Maynard, "Honeybee Killer Neonicotinoids Caused Colony Collapse Disorder, Harvard Study Says," *Tech Times*, May 11, 2014, http://www.techtimes.com/articles/6843/20140511/honeybee-killer-neonicotinoids-caused-colony-collapse-disorder-harvard-study.htm.
68 Chensheng, Warchol and Callahan, p. 127.
69 "Study on Neonicotinoids and Honey Bees," Bayer CropScience, United States, Press Release, May 12, 2014, https://www.bayercropscience.us/news/press-releases/2014/05122014-bee-care-harvard-statement.
70 Joe Ballenger, "Are Neonicotinoids the Sole Factor Responsible for Colony Collapse Disorder?," Biology Fortified, June 5 2014, http://www.biofortified.org/2014/06/are-neonicotinoids-the-sole-factor-responsible-for-colony-collapse-disorder.
71 Anne Fairbrother, John Purdy, Troy Anderson, and Richard Fell, "Risks of Neonicotinoid Insecticides to Honeybees," *Environmental Toxicology and Chemistry,* Vol. 33, No. 4 (April, 2014), pp. 719-731, http://onlinelibrary.wiley.com/doi/10.1002/etc.2527/abstract.
72 Jeffery S. Pettis et al., "Crop Pollination Exposes Honey Bees to Pesticides Which Alters Their Susceptibility to the Gut Pathogen Nosema ceranae," *PLoS ONE,* Vol. 8, No. 7 (July 2013): p. 7, http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0070182.
73 Fairbrother, Purdy, Anderson, and Fell, "Risks of Neonicotinoid Insecticides to Honeybees," p. 725.
74 Hannah Feltham, Kirsty Park, and Dave Goulson, "Field Realistic Doses of Pesticide Imidacloprid Reduce Bumblebee Pollen Foraging Efficiency," *Ecotoxicology*, Vol. 23, No. 13, April 2014, http://link.springer.com/article/10.1007%2Fs10646-014-1189-7.
75 Sara LaJeunesse, "Diet Affects Pesticide Resistance in Honey Bees," *Penn State News*, November 3, 2014, http://news.psu.edu/story/332959/2014/11/03/research/diet-affects-pesticide-resistance-honey-bees.
76 See G. Christopher Cutler And Cynthia D. Scott-Dupree, "Exposure to Clothianidin Seed-Treated Canola Has No Long-Term Impact on Honey Bees," *Journal of Economic Entomology,* Vol. 100, No. 3 (June 2007), pp. 765-772, https://dspace.lib.uoguelph.ca/xmlui/bitstream/handle/10214/2621/32546.pdf?sequence=1; J.P. Faucon et al., "Experimental Study on the Toxicity of Imidacloprid Given in Syrup to Honey Bee (Apis mellifera) Colonies," *Pest Management Science*, Vol. 61 (2005): pp. 111–125; as noted by Blacquière et al., in "Neonicotinoids in Bees: A Review on Concentrations, Side-Effects and Risk Assessment.".
77 "Effects of Neonicotinoid Seed Treatments on Bumble Bee Colonies Under Field Conditions," Food and Environment Research Agency, UK Department for Environment, Food and Rural Affairs, March 2013, http://fera.co.uk/ccss/documents/defraBumbleBeeReportPS2371V4a.pdf.
78 G. Christopher Cutler et al., "A Large-Scale Field Study Examining Effects of Exposure to Clothianidin Seed-Treated Canola on Honey Bee Colony Health, Development, and Overwintering Success" *PeerJ*, October 30, 2014, https://peerj.com/articles/652.
79 Ibid.
80 Christopher A. Mullin et al., "High Levels of Miticides and Agrochemicals in North American Apiaries: Implications for Honey Bee Health," *PLoS ONE,* Vol. 5, No. 3 (March 19, 2010), http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0009754.
81 T. Haarmann et al., "Effects of Fluvalinate and Coumaphos on Queen Honey Bees (Hymenoptera: Apidae) in Two Commercial Queen Rearing Operations, *Journal of Economic Entomology*, Vol. 95, No.1 (February 2002): pp. 28-35.
82 Randy Oliver, "The Learning Curve—Part 2: Killing Mites without Killing Your Bees," undated, http://scientificbeekeeping.com/the-learning-curve-part-2-killing-mites-without-killing-your-bees.
83 Francie Diep, "Royal Pains: Why Queen Honeybees Are Living Shorter, Less Productive Lives," *Scientific American*, September 16, 2013, http://www.scientificamerican.com/article/royal-pains-why-queen-honeybees-are-living-shorter-less-productive-lives/.
84 G. Christopher Cutler, Cynthia D. Scott-Dupree, and David M. Drexler, "Honey Bees, Neonicotinoids, and Bee Incident Reports: the Canadian Situation," *Pest Management Science*, Vol. 70, No. 5 (May 2014): pp. 779–783, http://onlinelibrary.wiley.com/doi/10.1002/ps.3613/abstract.
85 U.S. Agricultural Research Service, Honey Bees and Colony Collapse Disorder.
86 *Overview Report: Neonicotinoids and the Health of Honey Bees in Australia*, p. 2.
87 AgInfomatics, "The Value of Neonicotinoids in North American Agriculture: AgInfomatics Estimated Impact of Neonicotinoid Insecticides on Pest Management Practices and Costs for U.S. Corn, Soybean, Wheat, Cotton and Sorghum Farmers," 2014, http://growingmatters.org/wp-content/themes/growingmatters/pdf/FINAL_AgInfomatics_EstimatedImpact_2014.pdf
88 Ibid.
89 AgInfomatics, "The Value of Neonicotinoids in North American Agriculture: A Case Study of Neonicotinoid Use in Florida Citrus," 2014, https://docs.google.com/viewer?url=http://growingmatters.org/wp-content/themes/growingmatters/pdf/FINAL_AgInfomatics_CaseCitrus_2014.pdf&chrome=true

90 Ibid.
91 Rebecca Randall, "Pests Invade Europe After Neonicotinoids Ban, With no Benefit to Bee Health," Genetic Literacy Project, January 27, 2015, http://geneticliteracyproject.org/2015/01/27/pests-invade-europe-after-neonicotinoids-ban-with-no-benefit-to-bee-health.
92 Forrest Laws, "Ill-Advised Pesticide Ban Costing European Farmers up to Half their Crops," Farm Press Blog, October 17, 2014, http://deltafarmpress.com/blog/ill-advised-pesticide-ban-costing-european-farmers-half-their-crops.
93 Randall, "Pests Invade Europe after Neonicotinoids Ban, with no Benefit to Bee Health."
94 Todd Myers, "Nationwide Survey Shows Dramatic Improvement in Honeybee Health" Washington Policy Center Blog, May 16, 2014, http://www.washingtonpolicy.org/blog/post/nationwide-survey-shows-dramatic-improvement-honeybee-health.
95 Kaplan, "Survey Reports Fewer Winter Honey Bee Losses."
96 Hasan M Al Toufailia et al., "Towards integrated control of varroa: Effect of variation in hygienic behaviour among Honey Bee Colonies on Mite Population Increase and Deformed Wing Virus Incidence," *Journal of Apicultural Research,* Vol. 53, No. 5 (December 2014): International Bee Research Association, pp. 555-562, http://www.ibra.org.uk/articles/Hygienic-behaviour-against-varroa-mites-and-virus.
97 John Buchanan, "Beekeeper Initiative Sets National Example," *Highlands Today: An Edition of the Tampa Tribune*, September 17, 2014, http://highlandstoday.com/hi/local-news/beekeeper-initiative-sets-national-example-20140917/.
98 Lucas A. Garibaldi et al., "Wild Pollinators Enhance Fruit Set of Crops Regardless of Honey Bee Abundance," *Science*, Vol. 339, No. 6127 (March 29, 2013): pp. 1608-1611, http://www.sciencemag.org/content/339/6127/1608.
99 See: Operation Pollinator website, http://www.operationpollinator.com.
100 See: Bayer Bee Care website, http://beecare.bayer.com/bayer-bee-care/partnerships-and-projects.
101 See: Honey Bee Health Coalition website, http://honeybeehealthcoalition.org.

About the Author

Angela Logomasini is a Senior Fellow at the Competitive Enterprise Institute, where she conducts research and analysis on environmental regulatory issues and manages the consumer education website, SafeChemicalPolicy.org. She is co-editor of the CEI book, *The Environmental Source*. Her articles have been published in the *Wall Street Journal*, *New York Post*, *Washington Times*, and other papers. Logomasini also makes regular media appearances. She has appeared on dozens of radio shows, including NPR's "The Diane Rehm Show," CNN Radio, and Radio America. Television appearances include Fox Business's "STOSSEL," ABC's "Nightline," C-SPAN, CNN, and more.

She served as Legislative Assistant to Senator Sam Brownback (R-Kan.) from 1996-1998, advising the senator on energy and environmental issues. Before that, she was Environmental Editor for the Research Institute of America. From 1989 to 1994, Angela worked for Citizens for a Sound Economy (CSE), serving as Director of Solid Waste Policy for a CSE affiliate, Citizens for the Environment, and as a policy analyst covering various economic issues.

Angela Logomasini has a Ph.D. in politics, which she earned at the Catholic University of America.

COMPETITIVE
ENTERPRISE
INSTITUTE

The Competitive Enterprise Institute promotes the institutions of liberty and works to remove government-created barriers to economic freedom, innovation, and prosperity through timely analysis, effective advocacy, inclusive coalition-building, and strategic litigation.

COMPETITIVE ENTERPRISE INSTITUTE

1899 L Street NW, 12th Floor

Washington, DC 20036

202-331-1010

cei.org