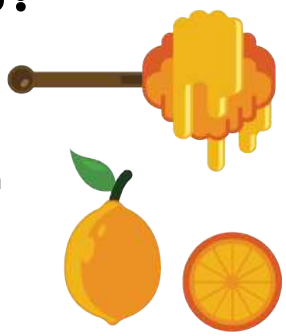
Teacher Key

WHAT'S THE BUZZ WITH THE BEES?



Around 2005, beekeepers began to notice a questionable disturbance among beehives: entire hives were simply vanishing or dying at unprecedented rates in a phenomenon that has come to be called Colony Collapse Disorder (CCD). Though you may not realize it, our agriculture depends on the bees. Bees are pollinators, which means that they help plants make fruit or seeds. If the collapse of beehives continues, our food supply will be seriously jeopardized.

There seem to be many different opinions regarding the culprit behind the disappearance of beehives, from pesticides to pollution, including the electromagnetism produced by the Wi-Fi networks. However, if you ask the experts, they might say that the cause of the demise is *multifactorial*. Where a resilient, healthy pollinator population might be able to resist any one of these factors, if multiple factors affect the beehive, there may be many complications that arise. Some of these factors may include parasites, pathogens, pesticides, and miticides, that weaken bees' nervous systems and immune systems; or loss of habitat due to industrialized agricultural practices and development, which limits bees' resources to nest and forage.

Other factors include beekeepers that feed bees exclusively sugar water, which leads to malnutrition. Lastly, fewer feral (wild) honeybees are found in man-raised beehives, which result in a small sample of bloodlines from commercial queen breeders. All of these factors have narrowed the genetic spectrum for the honeybee population, making it less diverse. Generally speaking, the less genetically diverse a population is, the less fit the population. For example, imagine a population of wild dogs have genes that allow for different levels of acidity of their stomachs; those with more acidic digestive juices may be able to scavenge a wider range of food items. If a catastrophe occurred in which the food chain was compromised, those with stronger stomach acid may have a higher chance of survival. The same logic can be applied to beehives. The more diverse a bee population, the more genetic variation exists, and the chance of survival as a species is higher.

Flowering plants (which include fruit trees, nut trees, etc.) coevolved with bees. Coevolution occurs when two closely associated species have an impact on each other's evolutionary history. In the case of bees and flowering plants, the flowers that smelled the sweetest, or were the brightest colors, or a combination of both, had a higher chance of being pollinated by bees. The increase in flower pollination performed by bees lead to a higher number of that particular species of flowering plants. The term "power in numbers" also applies to ecological populations: the higher the population, the more likely it is to survive. So, it is safe to say that bees helped certain flowering plants survive and multiply, while these flowers also provided nectar for bees to consume for food.

Since bees can positively affect the populations of flowering plants, the more bees there are, the more plants can grow! For example, the state of California has approximately 750,000 acres of almond trees. On average, each acre needs two bee colonies to effectively pollinate the area. Do the math and you will find that the state of California relies on over one million beehives- and that's just for almonds!

Almond blossoms in California.

Since California does not have that many naturally occurring hives, commercial beehives are used. Commercial breeders may rent their beehives to certain states or farms during certain seasons. Though this sounds good in theory, it can be problematic. Most commercial breeders breed the same "family line" over and over, resulting in very low genetic variation in these commercial hives.

Secondly, viruses and infections spread more easily these days thanks to things like commercial airlines (think H1N1 and Ebola)- the same theory applies to bees that are being trucked to places like California from hundreds of miles away- often times they are bringing new pathogens with them.

The decline in bees leads to a decline in crops. Researchers are now considering using populations of feral (wild) bees as a safety net to help save the crops. There are more than four hundred species of feral bees throughout the country. Feral bees are the populations of bees that occur naturally and are not bred in commercial hives. If we can somehow integrate these species with commercial honeybee hives, we may be able to increase the genetic variation, thus making bee populations less susceptible to disease.

However, feral bees are fighting their own battles. Have you seen those old cartoons where a bear searching for honey would find a beehive hanging from a tree branch (or in the tree), buzzing with angry bees that were guarding their home? Once upon a time, many people were able to find these types of hives not too far from their houses. Nowadays, they are a rare find.

In many cases, the demise of feral hives can be blamed by a parasite known as the varroa mite. The varroa mites adhere to honeybees and can transmit viruses that cause deformities in their wings, causing death and destruction. If we can get rid of the varroa mites, then the feral bee population can thrive. And since it's feral bees that are most at risk for the infestation of varroa mites, the demise of the bees is putting more at risk than just *our* food supply. These feral bees are supporting entire ecosystems.

Honeybees infected with varroa mites.

Have you noticed small white clovers or purple violets that show up on the lawn just at the peak of spring? Those attract honeybees. But, most lawns are mowed on a weekly basis, cutting back on a food supply for the honeybee. An interesting, yet unsurprising, study was performed in the city of Springfield, Massachusetts under the guidance of Dr. Susannah Lehrman, who studies urban wildlife. Lehrman encouraged homeowners to mow their lawns on a rotation of 1-3 weeks, and studied the results. Below is a chart containing hypothetical data that a scientist performing a similar experiment might encounter:

Number of weeks between mows	Number of bee species counted in each yard (average)
1	20
2	50
3	42

There is a saying among beekeepers and enthusiasts alike: "Find where the flowers thrive and you will have found the bees." If we can encourage bee colonies to thrive by keeping more bee-friendly plants readily available in our yards and parks, we can increase their numbers, their genetic diversity, and integrate the feral bees to help combat the effects of CCD in commercial hives. These efforts would naturally increase the production of flowering crops such as almonds, apples, oranges, kiwis, strawberries, onions, potatoes, beets, cauliflowers, broccoli, cabbages- to name a few.

1. Why are bees important for agriculture/farming?

Bees are important for agriculture because they help plants make new seeds by pollinating the crops.

2. According to the experts that study bees, what might be causing the decline of commercial beehives?

CCD is an acronym meaning Colony Collapse Disorder. Experts suggest it is multifactorial- meaning multiple things could be causing it, such as pesticides, pathogens, loss of habitat, malnutrition, and less genetic diversity among the hives.

3. Explain why higher genetic diversity in a population may lead to a more successful population:

The more genetically diverse a population is, the more types of genes are present in the population. This allows for a higher chance of survival because the bee population may have a better chance of adapting to new situations that may arise.

4. What is coevolution and how did flowering plants coevolve with bees?

Coevolution is when two closely associated species influence each other's evolutionary history.

5. Why can the use of commercial beehives sometimes be more harmful than beneficial?

Commercial beehives can pose problems because the generally have less genetic diversity, and they can travel long distances and carry pathogens with them that may jeopardize local hives.

6. What is one possible solution to the declining commercial beehives?

One possible solution is introducing feral (wild) hives to the mix, which would expand the genetic diversity of beehives and increase their chances of survival.

7. What has caused the decline of many feral beehives?

Many feral beehives have been affected with varroa mites, which carry viruses that cause deformed wings.

8. What was found from Doctor Lehrman's studies in Springfield MA?

More bee diversity occurred when homeowners mowed their lawn every two weeks, instead of every week or every three weeks.

9. What might be one possible explanation for finding fewer bee species when the lawn was mowed every 3 weeks compared to every 2 weeks?
Answers vary. There's no wrong answer! One suggestion might be more competition among plants or the grass gets too tall for bees to gain access to pollen.

GRAPHING EXERCISE: PERCENTAGE OF HIVE AFFECTED BY CCD 2011–2018

Create a line graph or a bar graph using the chart at right to depict the trends of CCD on a sample of commercial beehives from the year 2011 to 2018.

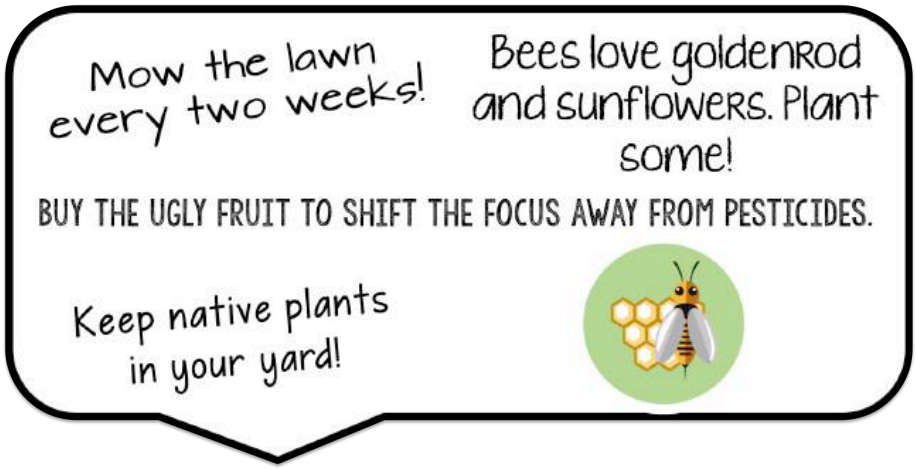
Be sure to label your x-axis and y-axis (reminder: the x-axis should always be the time/year in order to show the numbers over time).

Staple your graph to this packet.

Year	Percentage of beehives lost to CCD
2011	36%
2012	38%
2013	39%
2014	42%
2015	40%
2016	43%
2017	45%
2018	46%

10. Do you see any **trends** in your graph? Explain: The overall trend is a slow increase each year, with the exception of 2015 where it decreased slightly.

11. **Predict** the percentage of bees that may have been affected by CCD for 2019: Typically students will predict that it will rise slightly (or in some instances stay the same).



12. How can **you** help the bees?

Answers vary

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