BUZZING ABOUT BEES:
The Mystery of Pollinator Decline
case study | food and hunger unit

EARTH matters
Studies For Our Global Future

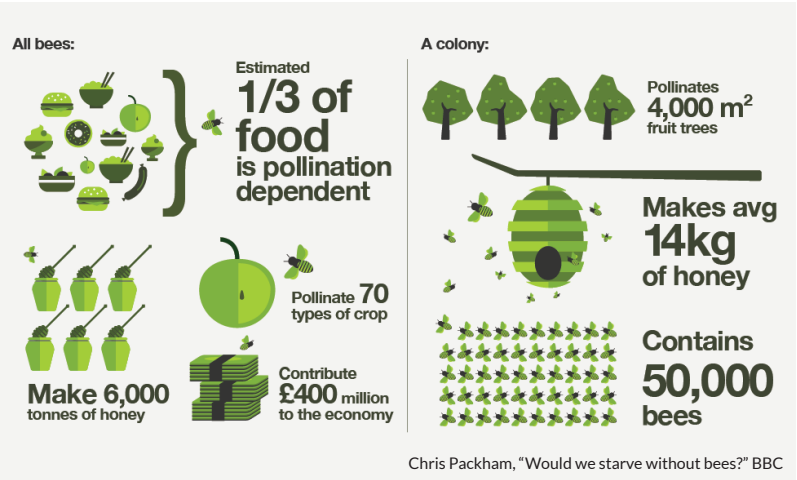
Almonds, apples, blueberries, chocolate, and coffee, all the way down the alphabet to watermelon, yellow squash, and zucchini. What do these foods have in common? They all make their way to our tables thanks to the hard work of bees. In fact, about one of every three bites of food—including many of the well-loved fruits and vegetables that enrich our diets—is made possible by insect-assisted **pollination**.[1] Unfortunately, bees and a number of other pollinators are in decline, putting major harvests in jeopardy.

A bee collecting pollen.

What is pollination?

Pollination is basically plant sex. A grain of pollen moves from the male part of the flower, called an anther, to the female part, called the stigma, beginning the fertilization process that creates seeds. In self-pollinating plants, this happens without help. Other plants rely on the wind to move pollen from flower to flower. But for about 90 percent of wild flowering plant species and many of our favorite food crops, unwitting animal helpers do the work of moving the pollen from bud to bud, allowing plants to form fruit and seeds or increasing crop yields.

Bees are the most well-known pollinators. There are over 20,000 species of wild bees, many of which have evolved to release pollen from specific plants. Other insects like beetles, butterflies, flies, moths, and wasps also transfer pollen, as do birds and some mammals; think of a hummingbird hovering around a trumpet blossom or bats flapping from plant to plant at night. Their work is what scientists call an "ecosystem service"—a natural process that benefit humans, like plants providing oxygen, wetlands serving as flood protection, or healthy forests purifying water.



What all honey bees, and a colony of honey bees, do for us each year.

Putting bees to work

As with many natural processes, humans have taken pollination into our own hands. On a small garden or farm, surrounded by a diversified wildflower-strewn landscape, wild pollinators might be abundant enough to make crops bear fruit. But as orchards and crop fields have expanded and are planted more frequently in **monocultures** (containing just one type of crop), farm managers have turned to beekeepers to bring in mobile honeybee hives at key flowering times. For example, each January and February about three-quarters of the U.S. honeybee army of 2.6 million hives convenes in California to pollinate 1-million-plus acres of almond orchards.[2]

Bee keeping and honey gathering may have been around for over 20,000 years, but today it is truly a commercial enterprise. Around the world, some 81 million honeybee hives service farms and also produce 1.6 million metric tons of honey each year.[3] They are responsible for most of the food produced with the help of pollinators, valued at up to $577 billion globally.[4]

Silenced hives

In 2006, a strange thing began to happen in the world of bees. Beekeepers around the United States were finding hives nearly empty, containing only a queen and the young bees, along with stocks of honey. The normally attentive adult bees that spend their days foraging for protein-rich pollen and carbohydrate-filled nectar to deliver to the colony were missing. Unlike in a direct poisoning incident, say from pesticides, where dead bee bodies typically litter the hive and its whereabouts, no bodies could be found. Without their food deliveries, the hives died.

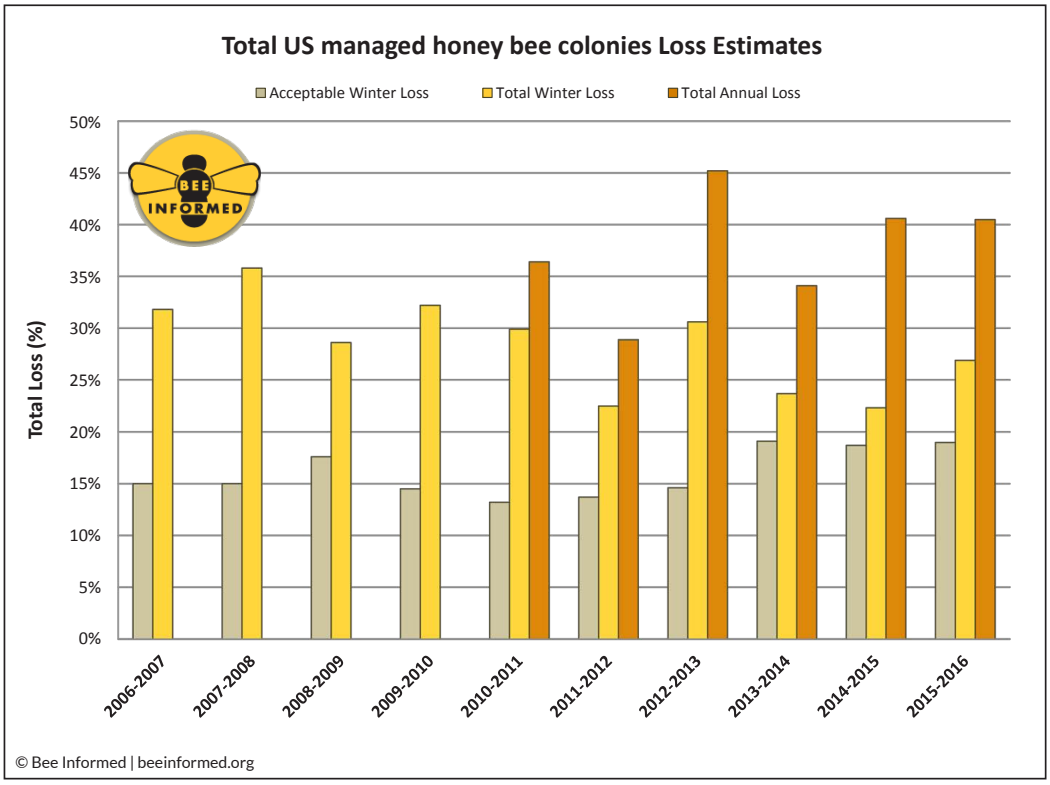


Figure 1: Summary of total overwintering colony losses in the United States across eleven years of conducting the winter loss survey (yellow bars; October 1 – April 1) and across six years of conducting the summer (April 1 – October 1) and annual loss survey. Total annual loss values (orange bars) include total winter and total summer losses. The acceptable winter loss rate (grey bars) is the average percentage of acceptable yearly colony losses declared by the survey participants in each year of the survey.

That year, beekeepers in many U.S. states lost close to a third of their hives. Some lost upwards of 90 percent.[5] The losses occurred quickly, going from healthy to near empty in as little as a week.[6] These mysterious losses were given a name: **Colony Collapse Disorder** (CCD).

Before CCD, beekeepers were accustomed to losing some of their hives every winter, generally considering a loss of around 15 percent acceptable. A parasite called Varroa mite that arrived in the United States from Asia in 1987 had been responsible for many of the hive deaths.[7] Varroa mites transmit various known and identifiable diseases, like acute bee paralysis and deformed-wing virus. CCD, however, elevated the baseline of hive loss beyond what could be linked to Varroa, killing colonies quickly and silently, leaving no evidence behind.

A decade later, the mystery of the collapsing colonies remains unsolved. Losses have continued to be high; in the 2015-2016 season, an estimated 44 percent of U.S. managed honeybee colonies died.[8] One particularly worrying trend is that more hives are collapsing not just in the vulnerable wintertime, when food stocks are low and immunity is weak, but also in the summer, when bees should be at the peak of health. Hives in northwestern Europe also appear to be experiencing widespread CCD. In other parts of the world, hive deaths appear to be more localized.[9]

Many suspects, but no smoking gun

Since the first colonies collapsed mysteriously, many people have questioned if pesticides could be to blame. After all, the goal of many pesticides is to kill insects, and many work indiscriminately, affecting beneficial bees and butterflies along with crop pests. Researchers investigating CCD at Penn State University note that over 1,200 active pesticide ingredients are approved for use in the United States, which show up in differing amounts and at differing toxicities in some 18,000 products. (This compares to England and France, where fewer than 300 and 500 chemicals are registered, respectively.)[10] In testing samples of pollen, honey, and honeycomb, they found that residues of systemic insecticides and fungicides were common, with pollen samples containing an average of 6 different pesticides. One sample contained as many as 39 different pesticides.[11]

Nowadays, pesticides are not just sprayed on field crops and orchards. They are also applied to seeds and even genetically engineered into plants (for example in Bt corn and cotton), making the plants themselves toxic to certain insects. Another form of **genetic modification** makes crops herbicide tolerant (as with most soybeans and canola), allowing for increased spraying of herbicides while sparing the target crop, but potentially killing weeds in fields and nearby areas that would otherwise be important sources of nectar and pollen for pollinators.

Farmer spraying pesticide.

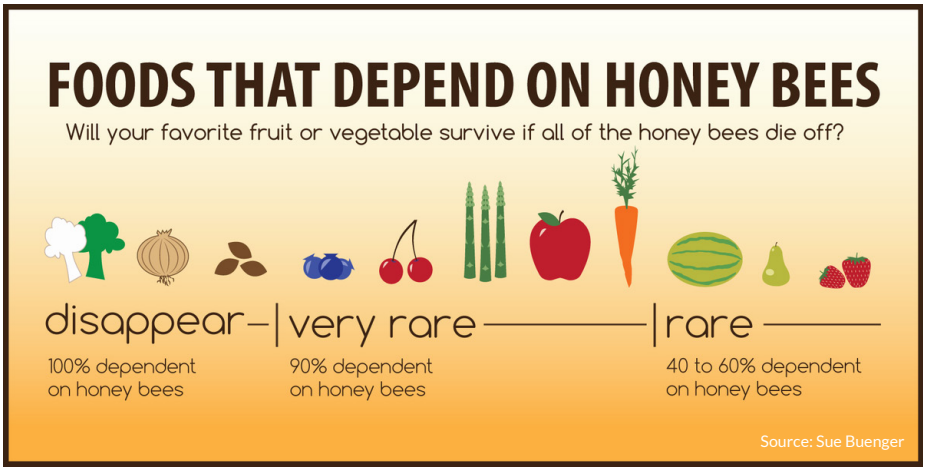
One class of systemic pesticides, called **neonicotinoids**, have been scrutinized for their effects on bees. Approved for use in the United States in the 1990s, neonicotinoids are now used on hundreds of thousands of acres of farmland, as well as on ornamental plants and turf. They show up in many products approved for home and garden use, as well as in plants themselves, persisting in soils for months after application, or in the woody parts of plants for up to six years.[12] Direct contact with these pesticides can be lethal for bees. Exposure at lower levels, for instance in the pollen of wildflowers adjacent to a treated crop, may not kill bees, but it can impair navigation. It also makes bees more susceptible to certain parasites. Because of these concerns, the European Union restricted use of some of these neonicotinoids in 2013.[13] In 2014, a U.S. presidential memorandum on pollinator health required their review.[14]

Overall, scientists suspect that pesticides are among a number of potential culprits that are interacting to the honeybees' detriment. Pests and parasites, diseases, and poor nutrition are all thought to be at play. These factors negatively affect both managed hives and wild pollinators, compounded by increasingly common agricultural practices, such as intensive monoculture farming that covers large expanses without wildflower buffers or corridors.

Global declines

In their first global assessment of the status of pollinators in 2016, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) warned that widespread declines in pollinator populations threaten global food security and nutrition. The group noted that over 40 percent of invertebrate pollinator species, importantly bees and butterflies, are threatened with extinction. For vertebrate pollinators, like bats—which recently in some regions have been suffering from unexplained deaths somewhat analogous to Colony Collapse Disorder—the figure is 16.5 percent.[15]

On top of widespread threats like habitat loss, the report pointed to climate change as a factor behind pollinator losses. Global warming has altered plant and animal ranges and their population sizes. An additional risk of a warming climate is the loss of synchronicity in important life cycle events that are keyed to temperature or day length, for instance, if flowers bloom before insects hatch or vice versa.



The higher atmospheric carbon dioxide levels that are causing climate change may themselves be problematic for pollinators. For example, a study of goldenrod samples collected from 1842 to 2014 found that protein quantities in the pollen fell by about a third over that time, with the most precipitous decline after 1960, when carbon dioxide levels began a faster climb. The author of the study, Lewis Ziska of the U.S. Department of Agriculture likened the reduced-protein pollen of the modern plants to "junk food for bees."[16] As important as bees are to our nutrition, our practices seem to be important to their nutrition.

What can be done?

Governments are beginning to take serious the threat of declining pollinator populations. After all, 91 of the 107 most-consumed crop types depend on animal pollination.[17] Additional research is needed to fully understand the mysteries behind the pollinators' declines, but some options for helping pollinators are clear.

Changing agricultural practices to re-diversify farms and include pollinator corridors that are spared agricultural chemicals should help. Overall, reducing pesticide use and choosing less-toxic pesticides can reduce extra stress on wild and managed pollinators. Studies show that organic farms have more pollinators present.

Off the farm, thinking about landscape diversity can help. Even in cities or suburbia, road median strips and railway right-of-ways can be planted with flowers that are good sources of nectar, and communities can encourage backyard and rooftop gardens and beekeeping. Homeowners and land managers also are advised to avoid indiscriminate use of pesticides, avoiding application during midday, when honeybees are most active. Yet this can also cause problems for bumblebees and other wild pollinators, which are active at different times of day. Better yet, a pesticide-free lawn sprouting some clover reduces the pesticide threat and provides food for insects.

Preventing pollinator loss is important for biodiversity conservation and for food production all around the world. As Achim Steiner, Executive Director of the United National Environment Program explains: "The growing threat to pollinators, which play an important role in food security, provides another compelling example of how connected people are to our environment, and how deeply entwined our fate is with that of the natural world. As we work towards food security, it is important to approach the challenge with a consideration of the environmental impacts that drive the issue. Sustainable development, including improving food security for the world's population, necessitates an approach that embraces the environment."[18] By taking care of bees, butterflies, bats and other pollen-spreaders, we are taking care of ourselves.

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