Slide 1


State of ‘Bee’ing
A Summary of
Honey Bee Health
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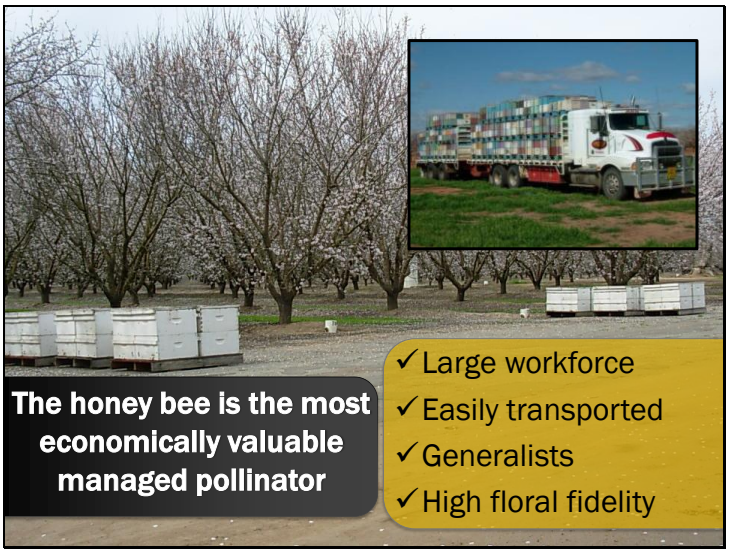
Image: Jim Kalish

Slide 2

The question of “how are the bees doing” is a common one I receive and with few exceptions, it is generally referring to honey bees. However, I think it’s important to start off today by putting honey bees in perspective. First, the diversity of known bee species globally is about 20,000 bees and about 4,000 known bee species in North America. The majority of these bees survive without living in a colony, in fact, over 90% of bee species are solitary. In many ways, honey bees are the exception rather than the rule. But bees are alike in the fact that they feed on pollen for protein so the vast majority of bees tend to be very good pollinators. You will notice that while these bees are different in size and color, their fuzzy bodies are adapted to gather pollen for food. It is the intersection of a unique life history and ability to pollinate that makes honey bees so valuable to humans.

Slide 3



It is in this regard that honey bees stand out above other bees. It's not that other bees aren't incredibly effective pollinators– they are! But for all the bee diversity and their ability as pollinators, we are awfully reliant on this single bee species to pollinate our crops. It is far and away the most economically valuable managed pollinator in monoculture crops in the U.S. Around $650 million dollars were paid to beekeepers for pollination services in 2012. And current estimates indicate that honey bees add ~$15 billion in value (quality and yield) to agricultural crops every year. Additionally, in 2013 U.S. colonies produced ~150 million pounds of honey worth $317 million.

This is due in large part to characteristics that make honey bees more like managed livestock. Their large workforces can be artificially increased through supplemental feedings and colonies are transported on trucks to back-to-back pollination events including almonds, apples, citrus, melons, canola, sunflower, cranberries, and blueberries. Between 90-130 crops benefit from insect pollination (http://www.ers.usda.gov/media/1679173/special-article-september_-pollinator-service-market-4-.pdf).

A honey bee colony has about 50,000-60,000 bees at peak population and 20,000 of these bees may be foraging. That's a lot of bees pollinating in a target crop. Commercial beekeepers keep their bees in standardized equipment making them easy to transport wherever and whenever they are needed. Honey bees are capable of living on a variety of different pollen sources (unlike other bee specialists) and this makes them valuable in a variety of different fruit, nut, and vegetable crops.

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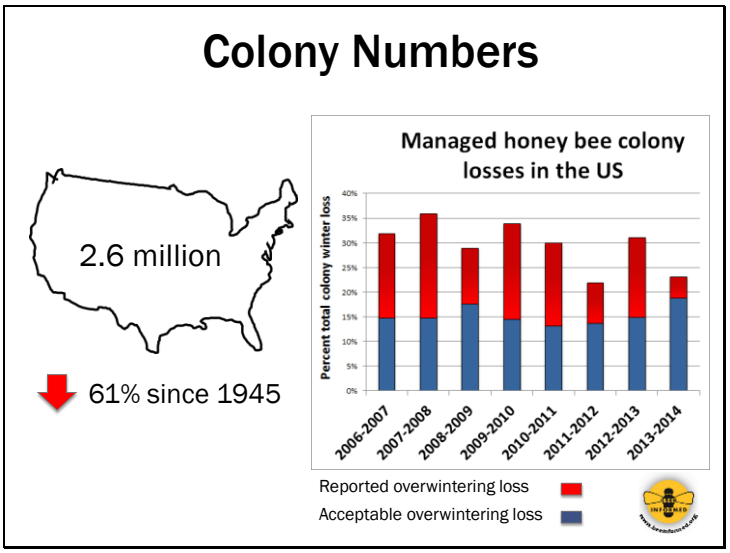

It is important to note that our demand for pollination services is very close to exceeding supply of colonies in the U.S. The U.S. has an estimated 2.6 million colonies in as of 2013 and while this may sound like a lot of bees, the number of colonies has been steadily decreasing by 61% since 1945. Decreasing colony numbers are the results of economic factors (imported honey, price of honey, trade agreements, etc.) as well as declining colony health.

To give you a sense of the health aspect of colonies, this graph illustrates a beekeeper survey taken since 2006 (when heavy colony losses were being seen in the US). The blue bars indicate what beekeepers consider to be sustainable losses for their business and the red bars indicate overwintering colony losses for beekeepers. We wouldn't ask any other agricultural producer to take those kinds of losses and remain in business for very long. This is the situation facing beekeepers today.

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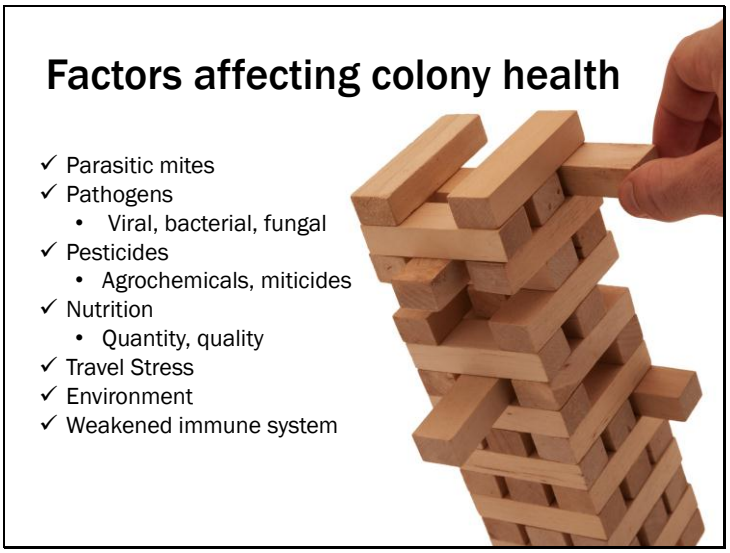

A variety of factors are responsible for the current state of honey bee health.

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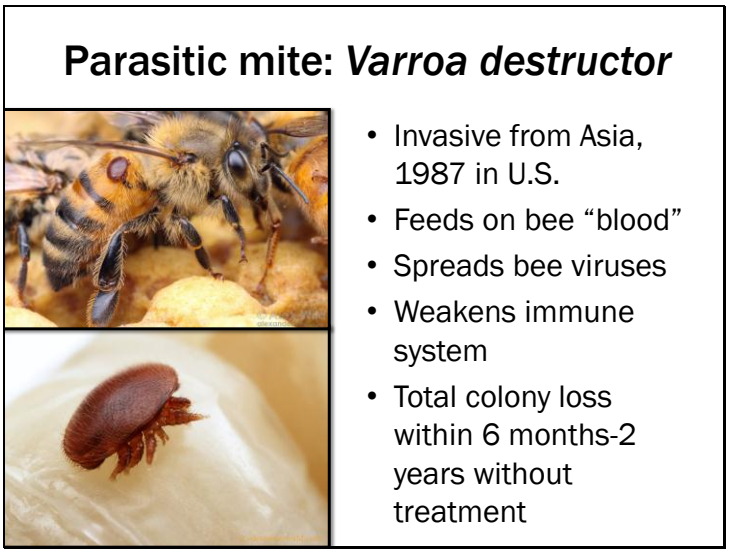
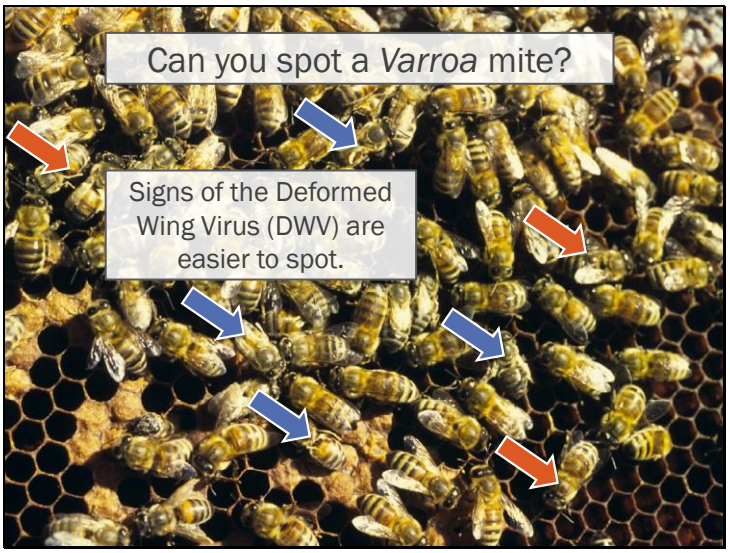


If you were to ask a seasoned beekeeper what the #1 problem facing honey bees is, he/she will probably tell you the varroa mite. It is aptly named Varroa destructor as it is very destructive to US honey bees. It arrived from Asia in 1987 and within a decade had spread across the US. It uses its sharp mouthparts to stab into adult or immature bees and feed on the bee "blood" (also called hemolymph). This type of feeding is capable of spreading a variety of bee viruses not only from individual to individual but from colony to colony. The feeding may also activate and replicate viruses already present in the bee. This destructive combination of parasitic feeding and viruses weakens the bee's immune system and it has been noted that colony loss can occur within 6 months to 2 years after infestation without application of treatment by a beekeeper.

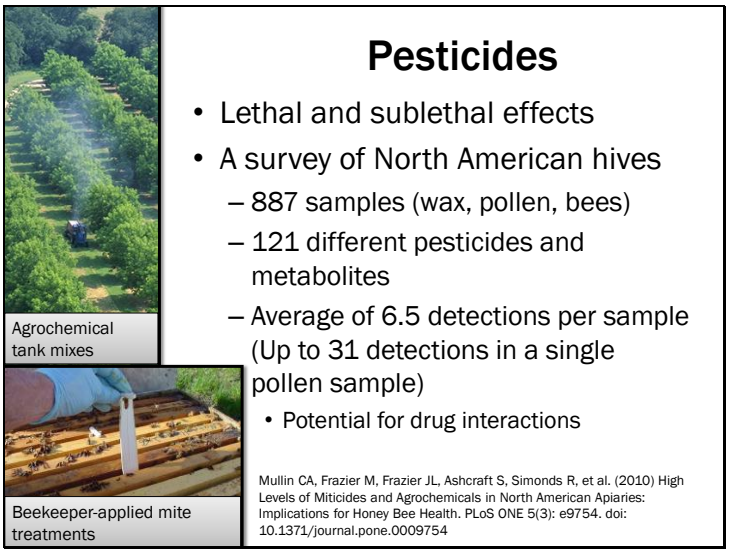
Slide 7



With the destructive capabilities of the mite, it is good to be able to recognize when you have a problem in a colony. Imagine you are a beekeeper. Can you spot a varroa mite? You can see how difficult it would be for beekeepers to visually inspect their colonies for an infestation of varroa mite. The mites can be seen here (orange arrows). So many times, beekeepers who are not sampling their hives for mites may have a problem and not even recognize it.

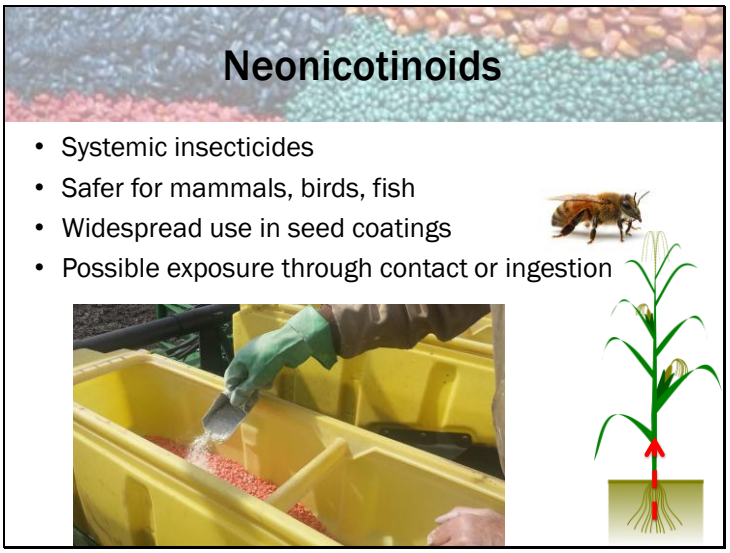
What IS easier to spot is the presence of bees with shriveled, deformed wings (blue arrows). These are bees showing symptoms of a virus spread by the varroa mite called DWV, or Deformed Wing Virus. By the time bees are showing these symptoms, the virus load is quite high and the infestation is severe. At this point it is often too late to treat the colony for mites and save the bees.

Slide 8



Pesticides are another factor impacting honey bee health. While colony deaths from direct pesticide spray is much rarer than it was in the 1960's or 1970's, colony loss from pesticides can happen. A bigger concern currently is the impact of sublethal exposures to a variety of different pesticides (including fungicides and herbicides which can have an additive or synergistic effect on toxicity when used in conjunction with insecticides). To give you a sense of the scope of pesticide exposure in North American colonies, consider a survey that was conducted of pesticide load in wax, pollen, and bee samples. The biggest take-away about this report was that the average number of pesticide and metabolite detections was nearly 7 per sample. This indicates that bees are expected to detoxify more than a single pesticide at once (and this is happening within the hive where bees are most protected from the environment).
Just like humans can have a bad reaction to multiple drug interactions, bees are dealing with the same difficulty. The effects of drug interactions (from multiple exposures) even at sublethal levels may have behavioral or physiological effects that are detrimental to colony health.

Slide 9



I want to discuss neonicotinoids because they have been covered in the media quite extensively as of late. I can point out pros and cons of this class of insecticides. Neonics are a new class of systemic insecticides (meaning they travel through the vascular system of the plant). This allows for a small amount of pesticide to be applied and protect the tissues of the plant decreasing the amount of pesticide being applied to the environment. Also they are less toxic to us and animals such as birds and fish. However, they are highly toxic to bees and other insects (including beneficial insects) and they are found widely in corn and soybean plantings (100% of corn and 50% of soybeans are treated with a neonic seed coating). This means there is possible unintended exposure to bees through direct contact or ingestion.

Contact can occur during seed planting. The seed coating makes the seeds sticky. A lubricant (such as talc or graphite) is added to the planter prior to planting to help the seeds pass through. Some of the insecticide comes off of the seed and is mixed with the lubricant. When the planter is cleaned out (by blowing out the dust), the insecticide can be blown onto nearby blooming plants (such as dandelion or blooming trees). As bees forage for food on these plants, they are exposed to a lethal dose of neonic. This has been documented in Indiana with hives near corn fields with dandelion blooming nearby. Technologies are being developed to improve seed coatings (so they stick better) and lubricants to lessen these impacts.

Also, ingestion is a potential route of exposure. Since neonics are systemic, they may be found at low levels in plant parts such as nectar or pollen. It is unknown if the sublethal exposure from bees gathering corn pollen might have an impact on bee behavior or health.

Slide 10

Honey Bee Nutrition

- Carbohydrates, proteins, lipids, vitamins and minerals
- Influences
  - Amount of progeny produced
  - Longevity and health of adults
  - Tolerance of pathogens, parasites, and pesticides
  - Survival and productivity of a colony
- Necessity of adequate quantity and diversity of pollen sources

Bees need nectar and honey for carbohydrates (sugars) and pollen for protein. Additionally lipids, vitamins and minerals are needed from their food to complete development. This influences many aspects of bee health.
A colony's ability to produce offspring depends on protein availability (in fact if a protein shortage occurs, bees may cannibalize developing bees for protein). Pollen is brought into the hive in pairs of pellets on the bee's legs. Each pair of pollen pellets is made up of ~7.7mg of pollen. A larva needs 42mg to develop properly. An adult nurse bee must consume 60mg to develop secretion glands for feeding brood. This means ~13 foraging trips for pollen are required for every bee that is raised in the colony. And a single plant source is often not enough to provide all the necessary amino acids needed for development.

Bees that are transported from monoculture to monoculture for pollination may not be getting all of the nutrients needed for healthy development (this is like humans eating nothing but chicken nuggets or hamburgers). And with weeds becoming more and more scarce due to herbicide use, natural bee forage is harder to come by. The quantity and diversity of pollen (from plants we consider weeds, but bees consider food) has decreased and without a good pollen supplement (which doesn't exist right now), colonies will struggle to develop robust numbers of bees throughout the season.

State of ‘Bee’ing

A Summary of Honey Bee Health

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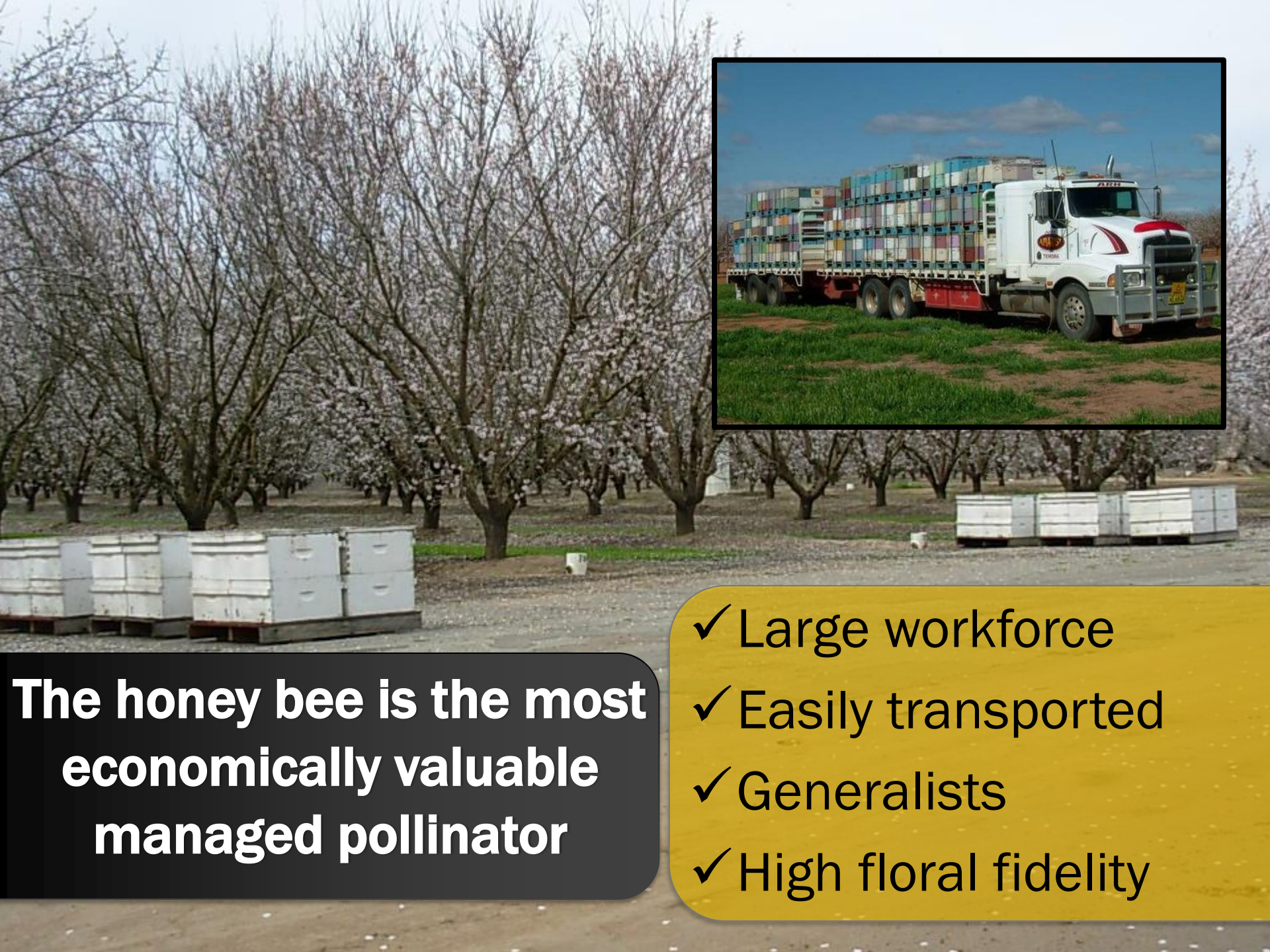
Beyond the honey bee

~20,000 bee species, globally

~4,000 in North America

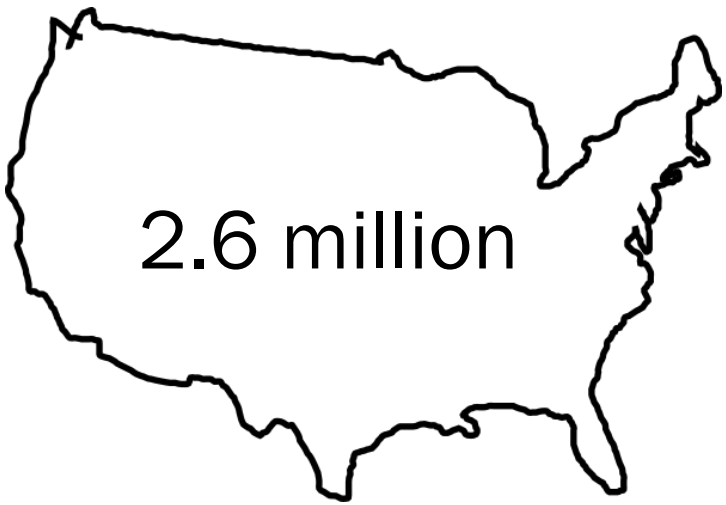
- Over 90% are solitary, living in the ground or in cavities
- Honey bees are the exception, not the rule



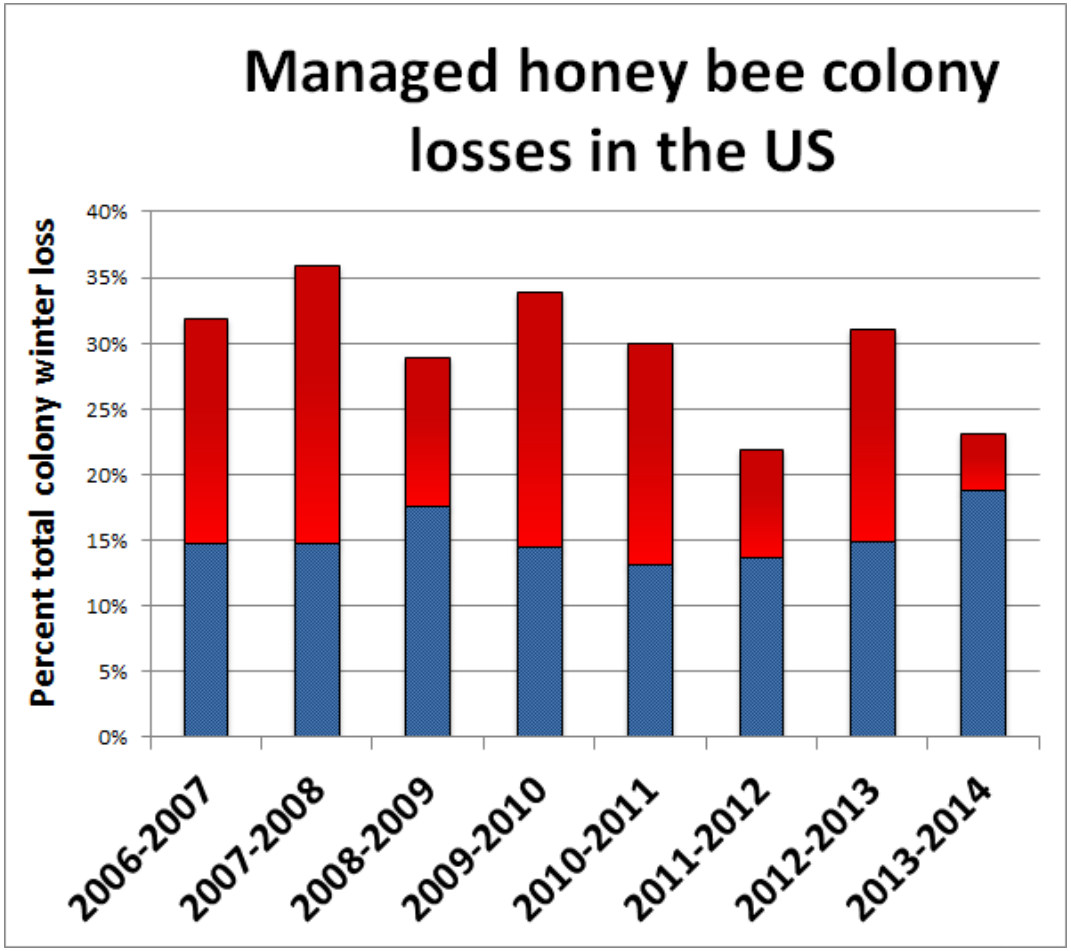
The honey bee is the most economically valuable managed pollinator

- ✓ Large workforce
- ✓ Easily transported
- ✓ Generalists
- ✓ High floral fidelity

Colony Numbers



61% since 1945



Reported overwintering loss

Acceptable overwintering loss

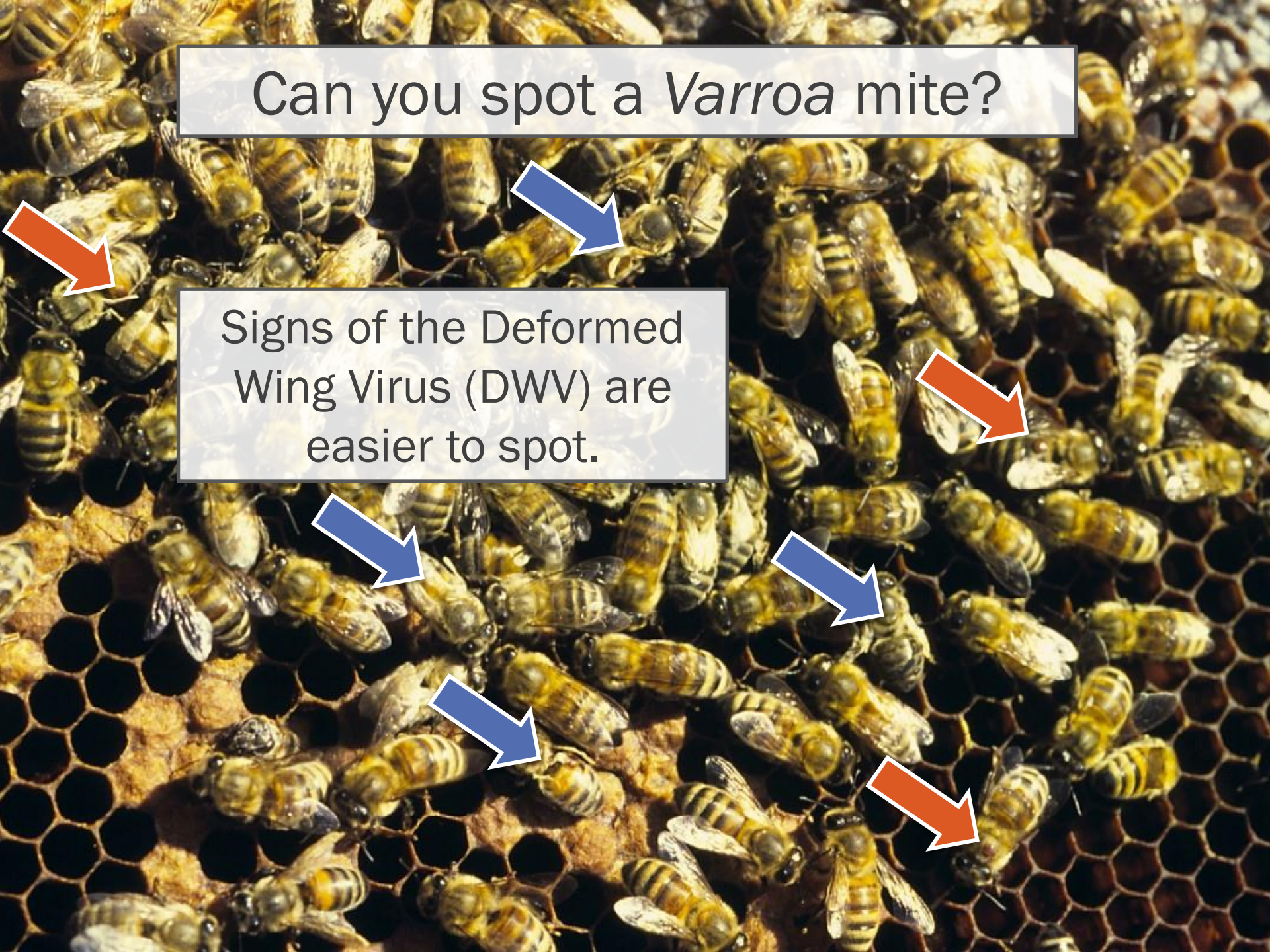
BEE INFORMED
www.beeinformed.org

Factors affecting colony health

- ✓ Parasitic mites
- ✓ Pathogens
  - Viral, bacterial, fungal
- ✓ Pesticides
  - Agrochemicals, miticides
- ✓ Nutrition
  - Quantity, quality
- ✓ Travel Stress
- ✓ Environment
- ✓ Weakened immune system

Parasitic mite: *Varroa destructor*

- Invasive from Asia, 1987 in U.S.
- Feeds on bee “blood”
- Spreads bee viruses
- Weakens immune system
- Total colony loss within 6 months-2 years without treatment


Can you spot a *Varroa* mite?
Signs of the Deformed Wing Virus (DWV) are easier to spot.

Pesticides

Agrochemical tank mixes

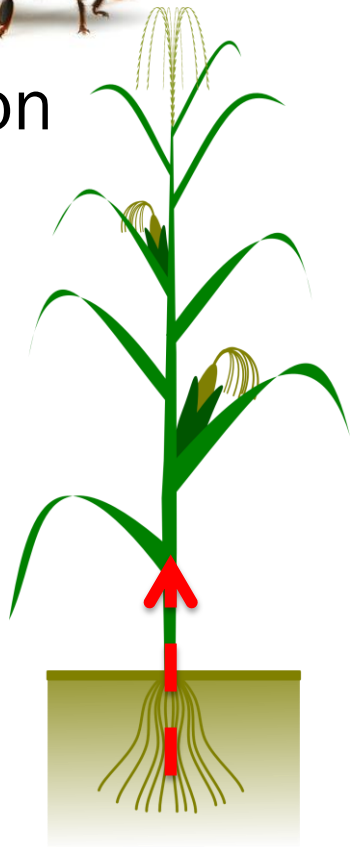
- Lethal and sublethal effects
- A survey of North American hives
  - 887 samples (wax, pollen, bees)
  - 121 different pesticides and metabolites
  - Average of 6.5 detections per sample (Up to 31 detections in a single pollen sample)
    - Potential for drug interactions

Beekeeper-applied mite treatments

Mullin CA, Frazier M, Frazier JL, Ashcraft S, Simonds R, et al. (2010) High Levels of Miticides and Agrochemicals in North American Apiaries: Implications for Honey Bee Health. PLoS ONE 5(3): e9754. doi: 10.1371/journal.pone.0009754

Neonicotinoids

- Systemic insecticides
- Safer for mammals, birds, fish
- Widespread use in seed coatings
- Possible exposure through contact or ingestion



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Want to know more?

Varroa mites	Yves Le Conte, Marion Ellis and Wolfgang Ritter (2010) Varroa mites and honey bee health: can Varroa explain part of the colony losses? Apidologie 41 (3) 353-363 http://www.apidologie.org/articles/apido/pdf/2010/03/m09176.pdf
Nutrition	Robert Brodschneider and Karl Crailsheim (2010) Nutrition and health in honey bees. Apidologie 41(3) 278-294. http://www.apidologie.org/articles/apido/pdf/2010/03/m09120.pdf
Pesticides	Reed M. Johnson, Marion D. Ellis, Christopher A. Mullin and Maryann Frazier (2010) Pesticides and honey bee toxicity – USA. Apidologie 41(3) 312-331. http://www.apidologie.org/articles/apido/pdf/2010/03/m09141.pdf
Fascinating read on the big picture	http://www.psmag.com/nature-and-technology/save-the-honeybee-sterilize-the-earth-pollination-industrial-complex-95566