2018
NYS Beekeeper Tech Team Report
New York State Beekeeper Tech Team

Overview

The New York State (NYS) Beekeeper Tech Team was created in response to unsustainable colony losses across the state in recent years. The Tech Team works closely with New York beekeepers to improve honey bee health, reduce colony losses, and increase the profitability and viability of beekeeping businesses. The Tech Team meets with participating beekeepers several times a year to conduct applied research and to provide information and recommendations that address beekeeping or business challenges. Participants manage operations that range in size from a few backyard hives to thousands of colonies. They remain enrolled in the Tech Team program for up to three years.

The program is funded by the New York State Environmental Protection Fund and the Empire State Honey Producers Association. It is implemented by Cornell University in collaboration with the New York State Department of Agriculture and Markets.

Tech Team Members

Emma Mullen As the Honey Bee Extension Associate at Cornell University, Emma is the Senior Lead of the NYS Beekeeper Tech Team, overseeing all aspects of the program including administration, data collection, report writing, and communications. She received a Master of Science degree from Western University, Canada, where she studied honey bee social behavior. Emma is passionate about communicating scientific research to beekeepers and working with them to implement best management practices.

Travis Grout As the Agricultural Economic Analyst for the Tech Team, Travis coordinates the Financial Analysis and Business Benchmarking (FABB) program for beekeepers. He received a Master of Science degree in Applied Economics from Cornell University and is focused on the financial health of New York's beekeeping businesses. Through FABB, Travis works with beekeepers to evaluate their businesses, track performance, and identify areas for improvement, based on the premise that basic business tools can make beekeeping more rewarding for operations of any size.

Connor Hinsley As the Technician for the Tech Team, Connor manages logistics of Tech Team operations, including sampling honey bee colonies in the field and drafting reports. He received a Bachelor of Science degree from Cornell University, where he studied Entomology. Connor is interested in addressing the challenges faced by both honey bees and native bees by helping beekeepers implement practical, evidence-based strategies to reduce the spread of disease and the overuse of chemical treatments.
Paul Cappy  As the NYS Apiculturist, Paul represents the Department of Agriculture and Markets on the Tech Team. Paul has more than 50 years of beekeeping experience and brings extensive knowledge of the beekeeping industry. He leads the NYS Apiary Inspection Program, which improves honey bee health by inspecting beekeeping operations, certifying colonies to cross state lines, and eradicating diseased colonies. He also collaborates with the National Honey Bee Survey to evaluate parasite, pathogen, and pesticide prevalence in NYS and investigate ways to reduce colony losses.

Scott McArt  As an Assistant Professor of Pollinator Health at Cornell University, Scott assists in coordinating Tech Team research design and communicating results. Research in the McArt lab focuses on the impact of pesticides, pathogens, and habitat on honey bees and wild bees. He is particularly interested in scientific research that can inform management decisions by beekeepers, growers, and the public.

Postdoctoral Research Associate

Christine Urbanowicz  As the NYS Honey Bee Postdoctoral Research Associate, Christine analyzes and summarizes Tech Team data and helps draft and edit reports. She received her PhD from Dartmouth College and is currently assessing the importance of invasive spotted knapweed as a forage item for honey bees and wild bees in New York. Christine researches plants and pollinators from the lenses of community ecology, landscape ecology, and management.

Acknowledgements

The Tech Team is grateful for our close collaboration with the Bee Informed Partnership (BIP). We appreciate the advisory support from Bee Informed Partnership Executive Director Karen Rennich, as well as Heather Eversole, Andrew Garavito, Pau Calatayud Vernich, and Dan Wyns, who together aided in sampling colonies and communicating with beekeepers. The University of Maryland Honey Bee Lab provides parasite diagnostic services for our team. We are grateful to the Empire State Honey Producers Association for supporting and promoting the Tech Team. Lastly, it has been a pleasure to work with members of our Beekeeper Advisory Board, who help to shape the direction and priorities of the Tech Team. We appreciate the contributions of Advisory Board members Chris Cripps, Christina Wahl, Chuck Kutik, Dan Winters, Earl Villecco, Mark Berninghausen, and Pat Bono.
Executive Summary

Beekeepers make an important contribution to New York State’s agricultural economy. In 2018, 28 Tech Team survey respondents managed 18,420 honey bee colonies, which represent 23% of the estimated 80,000 colonies kept in New York State. These respondents harvested over 343,000 pounds of honey, which comprises 11% of the approximately 3 million pounds of honey the industry produces annually. The value of honey for participants enrolled in the NYS Beekeeper Tech Team program is $1.8 million, and the total value of all production for these beekeepers—including honey, other apiary products, nucleus colonies, queens, and paid pollination services—is over $2.6 million. Honey is the main source of revenue for the beekeepers enrolled in the Tech Team program, followed by pollination services, queen and nucleus colony production, and other hive products and value-added products.

Annual colony loss rates were 10% lower than the previous year. The total annual loss for beekeepers enrolled in the Tech Team was 40.5% in 2017/2018, compared to 51% in 2016/2017. Summer loss was 20.9%, compared to 27% in the previous year, and winter loss was 34.5%, compared to 46% in the previous year. This reduction in colony loss may be due in part to increases in Varroa monitoring and treatment reported by Tech Team members in 2017/2018. Although colony losses have improved, they are still higher than what beekeepers consider sustainable.

Varroa mite levels are a significant predictor of winter loss in New York State. The Tech Team tracked winter mortality for 154 colonies sampled in fall 2017. Varroa, Lake Sinai Virus 2, and chronic bee paralysis virus loads emerged as significant predictors of colony loss.

Beekeepers who monitored and treated for Varroa more frequently experienced lower Varroa levels. Beekeepers are encouraged to monitor their Varroa levels monthly as weather allows, and to treat when—and only when—levels reach or exceed the treatment threshold. Unnecessary mite treatments can negatively impact colony health. Beekeepers who treated at least 3 times a year had average Varroa levels below the treatment threshold in fall.

More beekeepers managed Varroa with an Integrated Pest Management approach after receiving extension services from the NYS Beekeeper Tech Team. The proportion of beekeepers that monitored for Varroa increased from 28% in 2016 to 79% in 2018, that used cultural treatments (e.g., culling drone brood, screened bottom board, etc.) increased from 39% to 54%, and that used chemical treatments increased from 63% to 86%. Significantly more beekeepers timed their treatment applications based on Varroa mite thresholds in 2018 compared to 2016. Importantly, monitoring and treating are now commonly employed in the fall months, when Varroa levels are at their highest in New York.

Fewer colonies exceeded the Varroa treatment threshold in 2018 than in 2016. In September 2016, the NYS Beekeeper Tech Team’s first sampling year, 61% of colonies had 3 or more mites per 100 bees, a threshold that requires immediate treatment to prevent colony death. In September 2018, significantly fewer colonies (41%) had Varroa levels exceeding the threshold.

Incidence of Parasitic Mite Syndrome has declined significantly each year since 2016. This suggests beekeepers have been better able to prevent severe Varroa infestations.
For the first time since 2010, the Tech Team discovered an American foulbrood (AFB) infection that was resistant to the antibiotic oxytetracycline. The Tech Team recommends beekeepers carefully inspect their colonies for AFB three times per year, and send a sample to the USDA Beltsville Bee lab every time an infection is suspected and/or confirmed.

*Nosema* infections often clear up during summer without the use of fumagillin. Across all three sampling years (2016-2018), *Nosema* levels were high in spring and low in fall. Very few beekeepers used fumagillin in 2017 and none used it in 2018. Despite this, 91% of untreated colonies that were above the treatment threshold in spring naturally resolved their infection to spore counts below the treatment threshold in fall. 36% of colonies with *Nosema* spores in spring eliminated the infection entirely by fall.
Table of Contents

OVERVIEW ............................................................................................................................................................. 1
TECH TEAM MEMBERS ................................................................................................................................. 1
ACKNOWLEDGEMENTS ............................................................................................................................... 2
EXECUTIVE SUMMARY ............................................................................................................................. 3
INTRODUCTION ..................................................................................................................................................... 6
METHODS .............................................................................................................................................................. 7
SAMPLE SELECTION & COLONY INSPECTION .............................................................................................. 7
LABORATORY ANALYSES ........................................................................................................................................ 9
Varroa ........................................................................................................................................................... 9
Nosema ......................................................................................................................................................... 9
BEEKEEPER MANAGEMENT SURVEY ............................................................................................................ 9
INDUSTRY OVERVIEW ............................................................................................................................................ 9
HONEY PRODUCTION ........................................................................................................................................ 10
ADDITIONAL HIVE PRODUCTS ...................................................................................................................... 10
NUCLEUS COLONIES & QUEENS .................................................................................................................. 11
POLLINATION SERVICES .................................................................................................................................. 11
COLONY LOSSES ................................................................................................................................................... 12
COLONY HEALTH ................................................................................................................................................ 13
Varroa Mites .................................................................................................................................................. 13
High Varroa levels predict colony death ........................................................................................................ 13
Beekeeper management relates to Varroa levels ........................................................................................ 13
Varroa management practices have improved since 2016 ................................................................... 15
Fewer colonies have mites above the treatment threshold in 2018 ............................................................. 17
Parasitic Mite Syndrome .............................................................................................................................. 18
Noosema ....................................................................................................................................................... 19
Brood Diseases & Insect Pests ....................................................................................................................... 21
Sacbrood ....................................................................................................................................................... 22
Chalkbrood .................................................................................................................................................... 22
American foulbrood ..................................................................................................................................... 22
European foulbrood ...................................................................................................................................... 23
Idiopathic brood disease syndrome .......................................................................................................... 23
Small hive beetles and wax moths ............................................................................................................... 23
Deformed wings .......................................................................................................................................... 23
CONCLUSIONS ...................................................................................................................................................... 24
REFERENCES ........................................................................................................................................................ 25
Introduction

Honey bees in New York State face more challenges than ever before, and colony losses continue to occur at unsustainable levels. Between 42% and 68% of New York’s colonies have died each year since 2010. Parasites, viruses, pesticides, nutrition, and management practices all shape honey bee health outcomes. The complexity of factors that influence colony health and productivity makes it difficult for beekeepers to diagnose specific health problems in their colonies and respond appropriately.

Reliable information on colony health and performance empowers beekeepers to make informed management decisions. Knowing exact Varroa mite levels, Nosema spore counts, and pesticide residues takes the guesswork out of identifying issues with incomplete information. Coupling these data with resources and expert recommendations allows beekeepers to proactively manage their operations using effective, evidence-based practices. The NYS Beekeeper Tech Team was founded to foster this approach.

The Tech Team works with beekeepers across New York State, inspecting a sample of colonies from each participating operation. In the process, the Tech Team documents parasite infestations, pathogen levels, pesticide residues, and management practices of individual hobbyist, sideliners, and commercial beekeepers. Each beekeeper receives a detailed colony health snapshot of their own operation, along with values from similar operations for comparison. Recommendations based on individual test results inform production decisions and support proactive planning for improved pest, disease, and pesticide management. Sharing this information with beekeepers is critical to mitigating colony losses and enhancing the stability and profitability of the New York State beekeeping industry.

The main objectives of this report are to 1) present results from the 2018 Tech Team research that investigates colony health and beekeeper management practices; 2) compare results from 2018 with 2017 and 2016 to identify trends over time; and 3) interpret results and identify major findings to support decision making for improved management and colony health. Pesticide results from 2017 and 2018 will be presented in a separate report.
Methods

Sample Selection & Colony Inspection

In 2018, the Tech Team inspected 314 colonies belonging to 33 beekeepers across 22 counties in New York State. 26 of these beekeepers have been enrolled in the Tech Team services since 2016, 5 joined in 2017, and 2 are new in 2018. The 2018 sample included 8 hobbyists (apiarists who manage 1 to 49 colonies), 12 sideliners (50 to 499 colonies), and 13 commercial beekeepers (500 colonies or more). We inspected 1 colony from each hobbyist (8 total), 4 from each sideliner (46 total), and 20 from each commercial beekeeper (260 total). Colonies were inspected once in the first two weeks of June and again in the middle two weeks of September. All 314 colonies were sampled for Varroa mites and Nosema spores in both periods, while a subset of 84 colonies were sampled for pesticides in September. Pesticide results will be presented in a later report.

Figure 1. Breakdown of the regions of NYS (as defined by the NYS Department of Economic Development) and the number of Tech Team beekeepers in each region.

The Tech Team sampled beekeepers from all but the Southeast-most regions of New York. Broken into regions as defined by the New York State Department of Economic Development\(^2\), seen in Figure 1, one beekeeper was located in Western New York, seven in the Finger Lakes, seven in the Southern Tier, seven in Central New York, eight in the North Country, and three in the Mohawk Valley.
Of the colonies managed by beekeepers enrolled in the Tech Team program, 4301 (23%) were located in Western New York, 2492 (14%) in the Finger Lakes, 382 (2%) in the Southern Tier, 1722 (9%) in Central New York, 6923 (38%) in the North Country, and 2600 (14%) in the Mohawk Valley (Figure 2). These colony counts are similar to those in 2017, as the Tech Team worked with most of the same beekeepers in both years.

![Figure 2. Number of colonies managed by participating beekeepers, separated by region and year.](image)

A group of colonies was selected in each apiary, with preference for sampling 1) the same colonies as in previous periods to track their long-term health and 2) colonies that successfully overwintered. By tracking and sampling the same colonies over the course of a season or several seasons, the Tech Team can more accurately predict what contributes to or causes colony death. Within these constraints, the Tech Team selected colonies of a variety of strengths, sizes, and disease loads. If a colony died between sampling visits, the Tech Team recorded its hive ID for colony loss data and selected another queenright colony from the same yard for future identification and sampling.

In examining the health of a colony, the Tech Team visually inspected at least four brood frames for evidence of honey bee pests, parasites, and pathogens. If American or European foulbrood symptoms were observed, a Vita Bee test kit was used to verify the infection. If the colony tested positive for American foulbrood, the state apiculturist was contacted immediately in compliance with New York State apiary laws, and the Tech Team mailed a brood sample to the USDA Beltsville Bee Lab.
Laboratory Analyses

Varroa
Approximately 300 bees were collected from the brood nest of each colony in June and September and shipped in a saturated saline solution to the University of Maryland Honey Bee Lab. At the lab, the samples were shaken and washed to dislodge mites from the bees’ bodies. A technician counted the number of bees and mites in each sample and calculated the exact number of mites per 100 bees.

Nosema
One hundred worker bees were reserved from the Varroa sample. These bees were crushed to release Nosema spores from their guts. The crushed sample was mixed with 100 mL of deionized water, and 4 μl of the resulting solution was pipetted onto a hemocytometer. Using a microscope with 400x magnification, a technician counted spores covering an area equal to 20% of the hemocytometer. This count was converted to the number of millions of spores per bee.

Beekeeper Management Survey
All participating beekeepers received a comprehensive survey covering production, management practices, colony losses, and operation characteristics. At the time of printing this report, a total of 28 beekeepers completed the survey, resulting in an 85% response rate. In addition, the completed 31 beekeeper surveys from 2017 were included for comparison. Responses to the survey help explain trends in colony health outcomes documented by technicians in the spring and fall. Additionally, the survey results also allow beekeepers to evaluate how their colony health, product prices, gross production, and disease management practices compare to averages. Management survey data were collected both for both the entire operation and for the apiaries housing the individual colonies sampled by the Tech Team.

Industry Overview
The 28 respondents to the 2018 Beekeeper Management Survey managed a total of 18,420 colonies in 2018, which represents 23% of the estimated 80,000 colonies kept in New York State. These respondents harvested over 343,000 pounds of honey, which comprises 11% of the approximately 3 million pounds of honey the industry produces annually. The value of honey for participants enrolled in the NYS Beekeeper Tech Team program is $1.8 million, and the total value of all production for these beekeepers—including honey, other apiary products, nucleus colonies, queens, and paid pollination services— is over $2.6 million.

Honey is the main source of revenue for beekeepers enrolled in the NYS Beekeeper Tech Team program, followed by pollination services, selling nucleus colonies, and then selling additional hive products and value-added products (Figure 3).
Honey Production

Survey respondents harvested 343,318 pounds of honey in 2018, valued at approximately $1.8 million (Table 1). The average yield of 49.59 pounds per colony was lower than in 2016 (64 pounds per colony) and in 2017 (52 pounds per colony), suggesting that 2018 was a less productive year for honey producers enrolled in the Tech Team program.

Additional Hive Products

Table 1 outlines the amount of other apiary products harvested and the total revenue beekeepers received in 2018 from selling these products.
Table 1. Honey and additional hive products harvested in 2018.

<table>
<thead>
<tr>
<th></th>
<th>Amount harvested</th>
<th>Number of colonies from which the product is harvested</th>
<th>Average yield per colony</th>
<th>Total revenues from sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>343,318 lb</td>
<td>11,333</td>
<td>49.59 lb</td>
<td>$1,073,800</td>
</tr>
<tr>
<td>Beeswax</td>
<td>3,829 lb</td>
<td>5,868</td>
<td>1.08 lb</td>
<td>$21,391</td>
</tr>
<tr>
<td>Cut Comb Honey</td>
<td>10,026 units</td>
<td>266</td>
<td>38 units</td>
<td>$77,898</td>
</tr>
<tr>
<td>Pollen</td>
<td>177 lb</td>
<td>12</td>
<td>9.25 lb</td>
<td>$2,187</td>
</tr>
<tr>
<td>Propolis</td>
<td>67 lb</td>
<td>2,092</td>
<td>0.17 lb</td>
<td>$75</td>
</tr>
</tbody>
</table>

Nucleus Colonies & Queens

A total of 9 operations (32%) reported producing nucleus colonies for sale in 2018. The average sale price was $132.14 per nucleus colony, and the total value of nucleus colonies produced by survey respondents was $161,460.00. A total of 2 operations (7%) reported producing queens for sale in 2018. The average sale price was $22.50 per queen, and the total value of queens produced by survey respondents was $60,500.

Pollination Services

Nine survey respondents (32.1%) reported sending a total of 6,284 colonies into commercial pollination for 7 agricultural crops across 6 states in 2018. Table 2 shows the number of colonies sent to pollinate each crop, the state where pollination occurred, and the average reported price per colony. The total value of 2018 pollination services was estimated to be $235,280.00.

Table 2. Reported pollination services details in 2018. An entry of ND means the price was not disclosed by the beekeeper(s).

<table>
<thead>
<tr>
<th>Crop</th>
<th>State</th>
<th>Number Colonies</th>
<th>Average Colony Price</th>
<th>Estimated Gross income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>NY</td>
<td>2255</td>
<td>$82.00</td>
<td>$184,910</td>
</tr>
<tr>
<td>Blueberry</td>
<td>NC</td>
<td>300</td>
<td>$82.50</td>
<td>$24,750</td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>150</td>
<td>$80.00</td>
<td>$12,000</td>
</tr>
<tr>
<td></td>
<td>GA</td>
<td>64</td>
<td>$70.00</td>
<td>$4,480</td>
</tr>
<tr>
<td></td>
<td>NJ</td>
<td>1700</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Cherry</td>
<td>NY</td>
<td>12</td>
<td>$85.00</td>
<td>$1,020</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>NY</td>
<td>3</td>
<td>$75.00</td>
<td>$225</td>
</tr>
<tr>
<td>Almond</td>
<td>CA</td>
<td>1200</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Cranberry</td>
<td>NJ</td>
<td>400</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Vine Crop</td>
<td>NJ</td>
<td>200</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>
Colony Losses

High colony losses are a major concern and management challenge for beekeepers in New York State. The Tech Team calculates winter, summer, and annual colony losses based on colony counts reported by beekeepers. Winter losses cover the period from October 1, 2017 to April 1, 2018; summer losses cover the period from April 1, 2018 to October 1, 2018; and annual losses cover the period from October 1, 2017 to October 1, 2018. For a given period, the loss rate is calculated as the total number of colonies that died in the period divided by the total number of colonies kept during that period, using the method established by the Bee Informed Partnership.

Figure 4 shows total winter, summer, and annual colony losses for 28 beekeepers that completed the 2018 NYS Beekeeper Tech Team Management Survey. In 2018, annual colony loss rates were 10% lower than the previous year. Beekeepers lost 6,540 out of 18,953 colonies between October 2017 and April 2018, resulting in a total winter loss of 34.5%. The same beekeepers lost 4,156 out of 19,861 colonies between April 2018 and October 2018, resulting in a total summer loss of 20.9%. The total annual loss rate for the 2017 - 2018 year was 40.5% (10,696 out of 26,401 colonies). Though losses were lower in 2018, they were still 1.9 times greater than the average loss rate that beekeepers considered to be acceptable (21%).

![Figure 4. Colony losses in 2017 and 2018 in winter (October 1 – April 1), summer (April 1 – October 1), and annually (October 1 – October 1). The dotted line indicates the percent loss beekeepers consider economically sustainable.](image-url)
Colony Health

Varroa Mites

High Varroa levels predict colony death
Tech Team participants successfully tracked the winter survival of 154 colonies that were sampled in August 2017. As shown in Figure 5, high Varroa infestation in fall was a significant predictor of winter colony loss (P=0.04). For instance, a colony with a September Varroa level of 4 mites per 100 bees has, on average, a 50% probability of survival. A colony with a September Varroa level of 11 mites per 100 bees has, on average, a 25% probability of survival. Lake Sinai virus 2 (P=0.04) and chronic bee paralysis virus loads (P=0.03) also emerged as significant predictors of colony death. Other measures, including colony population size, Nosema infection, and other viruses, did not predict colony death. Managing these parasites before they reach immensely high levels is critical to prevent colonies from developing high virus loads, Parasitic Mite Syndrome, and ultimately dying.

Figure 5. High Varroa mite levels predict winter loss in New York State. Points are individual colonies. Points scattered around 0 on the y-axis represent colonies that did not survive winter, and points scattered around 1 on the y-axis represent colonies that did survive winter.

Beekeeper management is related to Varroa levels
High Varroa mites predict winter loss in New York, so it is important for beekeepers to track their mite levels by monitoring and managing them, when needed, with treatments. Beekeepers in New York State vary in their approach to monitoring and treating. Among those enrolled in the Tech Team program, monitoring frequency varied from zero to twelve times in one year, and treatment frequency varied from zero to ten times in one year. The
Tech Team recommends beekeepers monitor monthly as weather permits. Frequent monitoring allows beekeepers to 1) understand Varroa population dynamics throughout the year, 2) know when to apply a treatment, and 3) evaluate the efficacy of a treatment. Without regular monitoring, mite populations may grow to very high levels without the beekeeper knowing, or ineffective treatments may go unrealized.

The Tech Team investigated the relationship between fall Varroa levels and number of monitoring events beekeepers conducted during the year (for the 12 months prior to fall sampling) for 2016 through 2018. As the number of monitoring events increase, fall Varroa levels significantly decrease ($P=0.01$; Figure 6, left). This result is strong evidence that the more aware beekeepers are of their colonies’ mite levels, the more successful they are in their management. Similarly, and as might be expected, as the number of chemical treatments increases during the year, fall Varroa mite levels significantly decrease ($P=0.03$; Figure 6, right). Beekeepers who treated at least 3 times a year had average Varroa levels below 3 mites per 100 bees in fall.

![Figure 6. The relationship between monitoring frequency (left) or treatment frequency (right) and fall Varroa levels.](image)

The information above suggests beekeepers who monitor and treat more frequently are better at controlling Varroa. While there was no relationship between treatment frequency and annual colony loss rates among operations ($P=0.18$), excessive treatments are unnecessary and beekeepers are encouraged to only use treatments when needed. The Tech Team recommends treatments should be applied as soon as mites reach or exceed the treatment threshold, preventing a scenario where the population builds up to damaging levels before intervention occurs. In New York, the treatment threshold from March to July is 2 mites per 100 bees, and from August to November it is 3 mites per 100 bees. Applying threshold-based treatments avoids unnecessary applications that may negatively impact colony health. Since the Tech Team began in 2016, there has been a significant increase in the number of beekeepers who decide to treat when monitoring shows that mites have reached or exceeded the treatment threshold ($P = 0.002$).
Varroa management practices have improved since 2016
The NYS Beekeeper Tech Team emphasizes educating beekeepers in best management practices for Varroa and adopting an Integrated Pest Management Approach based on 1) regularly monitoring Varroa, 2) integrating cultural methods when appropriate, and 3) using monitoring results to time treatment applications. Since 2016, the NYS Beekeeper Tech Team has observed more beekeepers employing best management practices with regards to monitoring for and treating Varroa (Figure 7). In 2016, before receiving any extension from the program, only 28% of beekeepers monitored. In 2018, monitoring increased to 79% of beekeepers (in 2017, 90% of beekeepers monitored). Similarly, the proportion of beekeepers using chemical treatments to control Varroa increased from 63% to 86%, and the use of cultural methods increased from 39% to 54%. Importantly, monitoring and treating are now commonly occurring into the fall months, when Varroa levels are at their highest in New York. It is critical that colonies are healthy at this time so that they are able to produce a sufficient population size, healthy winter bees, and food stores to survive northern winters. It is likely that the adoption of best management practices to control Varroa has contributed both to the reduction in the number of colonies exceeding the treatment threshold in fall 2018, and to the reduction in colony losses.

An IPM approach for Varroa includes a) monitoring regularly, b) using cultural methods to delay mite population build-up (drone brood removal pictured here), and treating when populations reach or exceed the threshold (c and d). Beekeepers should regularly rotate treatments to delay the development of resistance.
Figure 7. Percent of respondents in 2016 and 2018 that monitored for Varroa (top), and that applied a chemical treatment (bottom).
Fewer colonies have mites above the treatment threshold in 2018

Varroa continued to present a challenge for beekeeping operations of all sizes in 2018. While levels were well controlled in June, beekeepers continued to struggle to keep Varroa levels below the treatment threshold in September.

[Figure 8: Mean (±standard error) Varroa mite populations by sampling date and operation scale.]

Average Varroa levels were highest in September and lowest in June (Figure 8). This is not surprising, as the seasonal dynamics of Varroa mite populations are well documented in New York State, where levels most often peak in September and October and are low in spring. Colonies require heightened Varroa management in fall. While there were no significant differences in average mite levels between fall of 2016 and 2018 (P=0.587), there was an improvement in the overall proportion of colonies that had levels at or above the treatment threshold; significantly fewer colonies had mites at levels that required treatments in September 2018 (41% of colonies) than in September 2016 (61%, P<0.001; Figure 9).
Parasitic Mite Syndrome

Parasitic Mite Syndrome (PMS), also known as Varroa Mite Syndrome, is an advanced stage of a Varroa/virus infestation. PMS typically manifests during the months of August through November in New York, after mites and viruses have been permitted to build up for several months. Throughout all sampling periods, colonies with PMS had significantly higher Varroa mite levels (8.19 mites per 100 bees, on average) compared to colonies without PMS (2.58 mites per 100 bees; P<0.001).

Symptoms of PMS include dead brood (a), visible mites (a), spotty brood pattern (b), chewed down brood (b), and adult bees with deformed wings.
Since 2016, the prevalence of PMS has decreased significantly each year (Figure 10, P<0.001). When beekeepers first enrolled in the Tech Team program in September 2016, PMS occurred in 21.3% of all colonies. By September 2018, 5.7% of colonies had PMS. This reduction reflects a major improvement in the health of colonies entering winter in New York State.

The prevalence of Parasitic Mite Syndrome differed across operation scales. Even with the decline in PMS between 2016 and 2018, colonies managed by commercial beekeepers experience a higher prevalence of PMS compared to colonies managed by hobbyists or sideliners across all three years. While Varroa mite levels provide an acute indicator of recent management and treatment choices, PMS reflects the cumulative impact of exposure to Varroa mites and associated viruses over time. While the Tech Team did not sample viruses in 2018, it is possible that commercial colonies were exposed to other stress factors that could make them more susceptible to developing PMS. It is also possible that Varroa levels in commercial colonies simply remained unmanaged for longer periods of time compared to hobby and sideliner colonies. This consistent trend demonstrates the critical need for commercial beekeepers to regularly monitor Varroa mites and treat colonies every time mite levels exceed the treatment threshold.

**Nosema**

In April 2018, beekeepers were surprised to hear that the company Medivet would no longer manufacture Fumagilin-B, the only Nosema treatment available in the US. This treatment, while commonly used in the past, is rarely used among beekeepers enrolled in the Tech Team program today. Fumagilin-B was used by two Tech Team participants in 2016, one in 2017, and none in 2018. Beekeepers stopped using Fumagilin-B because studies have
demonstrated that it does not reliably control Nosema ceranae⁶, and the beekeepers worried about its presence in honey for human consumption. Despite the limited use of Fumagillin-B, some beekeepers have grown concerned that there are now no treatment options for Nosema.

The Tech Team investigated to what extent Nosema-infected colonies require treatments. The sampling revealed Nosema does not appear to pose a serious threat to colony health during the summer months in New York State. Instead, most spring infections were resolved on their own without beekeeper intervention by fall (Table 3). Sampling also demonstrated that Nosema followed a clear seasonal pattern: infections were high in spring and low in fall (Figure 1). Although some colonies do continue to be infected in fall, Nosema levels did not emerge as a predictor for winter loss.

Table 3. Number of colonies with Nosema infections at or above 1 million spores per bee in spring that reduced their infection to below this threshold in fall (top); Number of colonies with any detectable Nosema infection in spring that completely eliminated their infection by fall (bottom).

<table>
<thead>
<tr>
<th>Percent of colonies that improved their Nosema infection without Fumagillin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of colonies with Nosema spores</strong></td>
</tr>
<tr>
<td>Year</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>2017</td>
</tr>
<tr>
<td>2018</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent of colonies that eliminated their Nosema infection without Fumagillin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of colonies with Nosema spores at or above one million spores per bee</strong></td>
</tr>
<tr>
<td>Year</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>2017</td>
</tr>
<tr>
<td>2018</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Although it appears most Nosema infections resolve on their own without any intervention, it is important for beekeepers to be aware of their levels. If beekeepers observe symptoms of Nosema (e.g., weak population, slow population build-up, reduced honey and brood production), they should regularly monitor. Colonies suffering from Nosema may benefit from supplemental feeding in spring and should be isolated from healthy colonies. If the infected colonies perish over winter, it is recommended beekeepers disinfect their equipment before introducing new bees by using one of the methods outlined in the Cornell Dyce Lab document “Nosema Disease: information for identification and control in New York”.

Brood Diseases & Insect Pests

In addition to Nosema and Varroa, honey bee colonies are susceptible to insect pest infestations, and brood is susceptible to a variety of viral, fungal, and bacterial infections. The Tech Team most commonly observed small hive beetles, sacbrood virus, chalkbrood, and deformed wing virus. Sacbrood and chalkbrood followed the same seasonal pattern: incidence was highest in spring and lowest in fall (Figure 12). Chalkbrood is a fungal brood disease most prevalent in spring, as it thrives in cool, moist conditions. As colony populations strengthen and weather warms, most chalkbrood infections clear in the summer. It is not known why sacbrood was most prevalent in spring (18.1% of colonies infected), but it was a minor issue by September (1.3% of colonies infected).
Figure 12. Percent of colonies infected with brood diseases or insect pests in June and September 2018. From left to right in order of most to least common, are small hive beetle (SHB), sacbrood virus (SBV), chalkbrood (Chalk), deformed wing virus (DWV), European foulbrood (EFB), idiopathic brood disease syndrome (IBDS), wax moth, and American foulbrood (AFB).

**Sacbrood**
As with other viruses, sacbrood is managed through proper nutrition and sustaining strong colony populations. In the early stages of infection, bees can prevent a major outbreak by removing diseased larvae through hygienic behavior. If a colony experiences a larger outbreak (with at least 5% of brood cells visibly infected), the beekeeper should discard brood frames that contain many infected cells and requeen the colony, ideally with hygienic stock.

**Chalkbrood**
Chalkbrood is not regarded as a highly detrimental disease as infections usually clear up in the summer as the temperature rises. If infections do not clear up on their own, requeening (ideally with hygienic stock) may help a colony overcome the infection. If more than 10–20% of brood cells on a single frame are infected, beekeepers should remove those frames and replace them with frames of drawn comb or foundation.

**American foulbrood**
American foulbrood (AFB) is the most contagious and destructive bacterial disease that honey bees can contract. The Tech Team discovered eight AFB-infected colonies across the five sampling periods, including colonies in 2018. Visual diagnosis was verified through an AFB Vita test kit and a follow-up inspection by a NYS Bee Inspector. It was surprising to learn the infection detected in September 2018 was resistant to oxytetracycline (i.e., Terramycin). According to the former NYS Apiculturist Paul Cappy, 17 colonies were infected with resistant American foulbrood infections in 2018, but before 2018, oxytetracycline-resistance...
had not been detected since about 2010. Prolonged use of antibiotics may favor the emergence of resistant AFB strains.

Because prophylactic use of antibiotics is now discouraged, and because antibiotics can only be obtained through a veterinary prescription, it is critical that all beekeepers stay vigilant about inspecting and testing their colonies. They should conduct three careful AFB inspections of every colony each year. Beekeepers must familiarize themselves with proper inspection techniques and learn how to recognize early symptoms of infection. It is the law in NYS to report all infected colonies to the state apiculturist.

**European foulbrood**

European foulbrood (EFB) is another destructive brood disease. The Tech Team observed 27 colonies with EFB across the five sampling periods, including fourteen colonies in June 2018 and two colonies in September 2018. In some cases, European foulbrood can be difficult to differentiate from other brood diseases. In ambiguous cases, diagnosis can be made by using an EFB Vita test kit or by sending a sample to the USDA Beltsville Bee Lab for a free analysis.

**Idiopathic brood disease syndrome**

Foulbrood diseases and parasitic mite syndrome can be confused for idiopathic brood disease syndrome (IBDS, also called crud brood or snotty brood). With this syndrome, unhealthy larvae appear “melted” into the bottom of a cell, though the liquefied larvae do not rope out. Although it closely mimics parasitic mite syndrome in appearance, this brood disease is present when there is no evidence of mites in the cells and colony mite levels are low. The causes of IBDS are not yet known, though a variety of viruses may partially contribute. While this syndrome is uncommon, the Tech Team did observe it in colonies across all five sampling periods. IBDS was found in 2.4% of colonies in 2018.

**Small hive beetles and wax moths**

Small hive beetles and wax moths are common insect pests in honey bee colonies in New York State. Both are opportunistic pests that typically exploit weakly populated colonies. To prevent infestation, beekeepers should maintain healthy colonies with strong populations and only super colonies when the colony population dictates. Neither pest kills colonies in New York. The prevalence of small hive beetles was at its highest in September 2018, when 15.4% of colonies were infested. The impacts of hive beetle infestation is most often observed when honey supers are not promptly extracted. The Tech Team encourages beekeepers to use beetle traps, Swiffer® pads, or Brawny-Max Towels® to control beetles, and discourages the use of Checkmite+™ and pymethrin soil drenches, as these pesticides can negatively impact bee health. Chemical treatments for small hive beetle are sometimes necessary in warmer regions where beetles can reproduce year-round. In more temperate regions with a cold winter, like New York, chemical treatments for small hive beetle should be used only as a last resort.

**Deformed wings**

Deformed wings were visually observed in 11.3% of colonies in Sept 2018. Deformed wing virus is the main virus vectored by Varroa mites, so its symptomatic prevalence reflects Varroa loads. The presence of deformed wings suggests that mite levels are high and should immediately prompt the beekeeper to monitor mites and apply a treatment if needed.
Conclusions

The NYS Beekeeper Tech Team works with beekeepers to improve colony health outcomes by inspecting a sample of their colonies twice a year and by reporting Varroa, Nosema, and pesticide levels for those same colonies. The Tech Team also helps beekeepers interpret their colony health reports and develop research-based management strategies that respond to their individual needs and production goals.

NYS beekeepers enrolled in the Tech Team program continue to generate most of their revenue through honey production, followed by pollination services, and nuc and queen production. Less honey, and fewer pounds of honey per colony, was produced in 2018 compared to 2017, which could either reflect environmental or management changes. Beekeepers who wish to continue learning about the management and business aspects of beekeeping are encouraged to visit the resources on the Cornell Pollinator Network webpage, www.pollinator.cals.cornell.edu.

2018 marks the third year of operation for the NYS Beekeeper Tech Team, and most beekeepers (78.8%) included in this report have been enrolled since its inception. By providing beekeepers with three years of colony sampling and recommendations to improve management practices, the Tech Team has observed measurable improvements in Varroa management with regards to monitoring, using cultural methods, and treating when mites reach or exceed the treatment threshold. It is likely that more rigorous Varroa management by these beekeepers has led to the improved colony health outcomes documented this year:

1. Significantly fewer colonies had mites at levels that required treatments in September 2018 compared to September 2016.

2. The prevalence of PMS significantly decreased over time, from 21.3% of all colonies in 2016 to 5.7% of colonies in 2018.

3. Beekeepers lost 10% fewer colonies in 2017/2018 than they did in 2016/2017. Nosema and bacterial and fungal pathogens appeared to be of low concern in colonies in 2018. We anticipate beekeepers in the Tech Team program will continue to refine their colony health management practices and, as a result, continue to see lower colony losses related to Varroa issues in future years.

4. Beekeepers who monitor and treat more frequently are better at controlling Varroa (P<0.001), but excessive treatments may harm colonies. Beekeepers should apply treatments only when thresholds indicate to avoid unnecessary applications that may negatively impact colony health.

Beekeepers can find additional management resources, including a detailed guide for developing an Integrated Pest Management (IPM) plan to control Varroa mites, online at the Cornell Pollinator Network webpage.
References


