

Using Hive Temperature Sensors

Who am I and how did I get here? My name is Cary Orange and I am finishing up my second year of beekeeping as a hobbyist. The following is a brief summary of my introduction to inexpensive temperature sensor monitoring, smartphone wireless technology, the internet and the integration of all three in bee hive management. I am pleased to provide a glimpse into the last twelve months of monitoring the inside temperature of one of the bee hives in my yard and how I was able to use the data to make decisions.

Why did I want more than just to wonder what's going on inside the hive? In my first year, like many other new beekeepers, I was faced with the anxiety of winter preparation of my hives with the hope that they would survive the winter. Being the overly anxious sort, I followed all of my training and instructions to prep the hives as much as possible and close them up for the last time without really knowing what was going to transpire on the inside for several months of winter weather. It reminds me that I am merely a helper in providing a protected, dry and resource-stocked hive domicile as the bee colonies are already keenly aware of all they need to do to cluster and survive through the winter. Still though, it is nice to get a visual of what's going on inside, if not with the naked eye, then at least with some inexpensive sensor monitoring technology.

How did I get started using sensor technology? Fortunately for me, before the winter prep last year, a friend in a local bee club mentioned how she used sensors to collect temperature and weight data from her hives and invited me to be included in a group order for sensor equipment that her bee club was placing. The group order for a large volume of equipment purchased at a reduced cost is the incentive that interested me in acquiring a few sensors. As a software developer myself, I've always been interested in small electronic devices that capture data for analysis so when the sensors arrived (batteries included), I immediately installed them in each of my four hives all powered up, activated and ready to go. The installation of the sensors was quite easy and I performed it as one of the very last steps while preparing my hives for winter.

What type of battery does the temperature sensor use? Each temperature sensor is powered by a small 3-volt CR2032 coin battery which has a life of at least twelve months before needing replacement. These types of batteries are available at most retail stores on the aisle where other watch batteries are sold. A small button when pressed (and held) for at least five seconds activates the sensor. A small LED light will blink for about a minute as an indication that the device has been activated. Once activated, the sensor measures the temperature on a periodic interval and stores data in its memory. There is ample memory to store thousands of temperature readings. Each sensor has a unique identifier using a series of three two-digit hexadecimal codes separated by colons (e.g., 47:03:FC).

How is the temperature data retrieved from the sensor? There is an app for that! The manufacturer provides a free smartphone application which is available via the Play Store for Android and the App Store for iPhone. Bluetooth must be activated on the smartphone in order for the smartphone application to communicate with the temperature sensors. I have found that

by standing within 30 feet of the hives the Bluetooth communication successfully transfers the data to my account.

Did I need to register my sensors before I could start retrieving the data? Yes! Before I could use the smartphone application to retrieve data, I needed to do a one-time setup for a free subscription at the manufacturer's hosted website. This accomplishes two important steps. First of all, the free subscription allowed me to create a virtual apiary with a nickname for each hive and associate each hive with one or sensor devices. I associated one sensor with each hive regardless of the number of hive bodies in the brood chamber. Secondly, the free subscription keeps a history of all the collected data so that it can be explored from a computer without the need of the smartphone application. I can go to the website anytime to review and share the captured data..

Do I need to pay for a monthly service? No. Although there are premium services available for a monthly subscription cost; I have found that the free subscription is more than adequate to view and chart the sensor data for my small number of hives. I have four hives in my yard using this technology.

Can I monitor the temperature for hives located out in a distant bee yard? Yes. It requires more equipment and a cellular subscription to do so. I'm not ready to do this yet so I'm only using the basic temperature sensor for the hives in my yard. Maybe I'll extend this to my hives out in the country at some point in the future.

Okay, I've set up my subscription and registered my devices, now what? Once registered, I can stand near the hives with my phone and the smartphone application will detect the active sensors and each sensor can be configured with a nickname and associated with a hive body (upper or lower brood chamber) for later reference.

What am I looking for in the day-to-day data capture? In the winter months I am interested in seeing the delta between the inside temperature of the hive (above the brood cluster) and the ambient temperature outside of the hive. Figure 1 below shows a graph of a three day period for the Avocet hive in late November with the temperature scale on the left in degrees F. Note how closely the temperatures trend the delta almost constant where the solid line is the temperature inside the hive and the dashed line is the ambient temperature outside. This indicates that the cluster is strong and maintaining a core temperature for survival despite the much colder temperature outside.

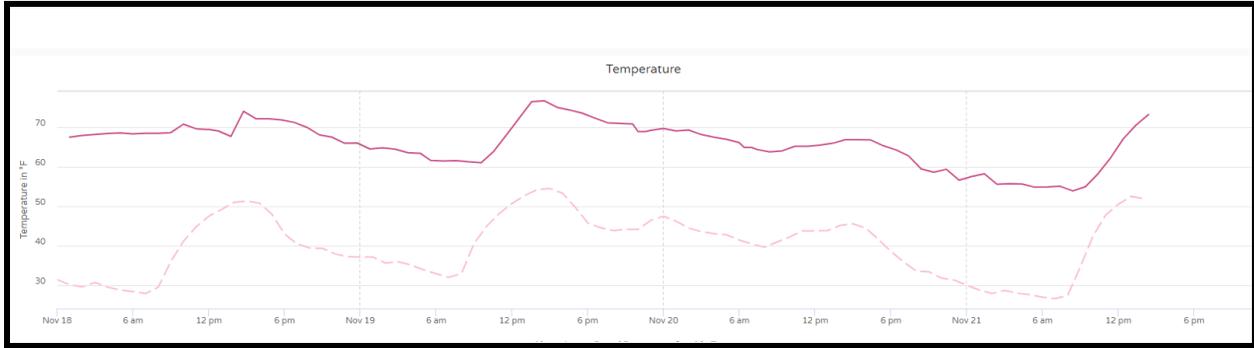


Figure 1

How do I use the data in the brood development seasons? During rapid increase in brood development which occurs in late winter I will look for a change in the pattern of the reported temperature inside the hive. Figure 2 below shows a graph of the hive temperature for the last twelve months on one of my hives. This temperature sensor device is for the Avocet hive and the green line graphs the temperature reading from the captured sensor data with the temperature scale in degrees F on the left.

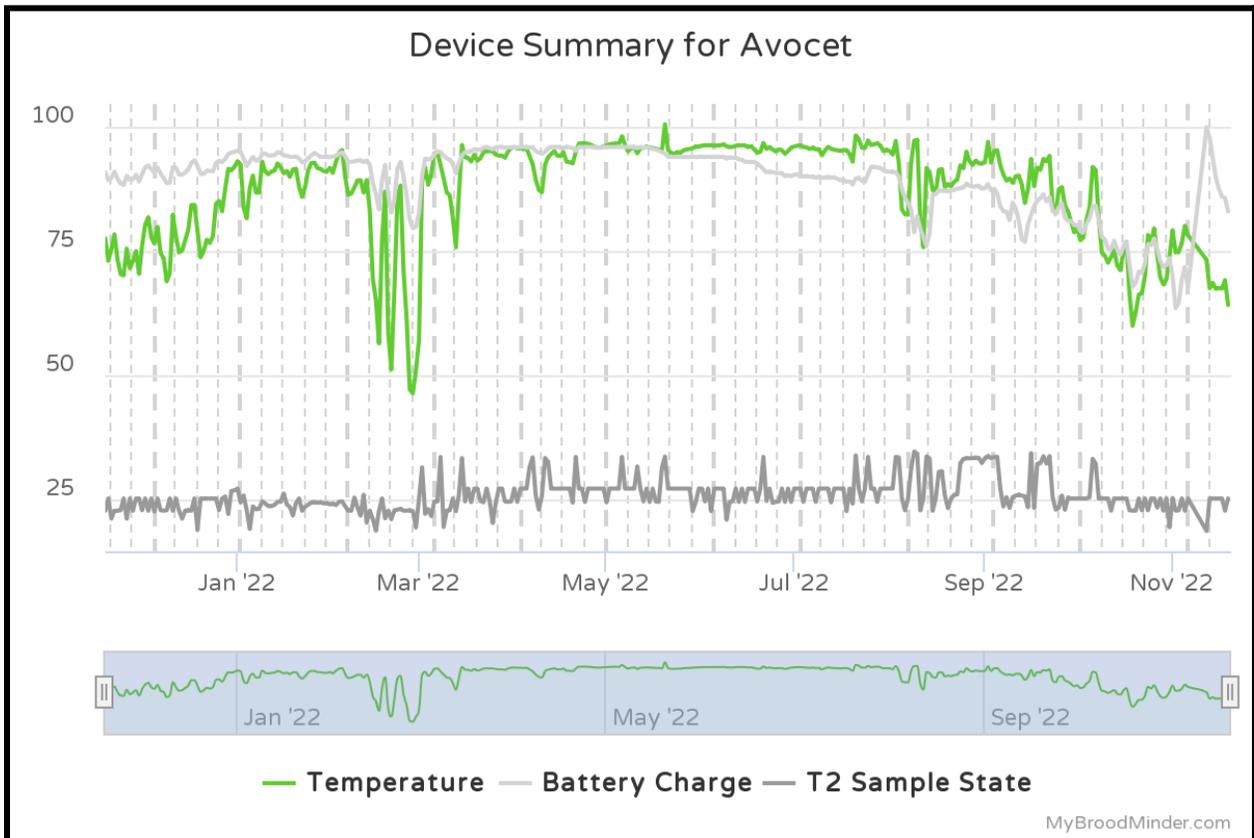


Figure 2

The graph in Figure 2 shows something interesting in Late February/Early March. This hive consists of two deep hive bodies and the temperature sensor is located *between* the two hive

bodies (directly over the middle frames in the lower hive body). In the early winter, the colony was clustered together in the lower hive body. As expected in the late December/early January time frame, the fairly steady temperature increase indicates that brood development is taking place at an accelerated pace within the colony. The sudden drastic changes in temperature indicates that the colony had moved up in the hive to the upper hive body to access food resources and thus the sensor recorded the ambient temperature similar to the temperature outside of the hive. A hive inspection confirmed this finding of the observed data. Had I installed an additional sensor above the upper hive body, then a more accurate reading of this hive could have been determined without the need to open the hive.

Also from the graph in Figure 2, another interesting event occurred in early August. Note change sudden drastic changes in temperature where the inside temperature is the same as the outside temperature. Upon hive inspection I found that the bee colony had absconded. The inspection revealed significant small hive beetle damage in frames in the upper hive body resulting in a situation where the colony decided it was too much to overcome and left to find a new home. I learned a lesson here. Had I examined the data more closely day by day, I might have been able to intervene sooner and move the colony to a safer place in another hive without the small hive beetle damage.

NOTE: The screenshots in Figure 1 and Figure 2 above are copied from my sensor data content housed at the "<https://mybroodminder.com/app/resources>" cloud storage web site.

What's next? At some point in the near future, I want to purchase weight sensors and add them to my hive stands so that I can monitor swarm activity and honey production.

Where did I get my sensor equipment, the smartphone application and any other useful information? The sensor equipment part that I purchased is the **BroodMinder-T2SM** (model 47). For more information on this product and a catalog of additional sensors and equipment, see the manufacturer's website at <https://broodminder.com/>. The smartphone application I use is called the **Broodminder Bees** app for Android (version 2.10), last updated on October 12, 2022. There also is a version available for the iPhone although I have not used it. The website <https://mybroodminder.com> provides resources that include helpful video and written user guides, supporting documentation to install, configure and use the sensors as well as helpful tips to use the smartphone application and their cloud storage website.