

Moisture Study Report

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Table of Contents

[Study Description & Overview](#)

[Humidity & Airflow in Winterized Hives](#)

[Study Highlights](#)

[Next Steps](#)

[Detailed Study Data](#)

2020-21 Winter Moisture Study

Reported Cause	2016	2017	2018	2019
#1	Varroa	Varroa	Varroa	Varroa
#2	Don't Know	Don't Know	Starvation	Weak colony
#3	Starvation	Starvation	Moisture	Cold Temps
#4	Other	Moisture	Don't Know	Queen Issues
#5	Weak colony	Cold Temps	Cold Temps	Moisture

3 different data recording vendors:

- Acurite
- Broodminder
- Wifi-Scale

- **Goal:** Using data from hive monitoring systems understand the effects of moisture on overwintering hives and how our winterizing methods might be improved.
 - No one moisture system is right or wrong but it must be in the correct combination to solve our winter moisture issues
- **17 Hives enrolled in study** (Merrimack County, Belknap County, Rockingham County , Strafford County & North Attleboro, MA)
 - 14 hives survived – none of the deadouts showed signs of moisture
- **Live Stream data & Mid-study report available at:**
 - <https://www.nh-honeybee-health.com/2020-moisture-study>
- Excellent resources about wintering bees:
 - <https://www.beezslc.com/single-post/the-problem-to-the-solution-of-winter-moisture>
 - <http://scientificbeekeeping.com/understanding-colony-buildup-and-decline-part-13a/>
 - <http://scientificbeekeeping.com/understanding-colony-buildup-and-decline-part-13b/>
 - <https://www.youtube.com/watch?v=KKCiIStfD7c>
 - William Hesbach speaking at Middlesex County beekeepers meeting

What We Learned

Temp & Humidity Probes:

- Can help indicate that the bees are eating through food, dwindling, have excess moisture, having a hard time keeping the hive at a constant temp, etc.
- However, figuring out what the sensors are telling you can be difficult because so many factors affect the readings, like cluster size, where it is located, outside temps, etc.

Humidity doesn't always indicate excess moisture, but sometimes it does

Venting doesn't always do what we expect.

- Moisture seems to take the path of least resistance which may not be out the air vent.

More airflow isn't always better.

Black hive wraps will increase the inside temperature of a hive if it is sunny.

Stronger colony does a better job of regulating temperature within the cluster.

What we still have questions about

If moisture goes out the vents, will it go between the woodenware and the wrap – if so, is this a problem?

Bees generate CO₂ when consuming stores & keeping the cluster warm, what is the effect (if any) of all the CO₂ in the hive?

Can we estimate colony strength by looking at sudden drop in outdoor temperature vs the drop in hive internal temperature?

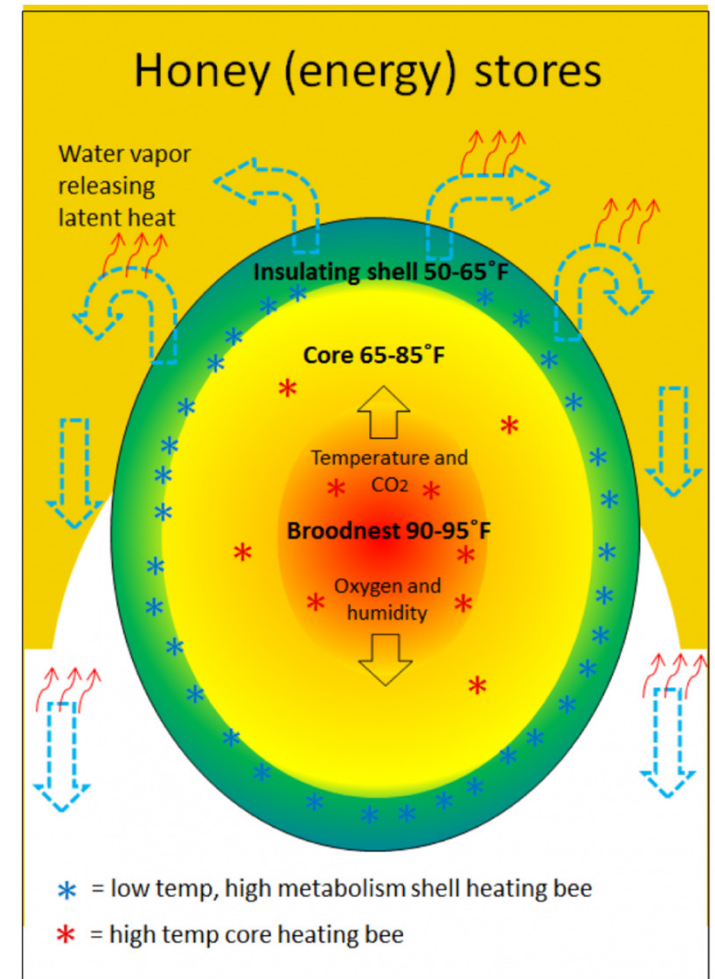
We see cases where the Relative Humidity doesn't change when the temperature does.. Indicating the humidity ratio should change, but doesn't. So the question is why doesn't it change?

- Could the bees be using the moisture (reconstitute crystalized honey?)
- Could they be evaporating moisture by fanning like they do to dry out honey?
- Bees use moisture when consuming honey & sugar. Could they be using it in other ways? The products of metabolizing honey is moisture and carbon dioxide.

Humidity & Airflow in Winterized Hives

Honeybee Challenges in Cold Climates

- A bee goes into a “**chill coma**” **below ~43F** and cannot move their flight muscles.
 - They **die within ~48 hours** if they do not warm back up to at least 50F.
- Bees cluster together in order to survive cold weather and avoid lengthy chill coma.
 - The cluster is in layers – outer layer (aka the mantle) being the coldest, core being the warmer.
 - Bees use their flight muscles to keep the outer layer above 45-50F. The core temperature depends on whether they are raising brood.
 - Oxidative stress from heating the colony may shorten a bee's lifespan.
- As warm air escapes the cluster and moves to cooler spots in the hive, it will condense to water droplets when it hits an areas with temperatures below the dew point temperature.
 - When water condenses, it gives off a small amount of heat.
- **Our Goal of winterizing hive:**
 - make it a little easier for bees to maintain their cluster temperature
 - ensure the moisture generated by the bees doesn't adversely affect the colony



Source: Randy Oliver

<http://scientificbeekeeping.com/understanding-colony-buildup-and-decline-part-13a/>

Some Fundamentals

Relative Humidity is the ratio of the amount of water vapor in the air to the max amount of water vapor at saturation.



50% relative humidity indicates that the air is currently at 50% of the maximum moisture capacity

Warm air holds more moisture than cold air.



Assuming the amount of moisture doesn't change, if the temp increase the relative humidity decreases

Dew point is the temperature at which water in the air begins to condense.



If warm air cools down to the dew point temperature, water starts being released

Example: Starting seeds using domed trays:

Soil is moist

As sun heats up the inside of enclosure, the warm air collects moisture and starts to rise. When the warm air hits the top of the dome, the moisture condenses and collects on the dome cover.

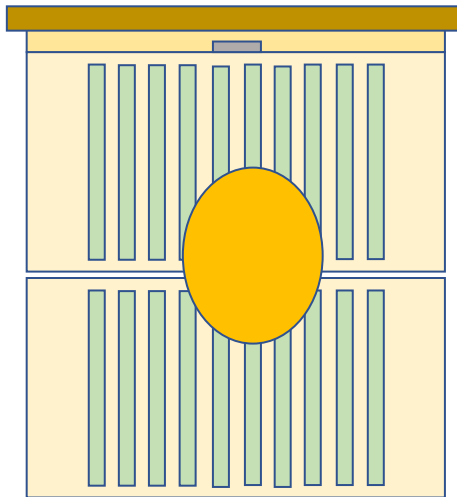


This is because the dome is at or below the dew point temperature

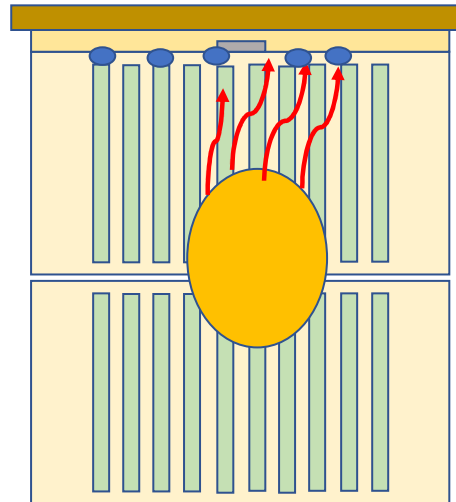
When enough moisture collects, it will drip back down onto the plants



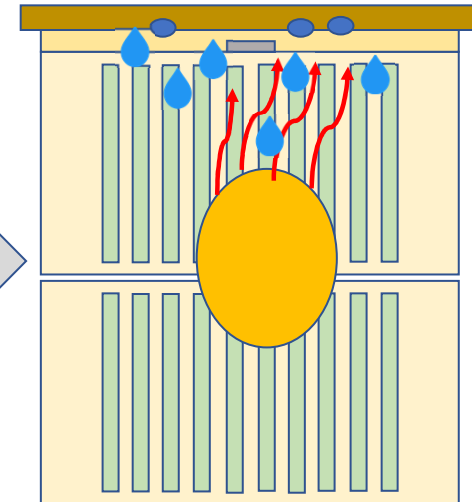
Applying the Fundamentals to Winter Hives



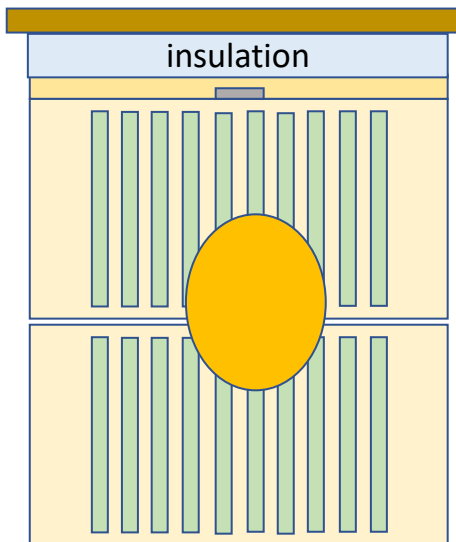
Cluster is generating heat keeping the outside layer at ~50F.



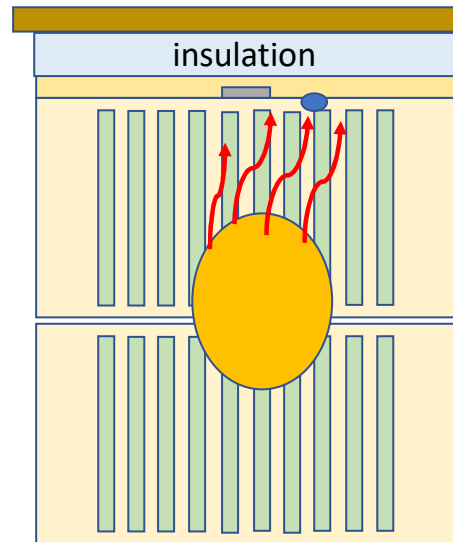
When the warm air hits to cold inner cover, moisture condensing.



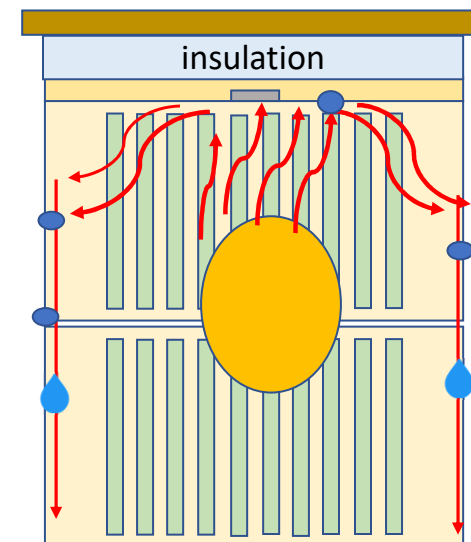
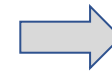
As moisture builds up, it can rain down on the cluster



Cluster is generating heat keeping the outside layer at ~50F.



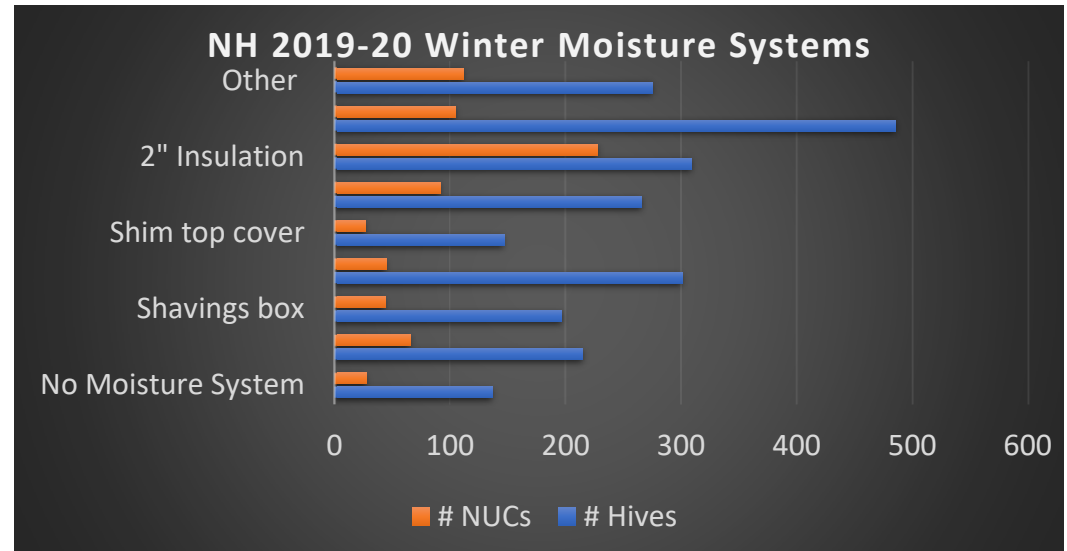
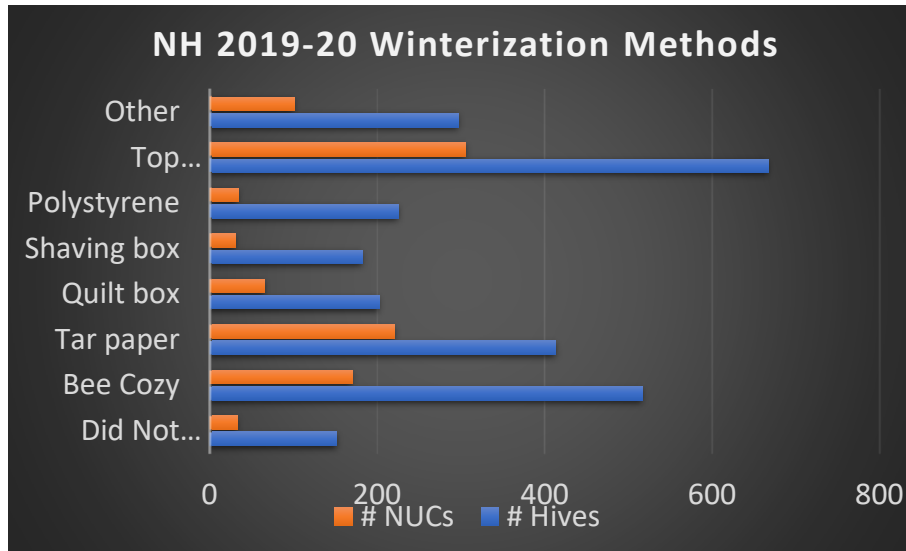
Insulation help keep the inner cover warmer so some condensation may occur but much less



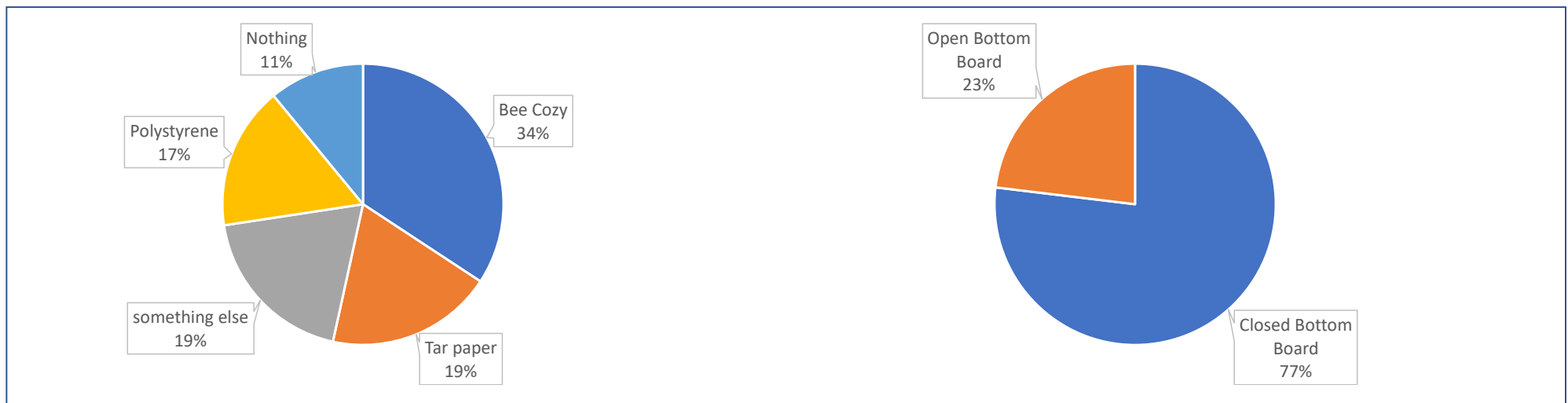
The air flows from the inner cover to the sides which are cold & moisture may condense, but it will run down the side & not on the bees.

Winterizing Hives in NH

In 2019, 89% of NH beekeepers used some type of “insulation” and 91% used some type of moisture system.*¹



2020 Winterization Methods*²



Sources: *¹NHBA 2019-20 Winter survey; *²2020 NHBA spring meeting poll

Study Highlights

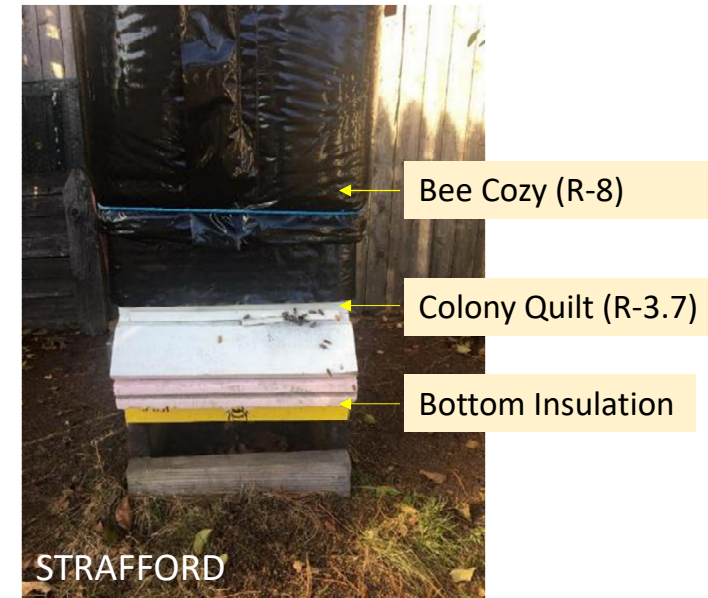
How Our Study Hives were Winterized



Winterization: homemade bee cozy (3/4" polystyrene + marine vinyl), reflectix wrapped around bottom, 2" insulation on top



Winterization: 1" Polystyrene under hive, inner cover, bubble wrap, 1" insulation on top, hive wrapped in 2 inch polystyrene.



Winterization: colony quilt, bee cozy, winter inner cover, 2" insulation on bottom

3 different data recording vendors:

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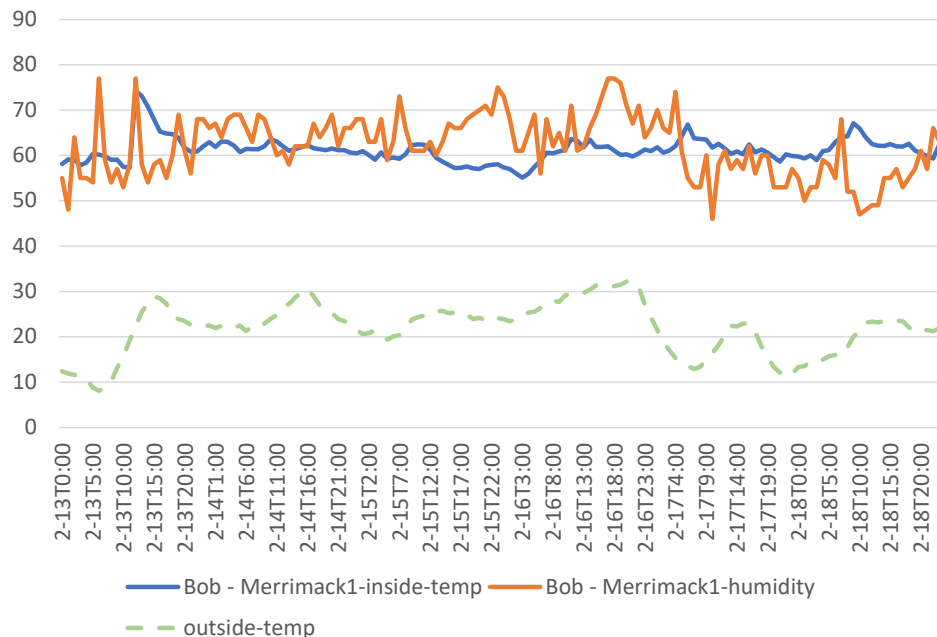


Winterization: 1/2" foil covered insulation board, Quilt boxes with shavings and four 1" vent holes above the shavings

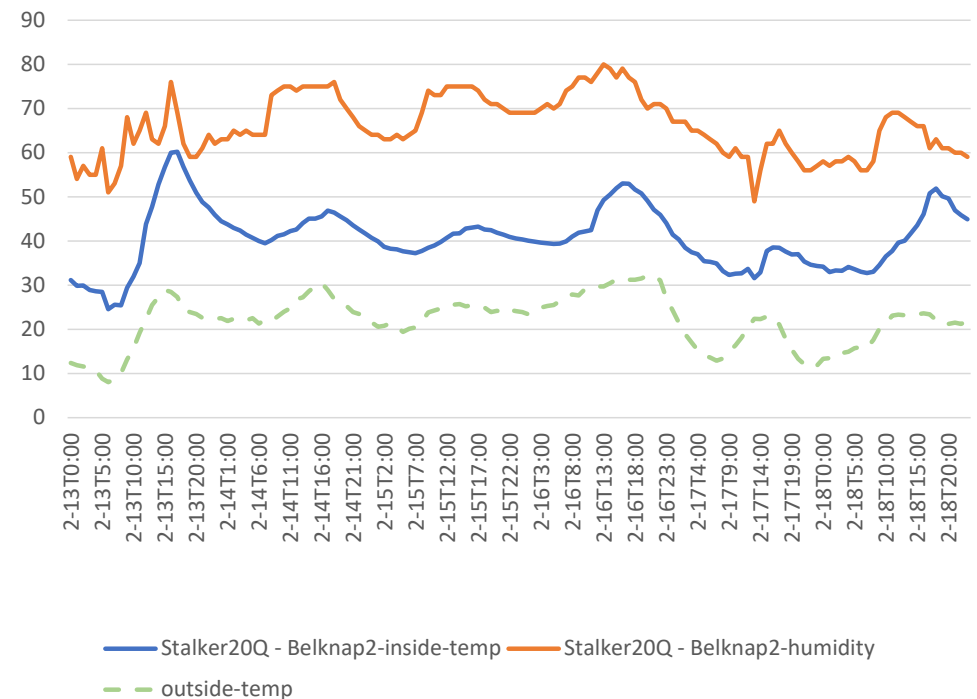
North Attleboro MA: No wrap, quilt box which uses shavings and four- 3/4" diameter vent holes

Using Temp/Humidity can give hints as to what is happening in the hive

Bob (Merrimack1) - Feb 13-Feb 18



Stalker (Belknap2) - Feb13-Feb18



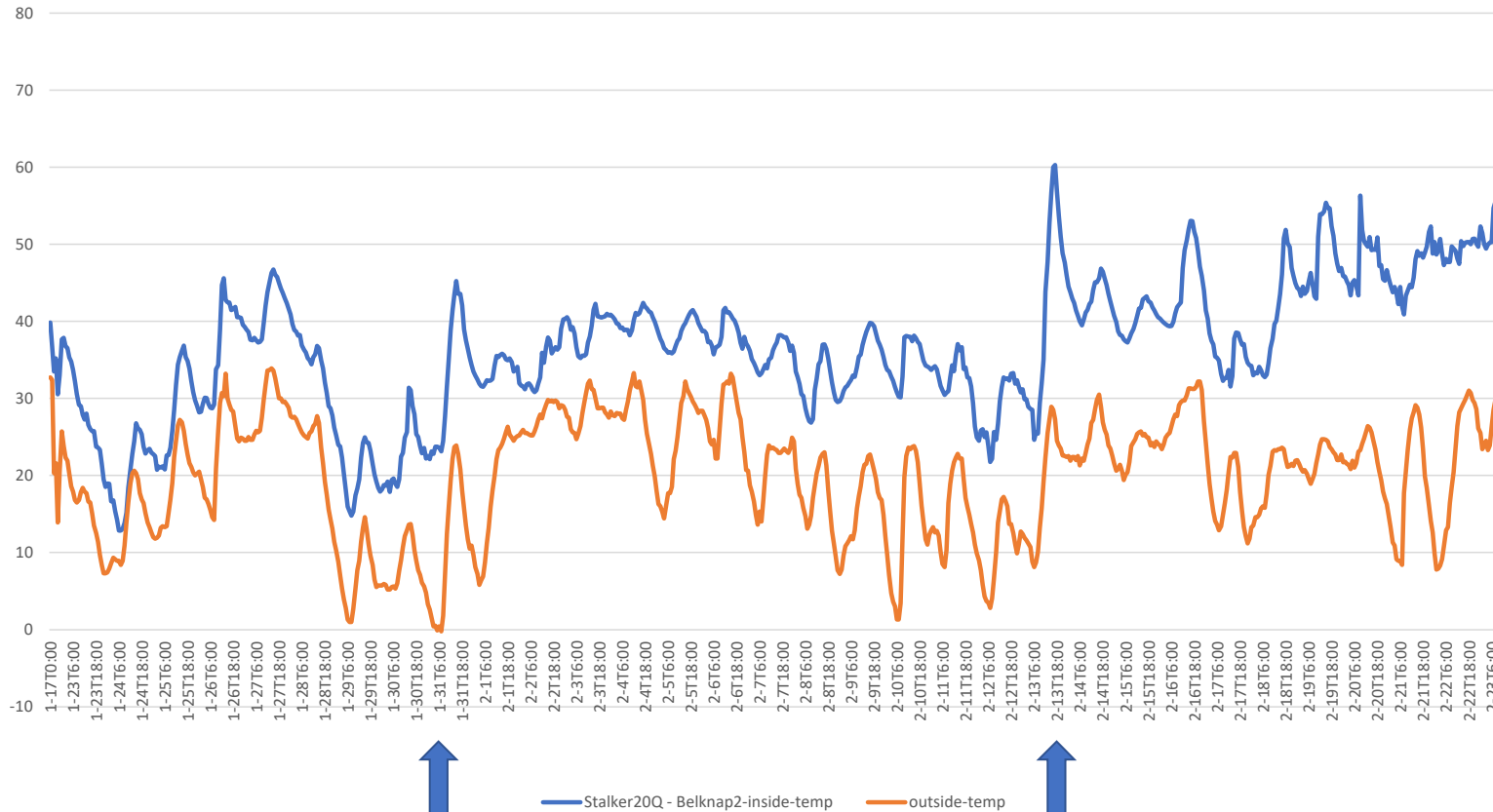
The fact that the temp & humidity are so high in the Bob Hive indicates the bees are probably at the top of the hive – so need to be concerned about food

The Stalker hive is a little harder to figure out because the humidity is high but the temp isn't – does this mean there's a moisture problem? Or is it a small cluster that is having a hard time keeping the hive at a higher temp?

Note: on Feb 13 – bees in both hives were at the top.

Too much airflow makes the bees work harder

Stalker(Belknap)



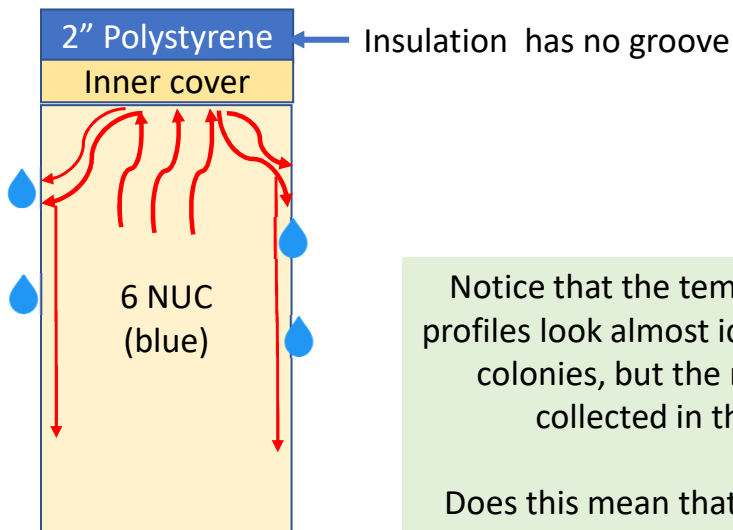
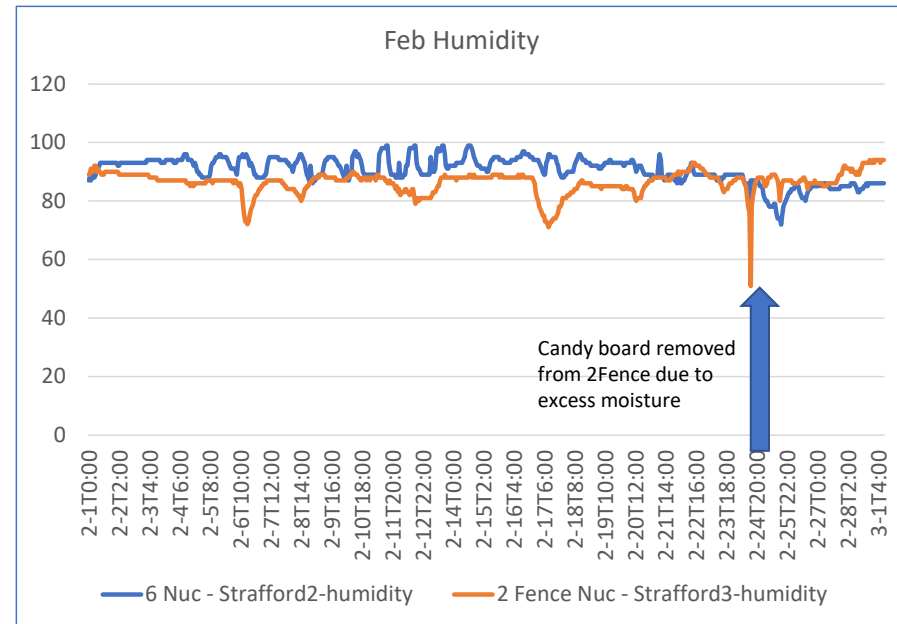
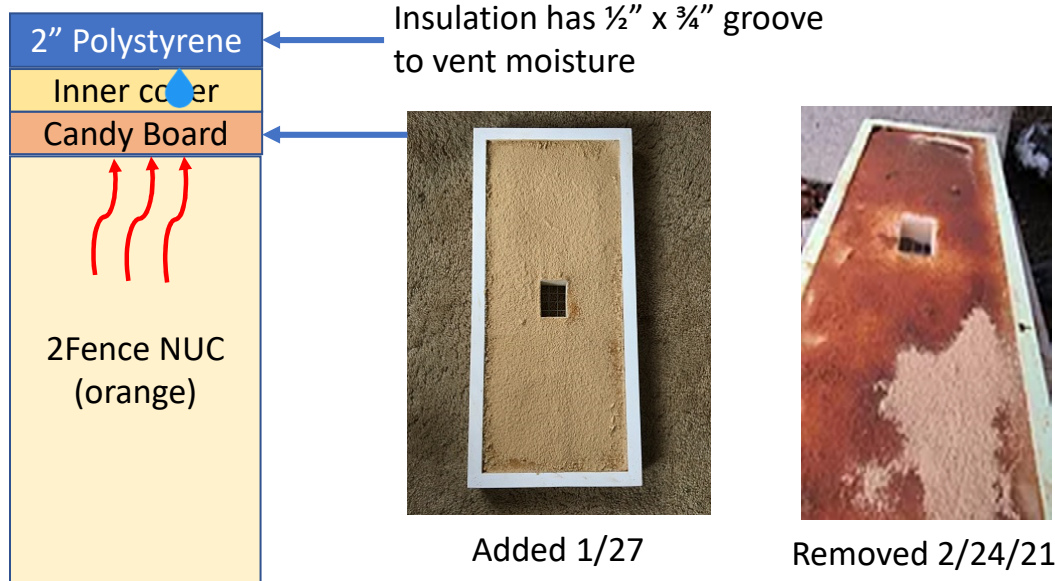
Blocked candy board entrance
& closed lower entrance from 1x2 = 1/2x1/2"

Reduced upper entrance to 1/4"



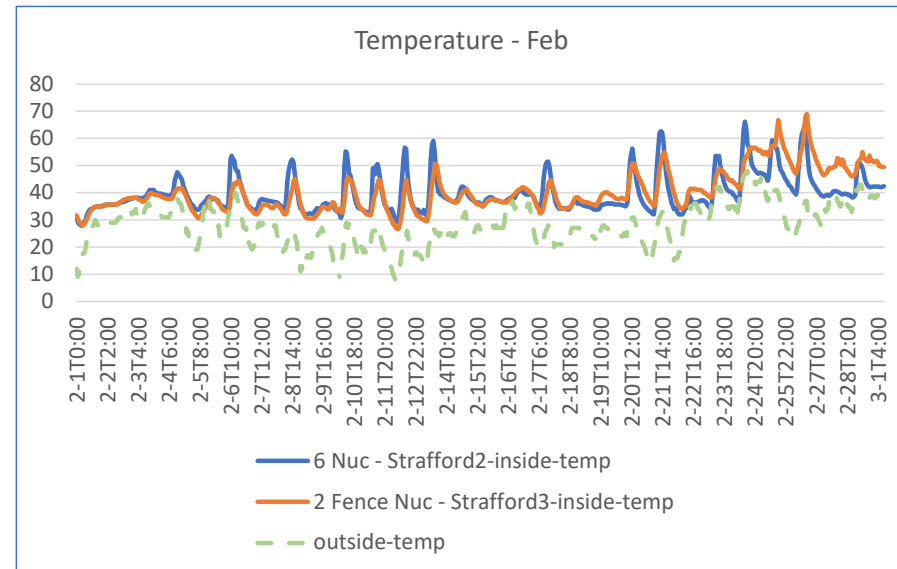
This colony survived the winter – even though the cluster was fairly small by March. Reducing airflow helped the bees keep it warmer & didn't cause any excess moisture

Humidity doesn't always predict excess moisture



Notice that the temperature & humidity profiles look almost identical between the 2 colonies, but the moisture in 2Fence collected in the candy board

Does this mean that a candy board is the right method of feeding?



But sometimes it does...

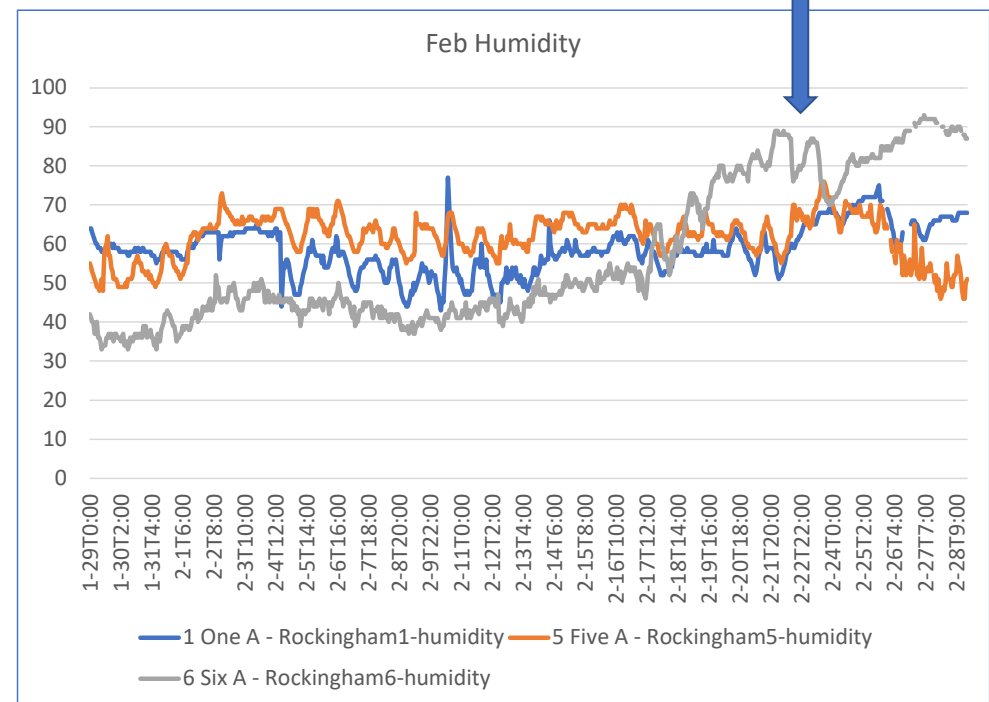
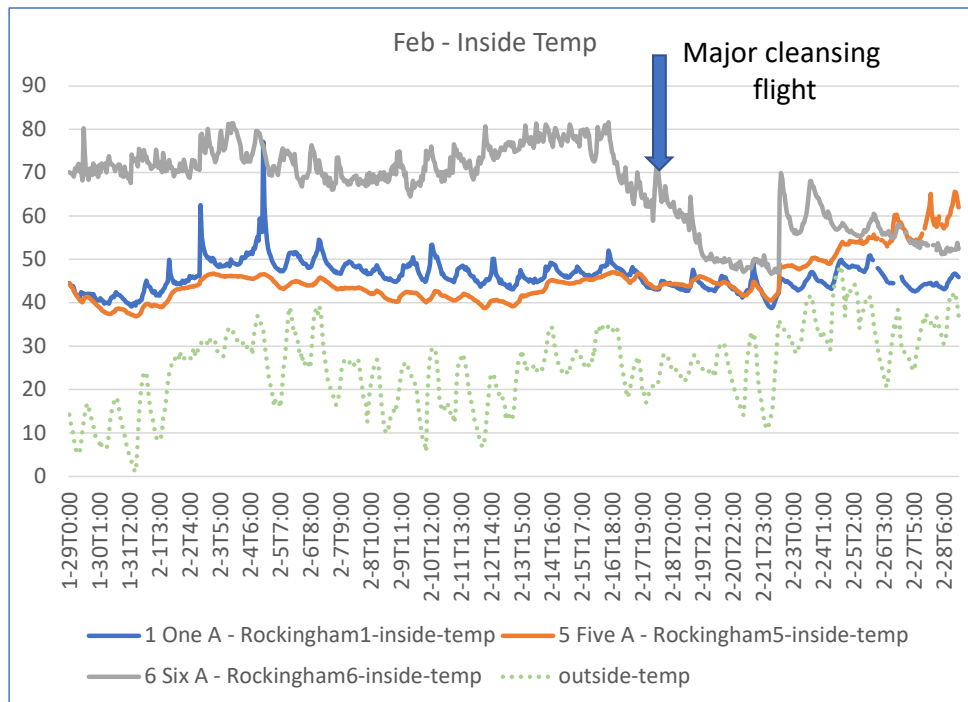


1/29/21 – taped up 3 of the 4 vents to increase temp & humidity in hive

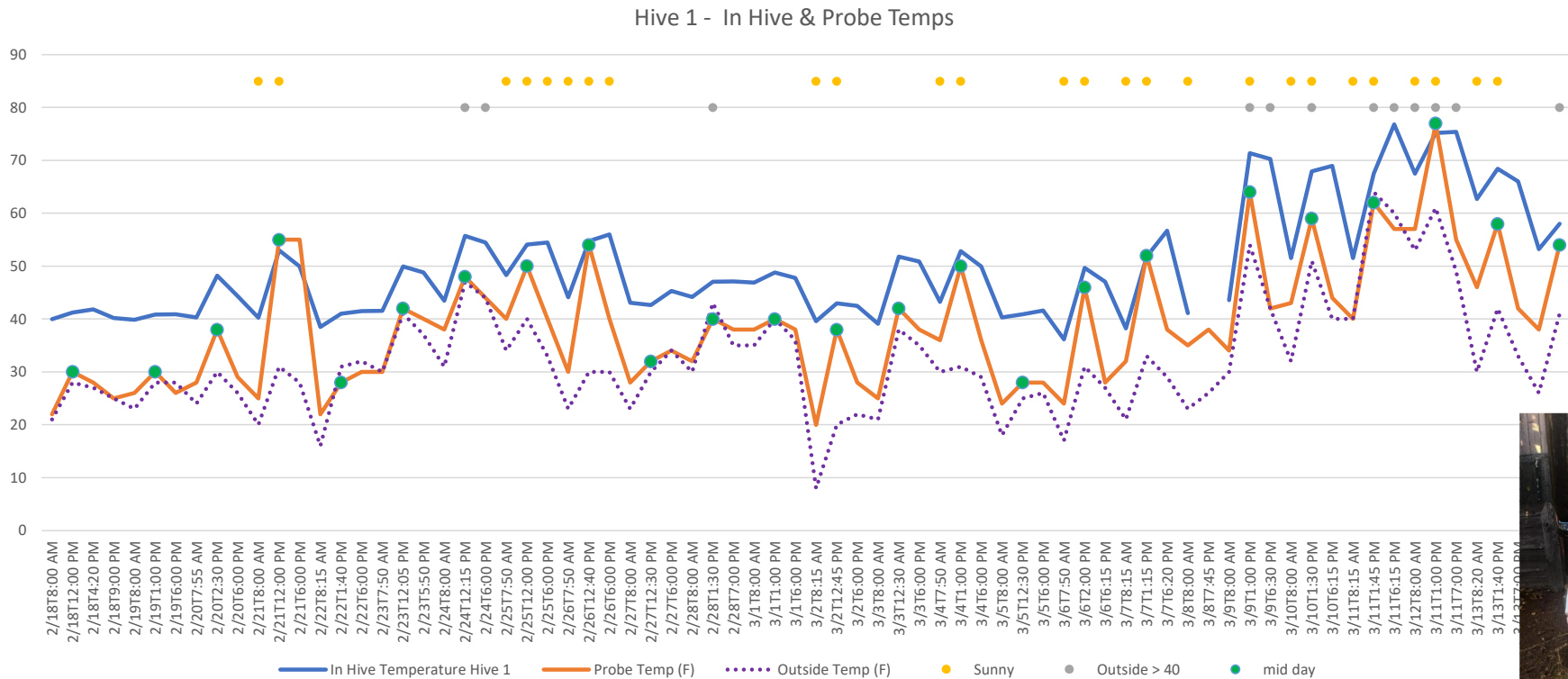
2/17/21 – major cleansing flight in hive 6 – many bees didn't make it back to the hive

2/22/21 - Hive 6 (gray) had damp shavings but other hive did not. (untaped hive 6's 3 vents)

Question: Did the drop in hive 6's cluster size mean it could no longer control humidity?



Inside vs outside temps when insulated with a Bee cozy



Blue = inside hive temperature

Orange = temp probe inserted between the bee cozy & colony quilt

Yellow dots = sunny days

Green dots = mid-day readings

Notice on sunny days (yellow dots), the probe & inside temperatures rise.
Above 50 the bees can break cluster to get food, but note there are also pretty big temperature swings in the hive on sunny days

Next Steps

- As always, the study brought up new questions to explore.
- We recommend a follow-on study next winter that could explore one or more of these topics:
 - CO2 levels in the hive and any affect they may have
 - The affect of different hive wraps on the hives internal temperature.
 - Methods of estimating colony strength using instrumentation
 - What is happening when we see the humidity ratio staying constant but the temperature changes? Where does the moisture go?
 - Does moisture collect between the hive wrap & woodenware? If so how & why?