Jennifer **Berry**

HONEYBEENET

NASA, Honeybeenet and Bee Informed measuring change, saving bees.

The weather in 2012 had a considerable impact on much of the U.S., which seems to be the trend lately. For instance, it was either too wet, too dry, too hot, too cold, (too windy even), and when you mix too hot, dry and windy, disastrous events can occur. For instance, these exact ingredients came together causing massive wildfires across the western states. The Colorado wildfires, specifically the Waldo Canyon fire that threatened Colorado Springs, was the one most folks witnessed. Remember last summer when hundreds of homes burned to the ground and thousands of acres were scorched? Even though wildfires are common in Colorado and the west, this particular fire was the state's costliest because of the number of homes destroyed.

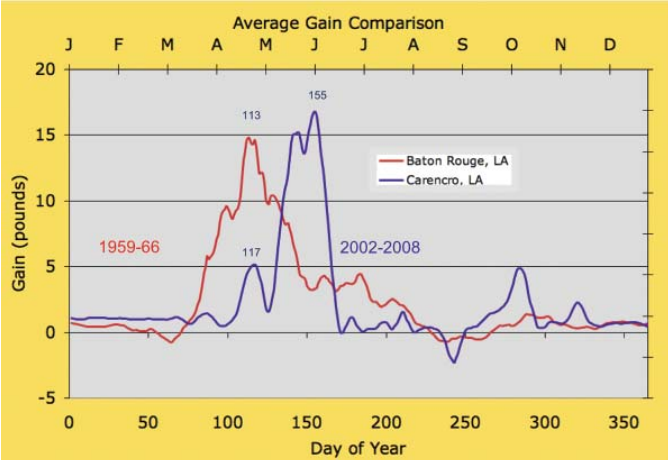
As the western skies glowed red, the Midwest experienced the warmest and driest summer on record (1895-2012). Excessive heat and lack of rain in the Midwest caused extensive crop failures in those areas. Plus, all time record highs were recorded in the southeast. Here in Georgia we experienced a week long stretch of scorching temperatures. One day while in the field working bees, the mercury rose to 112°. The bees, along with ourselves, were miserable, but as long as there was access to water, we survived.

When it came to the "too wet category" let's turn our attention to Florida. Prior to Memorial Day, 2012, about 84% of the state of Florida was in a moderate to extreme drought. Just a month later, the "Sunshine State" was rain soaked with some areas receiving up to 28 inches of rain in a couple days. It only took two tropical storms, Beryl and Debby, to eliminate the rain-starved area. But, with all that instant rain, streets, homes and businesses were flooded. So, how is all this crazy weather affecting our bees? Well, there are scientists trying to figure that out right now.

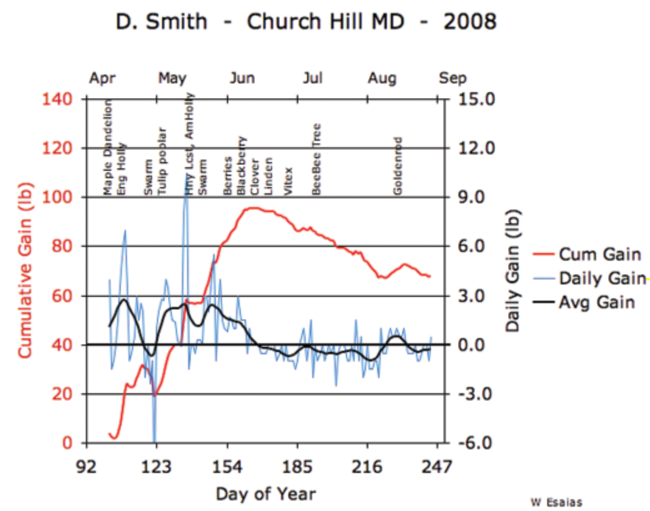
Back in 2009, I wrote an article about Dr. Wayne Esaias and his scale hive project. I felt his project was worth exploring and believe so even more today. At that time, Dr. Esaias was employed at NASA as a biological oceanographer at the Goddard Space Flight Center in Maryland. His earlier work examined the abundance and occurrence of phytoplankton in the oceans and how this related to climatic systems. But all of that was about to change. In 1992, Dr. Esaias became a beekeeper when his son's Boy Scout leader had to find a new home for several hives. Life with the bees was easy at first. Then numerous swarms weakened the colonies, which eventually perished. Blaming himself for being a bad beekeeper, Dr. Esaias couldn't get a handle on what he was doing wrong. Had he not read every book he could get his hands on about bees and beekeeping? Hence, he began to apply his scientific reasoning to come up with possible causes. That particular season in Maryland had been much warmer and wetter than normal-typical of an El Nino year (unusually warm ocean temperatures in the Equatorial Pacific). Were the bees simply reacting to the unusual climatic changes? Warm, wet spring seasons (precursors to earlier nectar flows) can trigger colonies to swarm sooner and more often.

Then, an idea came to him. Could honey bees be utilized as climate-impact data collectors? Bees are already excellent environmental samplers; they're already doing the work for us. So, one just needs to tap in on this tremendous resource. But how??? Then, it dawned on him: **SCALE HIVES**! By weighing colonies each day (positioned continuously on industrial scales) scale hive data, over time, can illustrate the relative abundance, timing and duration of seasonal nectar flows. But, one might ask, how does this tie into climate change? Dr. Esaias made the transition from sea to land in order to investigate the very possibility of a correlation between nectar flows and climate change. Funded by a grant from NASA, he has been trying to put these pieces together through his current work as an adjunct professor at the University of Maryland in the Entomology department. He has been coordinating with Dennis vanEngelsdorp, who is in charge

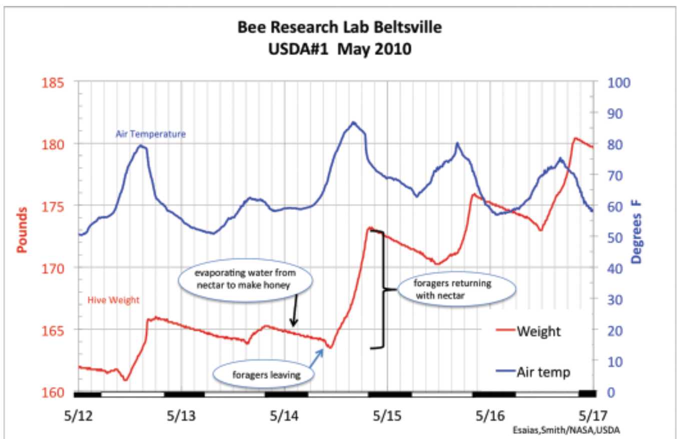
C. Vorisek uses a fairly new manual platform scale. Manual scales, some dating to the early 1900s, are the major type used by volunteers. (C. Vorisek photo on Honeybeenet)



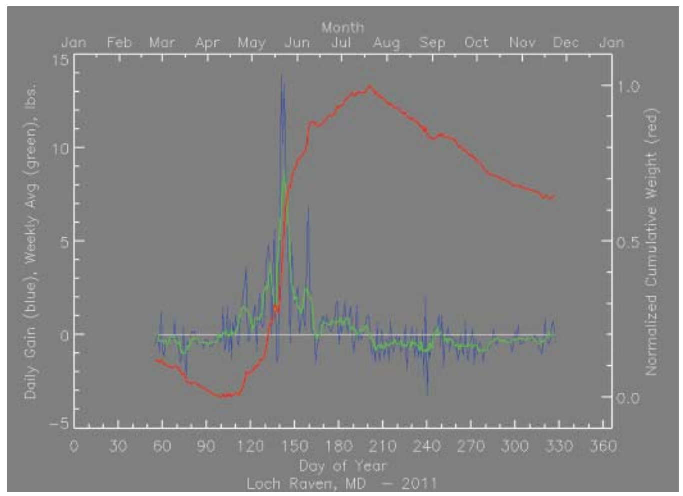
Data taken by E. Oertel in 1950s in Baton Rouge and by C. Harper in the 2005 era show a major difference in nectar flow, most likely due to the invasion of Chinese Tallow during the intervening 50 years. it would be interesting to have modern data from Baton Rouge for a comparison.



Plot of data provided by D. smith in Church Hill, MD gives blooming information for some sources to accompany his manual scale observations.



Electronic scales recording data every 10 minutes at the Bee Research Lab in Beltsville, MD reveal changes in colony behavior and nectar collected on sunny (higher temperatures) and overcast (lower temperature) days. Other interesting examples compiled by Paul Vonk can be found at ***hivetool.org*** *under Hive Management.*



Sample plot provided on Honeybeenet site for Loch Raven, MD, shows the Daily Gain in pounds/day on the left axis and green line, the weekly averaged Daily Gain (black line), and the relative increase during the active season (red line). The total gain was 149 lbs, not counting Spring and Fall syrup, supers added, and honey harvest. This overall shape is typical of Eastern tree dominated nectar seasons. Plots and digital data are available for all sites and years. The peak date has advanced by roughly a month since 1970 in central Maryland.

of the Bee Informed Project (http://beeinformed.org/).

NASA, the National Aeronautics and Space Administration, is a US agency that's responsible for the nation's space program, aeronautics and aerospace research, including earth remote sensing. These are pretty broad topics, but one of NASA's objectives is to understand how climate change impacts the earth. The physical climate, such as temperature and rainfall, is simply measured over time. So far, data shows that significant change has been occurring. How do these physical changes impact the earth or more specifically earth's ecosystems? Further, how do these changes affect plant and pollinator interactions? And finally, how does this affect humans on the planet?

As a former NASA employee, Dr. Esaias had wonderful resources available to him. Because his question is sought to unravel something so complex, he felt that large-scale satellite data would be needed to help. There are just too many plants, too many pollinators, too many different ecosystems all interacting and not enough hours available in someone's lifetime to explore each one.

So how is all this data collected, correlated, analyzed and then understood? Let's start by looking to the skies. Sensors, such as MODIS (Moderate Resolution Imaging Spectroradiometer) located on NASA's Aqua and Terra satellites, are continually snapping detailed images of the planet. Along with these there's NPOESS Preparatory Project (NPP), NASA's newest polar-orbiting environmental satellite. Because of the orbits of these satellites, within days (some areas may be under cloud cover) an entire image of the earth is available. Overtime these recorded images show the earth "greening up" (when the earth wakes up from its long winter slumber and vegetation begins to sprout new leaves) and then "browning down" (when vegetation looses its leaves). Terrestrial scientists have discovered that spring green-up was arriving earlier on average, due to warmer winters. Dr. Esaias takes these space satellite images of the earth's greening and compares them with the nectar flow data collected from the scale hives. They corresponded nearly perfectly. But recently something unusual was detected; it seems the Northern US is "greening up" a half a day earlier each year, and the dates of the nectar flows in the north east US are staying right in sync. "In total, since the 1970s, it has moved forward by about one month in Maryland" says Esaias.

At this point, Honeybeenet has 147 data collection sites, scattered across 34 states, including DC and 2 provinces and over 400 individual annual records. The south, however, is especially void of these experimental sites. Unable to be at all 147 sites each day, Dr. Esaias and Honeybeenet depends on a network of citizen-scientist-beekeepers across the country, who volunteer their time to collect hive weights. The data is sent to Dr Esaias via email and winds up on a web site set up specifically for this project: HoneyBeeNet (*honeybeenet.gsfc.nasa.gov*). As the data flows in, scientists are able to better understand how climate is affecting the dynamics of incoming nectars. So how does this information help me, the beekeeper?

By placing colonies on a scale and weighing them each day, data records the ebbs and flows of the season. A rapid increase in hive weight indicates nectar intake, a steady decrease in weight indicates a nectar dearth since a colony loses weight as food stores are being depleted. So far the most weight Dr. Esaias has seen a colony gain in one day is 25 pounds. As a colony gains weight brood is being reared, comb drawn out, and honey stored. But something else may be happening as well. Colonies may be preparing to swarm. If all of a sudden a colony looses 3-8lbs in a day something has obviously happened: a swarm perhaps? Many beekeepers aren't aware that their colony has swarmed, but with this sort of data it would help reduce the amount of time the colony is queenless which would be a great help in hive management.

Such data could also help us forecast when or if Africanized honey bees (AHBs) will be encroaching upon an area. At this point, theoretical models, which are too unstable and unpredictable, project AHBs advancing all the way to Canada. But based on climate and vegetation patterns are these northern areas suitable for AHBs? There are two factors largely responsible for keeping AHBs contained to the western part of the US and Florida: temperature and food availability. For instance, when AHBs crossed the border into Texas they headed north then tracked west, barely making it in to the state of Louisiana. The most likely reason: no fall nectar flow. From east Texas to Georgia plants and nectar flows are dramatically different. However, Florida and Arizona both have fall nectar flows, which resemble nectar flows in Africa. Scale hive data in those regions may be able to determine if AHBs can survive.

This data will also be beneficial to commercial beekeepers. A certain percentage of commercial beekeepers move colonies to follow nectar flows. They may be moving south for the winter to take advantage of early blooming crops or north to the Dakotas for clover. With climate change comes a whole host of issues, which impacts blooming dates, which in turn affects nectar flows. They may come earlier or later. They may be more or less productive. With this information at hand, areas predicted to be less productive could be avoided while more productive areas can be accessed. It could also help beekeepers know when they should be feeding to avert colony starvation. Overtime such data would provide a more reliable idea of when to expect a nectar flow in a given area. It could help us predict good years, or bad years and on a larger scale, agriculturally speaking, it could predict possible times of crop failure leading to famines.

Example of an electronic scale in use. This scale at Loch Raven, MD has withstood three Winters and three hurricanes. Data must be retrieved manually every three to six months.

Yet the question most beekeepers ask; wouldn't it be beneficial for the bees if winters were warmer and nectar flows earlier? Perhaps, but lets explore the downside to this. If plants are blooming earlier each year, will the pollinators be able to keep up with this forward motion or will they fall out of sync with the plants? Overtime pollinators and plants have become in sync with one another since they both rely on the other for survival. Most plants need pollination in order to produce seeds and they accomplish this by luring the pollinator in with nectar. Both benefit and both survive. But, if plants bloom too early when the pollinators aren't there, the plants loose the benefit of pollination and when the pollinators finally do arrive the flowers are no longer in bloom and they get less nectar and pollen. Hence, system failure.

Other issues that we've observed here at the horticulture farm are required chilling hours and late frosts killing early blooming fruit trees. Particular plants, especially fruit bearing trees, need a certain amount of hours of cold in order to bloom or properly bloom; without which, they exhibit a loss of yield. Also, fruit trees fooled into early blooms by warm Winters and/or early Springs are often caught off guard by late frosts; again, the results are significant crop losses.

As climate changes, how are our bees/pollinators coping with these phenomena? Scale hive data is focusing in on this pollinator/plant interaction, which to a degree has never been explored before. By having this data it gives us a picture so that we may be better prepared in the future. Climate prediction models know very little about blooming dates and how they relate to nectar yields as a function of climate. As climate change continues ranges will shift. First the most obvious is when the nectar flow begins and ends. With this information scientists can extrapolate when the nectar flows are occurring across the nation in accordance with the wall to wall ubiquitous coverage of satellite imagery. Secondly, as the climate shifts, the plants and trees present in an area may find themselves in poor conditions in the southern portion of their range, and may not produce as much nectar. The same species growing in the northern extents may become much more productive. This may be a reason why tulip poplar honey, once the mainstay of many Mid-Atlantic beekeepers, has now become relatively rare compared to black locust. Scale hives may be able to give us a piece of the puzzle into what is going on.

How do I become a volunteer?

First you go to the HoneyBeeNet web site and download the "How To Do It Protocol" under the Site Data. Then you will answer a short questionnaire and put in your GPS coordinates and email that back. Citizen-scientist-beekeepers will need to purchase an industrial-sized scale on which to keep a strong healthy colony, and weigh their colony each day. Data is then entered on data forms and sent directly to Dr. Esaias through the HoneyBeeNet site. The best possible scenario is if the colony could be weighed each and every day. But we all have lives and sometimes are not around to take such measurements, and some gaps are OK. Since these scales cost around $400 new (used from $25 up at farm auctions), I think it would be an appropriate use of local or state beekeeper's association funds. If a local/state club set up a scale hive the members could rotate responsibilities weighing the colony so no one person is carrying the entire burden. Beekeeping clubs would greatly benefit by having the local nectar flow data, so it may be something that should be encouraged throughout the region. Several regional networks have even developed in Europe.

Electronic scales for use as hive scales are now coming on the market. They tend to be much more expensive but may make a big difference. They have the advantage of recording and storing the weight daily, hourly and even every 10 minutes. Some send the data thru the internet, or directly to a home computer. Some examples can be seen at http:/*hivesensors.com*, http:/*hivetool.org*, Swienty.com and at some of the sites pictured on the HoneyBeeNet site. Beekeepers with good computer and electronic skills can put together their own data collection systems, as Paul Volk and colleagues have done with the Rabun Gap Nagoochee School and other sites in north Georgia and North Carolina. The NASA crew is also working with BIP (Bee Informed Project) and other groups to transition the Honeybeenet activity to a more permanent home in the bee research community.

With milder Winters, the eastern U.S. is experiencing earlier spring nectar flows and longer summer dearths. However, yields from the spring nectar flow are not greater (since no increase in bee forage) and are often less (colonies are not yet at maximum strength). And, the fall nectar flows are now unreliable and weak. This is a problem. Since bees use much more energy (honey) when the weather is warm, the honey they make during the spring nectar flow has to last them up to two months longer now than it did back in 1970s. Colonies often run out in late August-September, just when they are trying to make lots of winter bees, and this can lead to increased winter losses if beekeepers are not paying attention. In the Mid Atlantic and the southern states, beekeepers are now told to start feeding syrup in August. Other regions, like the Mid West, can have very different nectar flow seasons and the bees may respond to climate change differently than what's been experienced in the east. That is why more scale hive sites are needed in order to establish the relationship between nectar flow timing and intensity, with satellite vegetation and climate images. Since honey bees are managed pollinators, we can adjust our management techniques in response to these slow changes if they can be identified. Another goal of this project is to come up with a map of the northern US with nectar flow dates and variability. Right now the resolution of this information is very course but as more data is collected and analyzed the clearer the picture will become.

If you can contribute past scale hive records, from any year, for North America, please contact Dr. Esaias and make arrangements to get the information to him. It would be a shame to have that data lost forever. BC

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