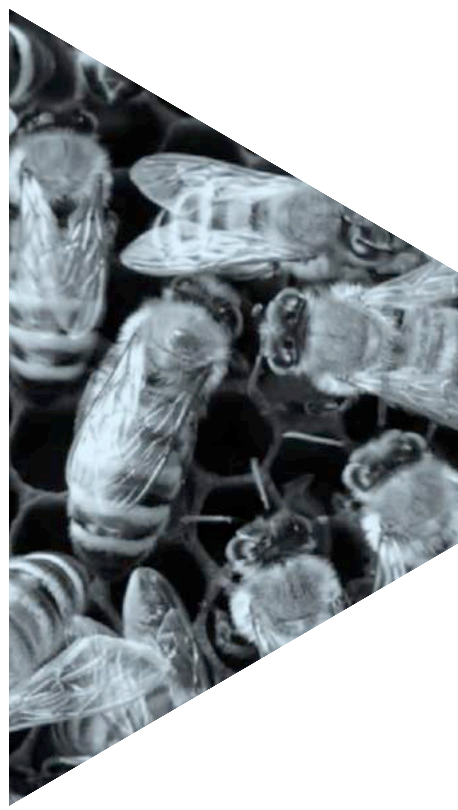
2016
NYS BEEKEEPER TECH TEAM REPORT



TECH TEAM MISSION

- improve honey bee health
- reduce colony losses
- improve the profitability of the beekeeping industry

March 2017

Cornell University
College of Agriculture and Life Sciences

NEW YORK STATE OF OPPORTUNITY. | Agriculture and Markets

2016 NYS Beekeeper Tech Team Reports

March 29, 2017

NYS Beekeeper Tech Team

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New York State Beekeeper Tech Team

In response to growing concern about pollinator declines across the state, the New York State (NYS) Pollinator Protection Plan announced the development of the NYS Beekeeper Tech Team in 2016. The Tech Team is an interdisciplinary group of professionals that works directly with beekeepers to improve honey bee health, reduce colony losses and increase profitability of the beekeeping industry. The Tech Team transfers information, tools and resources to individual hobbyist, sideliner and commercial beekeepers. In 2016, the Tech Team members visited beekeepers' bee yards to gather data on parasite and pathogen levels, pesticide residues, colony losses, honey production, and management practices. The Tech Team synthesizes this data, then meets with participants to discuss results from their own colonies and share customized recommendations. Beekeepers can also receive a complete business analysis of their beekeeping operation. Funding for services provided by the NYS Beekeeper Tech Team comes from the NYS Environmental Protection Fund.

Emma Mullen

Emma Mullen is Senior Lead of the NYS Beekeeper Tech Team. She is also the Honey Bee Extension Associate at Cornell University. She received her Masters Degree from Western University, Canada, where she studied honey bee social behavior. She works with beekeepers in New York State to understand factors affecting honey bee health, with a focus on parasites, pathogens, pesticides, and management practices. She is particularly interested in communicating this research to beekeepers and working with them to improve colony health.

Mary Kate Wheeler

Mary Kate Wheeler is the Agricultural Economic Analyst of the NYS Beekeeper Tech Team. Mary Kate grew up in Ithaca, New York. After earning her BA in Environmental Studies from Bowdoin College, she worked as an outdoor educator and vegetable farmer in the Pacific Northwest for several years. The experience of managing a small farm business led her back to Ithaca for a MS degree in Applied Economics at Cornell. She is passionate about helping farmers to achieve their goals and build businesses that are financially and ecologically sound.

Paul Cappy

As the NYS Apiculturist, Paul Cappy represents the Department of Agriculture and Markets on the Tech Team. Paul has 54 years of beekeeping experience, which informs his strong familiarity with the NYS beekeeping industry. He leads the Apiary Inspection Program, which i) improves honey bee health in NYS by inspecting and eradicating diseased colonies, ii) certifies colonies that cross state lines to control the spread of diseases, and iii) collects some new beekeeper contact information through the Honey Bee Health Program. He has initiated collaboration with the National Honey Bee Survey to evaluate parasite, pathogen, and pesticide prevalence in NYS and investigate ways to reduce the high annual colony losses.

Scott McArt

Scott McArt is an Assistant Professor of Pollinator Health at Cornell University and scientific advisor to the Tech Team. His research is focused on the impact of parasites, pathogens, and pesticides on honey bees and wild bees. He is particularly interested in scientific research that can inform management decisions by beekeepers, growers and the public.

Tech Team Services

In 2016 the Tech Team provided services to 30 beekeepers in Central, Western and Northern NY. Tech Team services include (i) monitoring colonies for parasites, pathogens and pesticides; (ii) customized reports for beekeepers that compare results from their operation to other operations in New York State; (iii) access to the annual Tech Team summary report; (iv) an in-person meeting to review the report and discuss individualized goals and recommendations; and (v) an optional beekeeping business analysis. Participation in the Tech Team program is completely voluntary and all information gathered from beekeepers is confidential. Beekeepers who receive Tech Team services are expected to participate in colony sampling, and to complete an annual survey that documents apiary characteristics and management practices. These services are fully funded by the NYS Environmental Protection Fund.

Beekeeper Advisory Board

The NYS Beekeeper Tech Team believes that beekeepers should be the individuals who decide the direction, goals, and sampling priorities of the Tech Team. Five NYS beekeepers have volunteered to comprise the initial advisory panel to guide immediate decisions for the 2017 sampling season. This initial advisory panel consists of Mark Berninghausen, Pat Bono, Chris Cripps, Chuck Kutik, Earl Villecco, and Dan Winters. The Tech Team appreciates having these beekeepers on board to provide them with advice and guidance while program decisions are made. Beekeepers present at the 2017 Empire State Honey Producers Association (ESHPA) summer picnic will vote for advisory panel representatives from July 2017-July 2018.

Acknowledgements

The 2016 sampling season could not have been accomplished without the cooperative help of the Bee Informed Partnership, Inc. Karen Rennich provided guidance in sampling design, survey construction, communication with beekeepers, and also helped sample colonies in person. Dan Wyns and Andrew Garavito also provided substantial assistance sampling colonies and communicating with beekeepers. Ashley Fersch and Katherine Urban-Mead from Cornell University provided additional colony sampling support. The University of Maryland diagnostics lab conducted laboratory analyses for parasites and pathogens. Eleanor Andrews created the record keeping sheets in Section 7. This pilot year of the NYS Beekeeper Tech Team could not have run as successfully without their help.

Executive Summary

- In aggregate, our 56 survey respondents reported harvesting a total of 1.2 million pounds of honey from about 19,000 colonies in 2016, with an average yield of 64 pounds per colony. Comparing these numbers to USDA data from 2015 suggests that the beekeepers in our sample may account for about a third of statewide honey production.

- NYS beekeepers report income from a wide range of apiary products. Unsurprisingly, honey is the most common product sold by operations of all sizes. Commercial beekeepers are more likely to earn income from crop pollination, while sideliners are more likely to sell queens and nucs.

- Winter and summer losses affect beekeeping operations of all sizes. Maximum winter loss rates reported by individual beekeepers reached 57% for commercial operations, 64% for sideliners, and up to 100% for hobbyists. Although summer losses were typically smaller than winter losses, they were significant for some operations.

- *Varroa* mites are extremely common in NYS and were not well controlled in fall 2016. Ninety percent of colonies sampled had mites, and 78% of operations had one or more colonies that exceeded the economic threshold for *Varroa*.

- Viruses were also prevalent in honey bee colonies in NYS. All 208 colonies tested had at least 1 virus present. The most common virus was Deformed Wing Virus (DWV), which we found in 96% of the colonies and 100% of the operations that we sampled. DWV is transmitted by *Varroa* mites, and DWV levels were positively correlated with mite levels. Currently, the only method to control virus levels is by maintaining low mite levels.

- *Varroa* monitoring is not a common practice among beekeepers in NYS, as only 36% of beekeepers reporting monitoring for mites in 2016 using a quantitative method: 14% used a powdered sugar shake, 14% used an alcohol wash, and 7% used an ether roll. Beekeepers who had high *Varroa* mite levels, or who experienced high summer losses, were more likely to monitor for *Varroa*.

- Twenty-seven percent of operations in our sample did not apply any chemical treatments for *Varroa* in 2016. A majority of beekeepers (57.1%) used only natural chemicals (thymol, formic acid or oxalic acid) to treat for *Varroa*, while just a few (5%) used only synthetic chemicals (Apivar© or Apistan©). The remaining 11% of operations used both natural and synthetic chemicals as part of their *Varroa* treatment strategy

- Beekeepers that used both natural and synthetic treatments treated significantly more frequently (5 times per year, on average) compared to operations that used only natural or only synthetic treatments (2 times per year, on average).

- Beekeepers who used at least one natural chemical treatment and at least one synthetic chemical treatment as part of their annual *Varroa* management strategy had colonies with lower *Varroa* levels going into the winter, compared to beekeepers who use only natural chemicals and those who use no chemical treatments whatsoever. Moreover, this was the only treatment group with average *Varroa* levels that did not exceed the economic threshold of 3 mites per 100 bees.

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Introduction

Pollinators are integral to food production in New York State (NYS). Pollination services to a variety of specialty crops contribute $500 million annually to the state's agricultural economy[1]. In addition, NYS beekeepers produced 3.6 million pounds of honey in 2015, making NYS the top honey producing state in the northeast and 10th in the nation[2]. Despite growing demand for crop pollination, NYS beekeepers are experiencing unsustainable colony losses. These losses totaled 54% in 2014, exceeding the national average (42%)[3]. Rising concerns about pollinator declines and the consequences for agriculture motivated the development of a NYS Pollinator Protection Plan in 2016. However, the status of honey bee health and management practices in NYS have not been systematically assessed. Such assessment is a critical first step towards providing tools and recommendations to NYS beekeepers to improve honey bee health.

Multiple stressors are known to impair honey bee health, including forage quality and diet [4,5], agricultural chemicals[6-10], parasites and pathogens[11-16], and suboptimal management practices[14,17]. Despite growing concern about parasite and virus levels in colonies across NYS, current apiary inspection data is only collected from a subset of commercial operations, with little known about their prevalence among sideliners and hobbyists, who comprise 96% of the state's beekeepers[18]. This is important since honey bees in NYS are susceptible to a variety of parasites and pathogens, and considerable evidence shows parasites and pathogens are a leading factor contributing to declines in honey bee health. Of these, the *Varroa* mite is the most detrimental and widespread. *Varroa* mites feed on the blood and fat bodies of bees and transmit several viruses. A second parasite, *Nosema*, is also prevalent in New York and infects the honey bee gut. A recent survey found 97% of *Nosema* detected in New York is a recently introduced species more virulent than the historical species[19]. Colony losses attributed to these parasites translate into decreased honey production and a reduction in the stability of pollination services to the state's most important crops.

The complexity of factors that influence the health and productivity of honey bee colonies presents a significant management challenge to beekeepers, regardless of scale. Responding to this challenge requires a proactive and nuanced approach based on accurate data and proven management practices. Access to information about colony health and performance, can guide and improve beekeeper management decisions. Moreover, beekeepers must select management practices that are both scientifically valid and appropriate to the objectives and scale of their individual operation.

In 2016, the NYS Beekeeper Tech Team developed a program that documents parasite and pathogen levels, pesticide residues, and management practices among hobbyists, sideliners and commercial beekeepers across the state. Findings will allow beekeepers to assess their own performance relative to similar operations. Recommendations based on these results can inform production decisions and support proactive planning for improved pest and disease management. Sharing this information with beekeepers is critical to mitigating colony losses and enhancing the stability and profitability of the NYS beekeeping industry. The main objectives of this report are to **(1)** ***present results from the Tech Team research that investigates parasite, pathogen and pesticide levels and beekeeper management practices***, and **(2)** ***share insights from the research, alongside practical tools, resources and recommendations, to support decision making for improved management and colony health.***

Research Methods

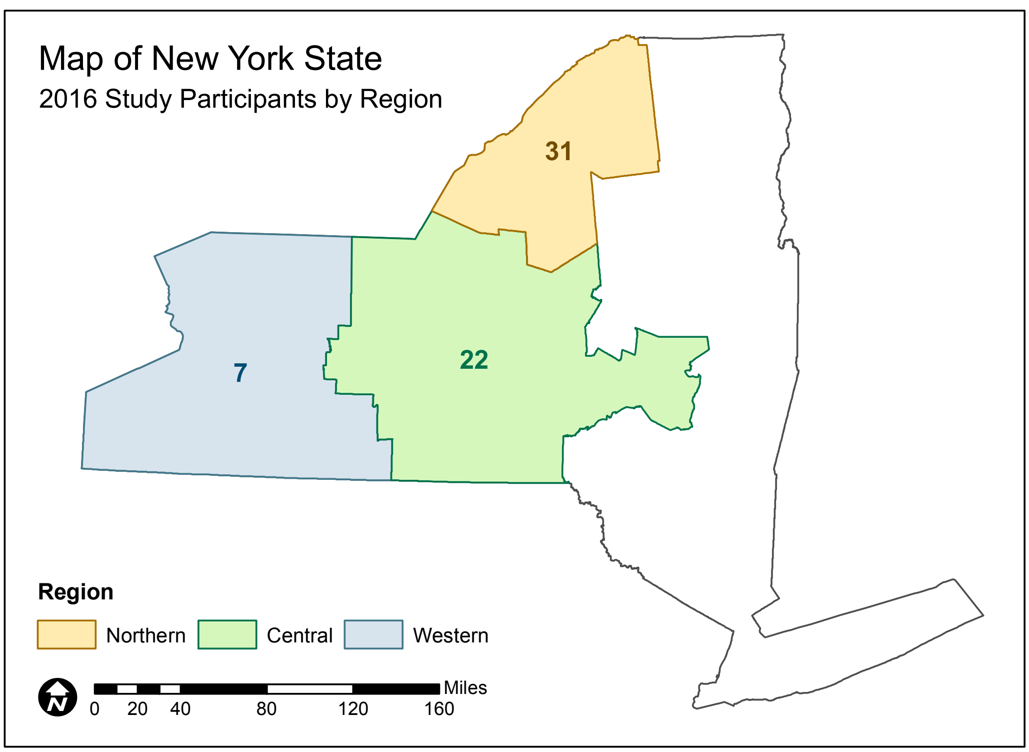
Contacting Beekeepers

Participants in the 2016 Tech Team program were enlisted on a first-come, first-served basis. Calls for participants were put out through beekeeping clubs in NYS, the ESHPA summer picnic, the Cornell Pollinator Network website (http://pollinator.cals.cornell.edu/), the Northern New York Beekeeping Directory, and a list of beekeeper contact information maintained by Cornell University. Through these avenues, 30 beekeepers were enrolled in the Tech Team program. An additional 30 beekeepers were enrolled in a research project to collect similar data. Information in this report presents and analyzes data from 60 beekeepers from both programs.

Sampling Honey Bee Colonies

In September 2016, we sampled a total of 309 honey bee colonies distributed over 70 apiaries belonging to the 60 participating beekeepers. The sample included 31 hobbyists (1 - 49 colonies), 13 sideliners (50 - 499 colonies), and 16 commercial beekeepers (500 colonies or more). The number of colonies sampled per operation varied according to the operations size. We sampled one colony from each hobbyist, many of whom managed only a single colony. We sampled multiple colonies from sideliner and commercial operations in order to better understand the trends within these larger operations. On average, we sampled 6.5 colonies from each sideliner (84 total colonies) and 12.1 colonies from each commercial beekeeper (194 total colonies). Adult honey bees from the brood nests were sampled for *Varroa* mites in all 309 colonies, while 208 of the colonies were also tested for Nosema and 8 different viruses. Wax samples from the brood nest were sampled for pesticide residues in 208 colonies.

Figure 1. Number of participating beekeepers by region.



The 31 beekeepers in Northern New York made up the majority of participants in our sample (51.7%), followed by 22 beekeepers in Central New York (36.7%) and 7 in Western New York (11.7%) (Figure 1). However, beekeeping operations in Northern New York tended to be smaller (104 colonies per operation), on average, compared to respondents in Central New York (719 colonies per operation) and Western New York (1030 colonies per operation). As a result, although a majority of the survey participants are concentrated in the Northern Region, the total colonies managed by beekeepers in the sample are concentrated in the Central Region. Of the 23,682 total colonies managed by survey respondents in September of 2016, we estimate about 61% are in Central New York, 26% in Western New York and 13% in Northern New York.

Determining Varroa Levels

Approximately 300 to 400 bees from the brood nest of each colony were collected in a saline solution and shipped to the University of Maryland Honey Bee Lab in College Park, MD for processing. At the lab, the samples were shaken and washed to dislodge *Varroa* mites from the bees' bodies. The total number of bees and mites were recorded and translated into a ratio of 'mites per 100 bees' as an indicator of infestation severity.

Determining Virus and Nosema Levels

Fifty bees were collected from the brood nest of each colony and frozen on dry ice. Samples were shipped to the University of Maryland Honey Bee Lab in College Park, MD for processing. RNA was extracted from all bees and quantitative PCR was performed to measure *Nosema ceranae* levels, as well as viral loads for deformed wing virus, acute bee paralysis virus, black queen cell virus, chronic bee paralysis virus, Israeli acute paralysis virus, Lake Sinai virus 2, Kashmir bee virus, and slow bee paralysis virus.

Determining Pesticide Levels

Three grams of the oldest available wax was collected from the brood nest. Unlike pollen, which provides a snapshot of pesticide exposure over a short period of time, wax contains pesticides that have accumulated over many years and provides a more comprehensive view of the colony's exposure. Pesticides will be analyzed in the Cornell Pesticide Residue Analysis Facility to quantify levels of herbicides, insecticides, fungicides, and miticides. Results from the pesticide analysis will be communicated to beekeepers as soon as they are available, later this spring.

Beekeeper Management Survey

A comprehensive survey, including questions on beekeeper characteristics, parasite monitoring practices, parasite treatment history, and colony health concerns, was conducted. This survey was approved by the Cornell Institutional Review Board, and was mailed out to each of the participating beekeepers in August 2016. From our total sample of 60 beekeepers, we received 56 completed surveys, resulting in a 93% response rate.

Industry Overview

This section summarizes key variables of economic importance to the beekeeping industry in NYS. These findings offer a descriptive snapshot of the 56 beekeeping operations that completed our management survey, with regards to colony losses, pollination services, apiary products and honey yields. By highlighting NYS industry averages, these results allow individual operators to compare their own production statistics with statewide trends. Moreover, this section presents average values for hobbyists, sideliners and commercial beekeepers to explore whether these indicators vary by operation scale.

Colony Losses

Colony loss rates are useful as a general indicator of honey bee health, with direct implications for the economic health and profitability of individual beekeeping operations. Our team calculated winter and summer loss rates for each operation[20]. Winter losses reflect the percent of colonies that died between October 2015 and April 2016, while summer losses are defined as the percent of colonies that died from April 2016 to September 2016.

Across our entire sample, beekeepers lost 28% of their colonies during the winter season and 7% of their colonies during the summer season, on average. However, almost a quarter of survey participants registered winter losses of 50% or more, while a small group (9%) lost 30% or more of their colonies during the summer season.

Winter and summer losses affect beekeeping operations of all sizes. Maximum winter loss rates reported by individual beekeepers reached 57% for commercial operations, 64% for sideliners, and 100% for hobbyists. Although summer losses were typically smaller than winter losses, they were significant for some operations. Maximum summer colony losses reached 50% for hobbyists, 34% for sideliners and 54% for commercial beekeepers. Figure 2 shows average losses for each of the three groups. Although hobbyists have a higher average winter loss rate, and commercial beekeepers have a higher average summer loss rate, none of the differences among the three groups is statistically significant. For all groups, average annual losses exceed the 17% threshold that most beekeepers consider to be economically sustainable[3].

Figure 2. Average colony loss rates (mean ± S.E.) by season and operation size.

Pollination Services

Commercial pollination services represent an important source of revenue, particularly for larger beekeeping operations in the state. While some hobbyists reported using their colonies for pollination on their own property, about a quarter of sideliners and more than three quarters of commercial beekeepers provided pollination services for agricultural businesses (Figure 3). The role of sideliners and commercial beekeepers is particularly important for apple production in NYS. NYS beekeepers also provide pollination services for a diverse range of crops within New York and in at least nine other states.

Figure 3. Commercial pollination services by operation size and by crop.

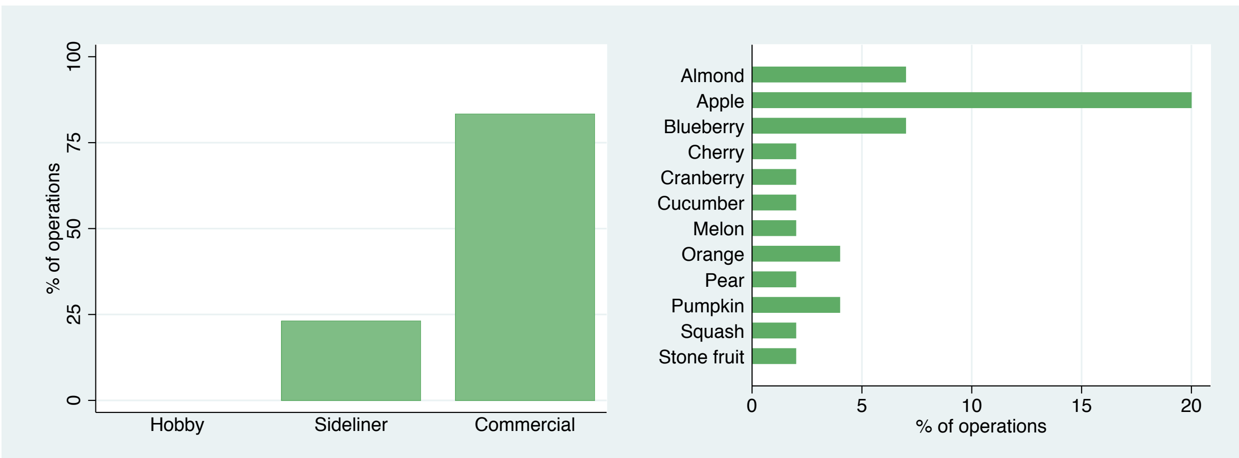


Figure 4. Apiary products by operation size.

Apiary Products

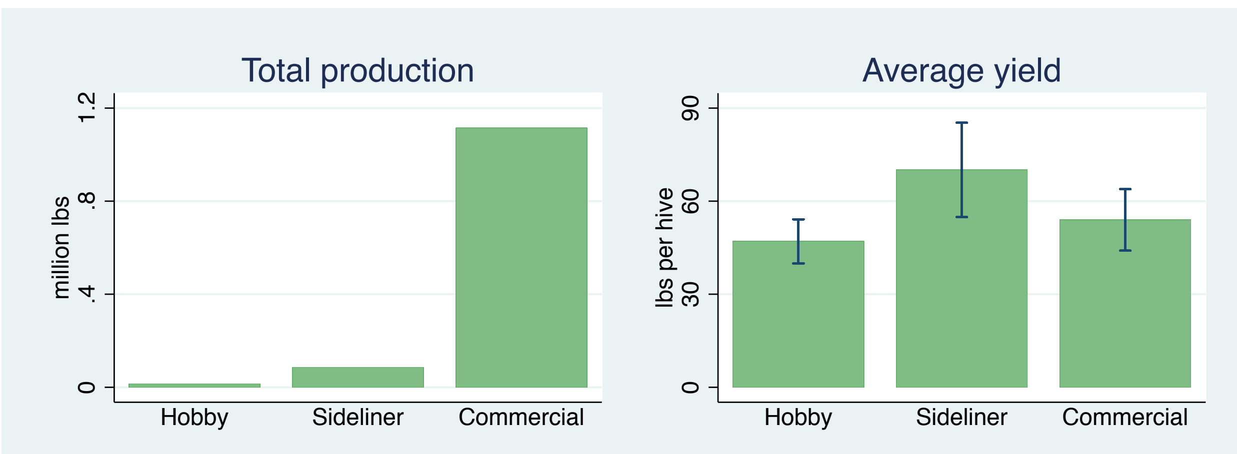
New York State beekeepers report income from a wide range of apiary products. Unsurprisingly, honey is the most prevalent, as most hobbyists and all sideliner and commercial beekeepers report honey sales. A majority of sideliners and commercial operators also sell beeswax and wax products. Propolis and pollen sales are less common. About half of sideliners and commercial beekeepers sell propolis, and only about a quarter report pollen sales. Commercial beekeepers are more likely to earn income from pollination activities, while sideliners are more likely to sell queens and nucs. Figure 4 shows the percentage of hobbyists, sideliners and commercial beekeepers that sold each product in 2016.

Honey Yields

Honey yield data provide a measure of productivity for one of New York State's most important apiary products. According to the National Agricultural Statistics Service of the USDA, in 2015 New York State beekeepers with 5 or more colonies harvested 3.6 million pounds of honey from 58,000 colonies, resulting in an average yield of 62 pounds per colony. As a result, New York earned a place on the list of the nation's top ten honey producing states in 2015.

The data presented here reflects honey harvested by producers in our sample between May and September of 2016. In aggregate, our 56 survey respondents reported harvesting a total of 1,214,372 pounds of honey from about 19,000 colonies, with an average yield of 64 pounds per colony. Comparing these numbers to USDA data from 2015 suggests that the beekeepers in our sample may account for about a third of statewide honey production.

Figure 5. Aggregate honey production and average yield (mean ± S.E.) by operation size.



Commercial operators account for the vast majority of the total honey volume reported by the survey respondents (Figure 5). Hobbyists, who make up more than half of the sample, account for just 1% of total honey production. Sideliners make up 23% of survey respondents and account for 7% of total honey production, while commercial beekeepers comprise 21% of the sample, but produce 92% of the honey. Honey yields are similar across the three categories, however, with hobbyists reporting average yields of 47 pounds per colony, compared to 70 pounds per colony for sideliners and 53 pounds per colony for commercial operations. ***Differences in honey yield across categories are not statistically significant*** due to the considerable variation among the yields of individual operations within each category.

Pests and Diseases

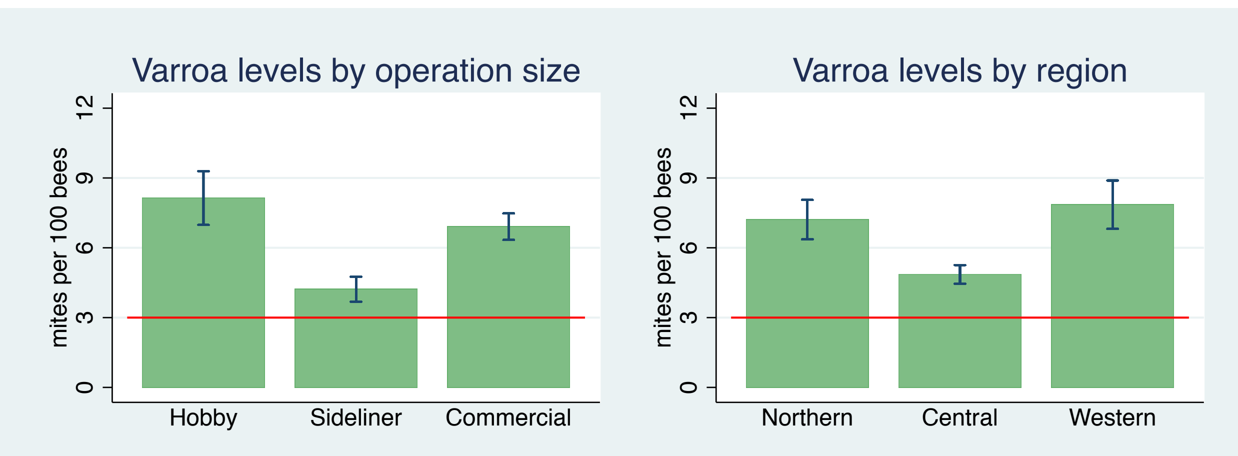
This section presents pest and disease levels from September 2016, including levels of *Varroa*, eight different viruses, and *Nosema*, for all 60 beekeepers in the sample. Due to the high prevalence of *Varroa* and the critical threat it poses to colony health for beekeepers in New York State, this section also evaluates *Varroa* monitoring and treatment strategies based on data from 56 beekeepers who completed the management survey. In addition, this section documents the prevalence of four additional pest and disease symptoms reported by beekeepers in the survey.

Varroa Prevalence and Intensity

Varroa mites were extremely common in NYS colonies in the month of September. Of the 309 colonies sampled, 277 colonies (90%) contained *Varroa* mites, and 192 colonies (62%) exceeded the economic threshold of three mites per 100 bees. Fifty-nine out of the 60 operations in our sample (98%) had at least one colony with *Varroa* mites, while 47 out of 60 had one or more colonies with *Varroa* levels above the economic threshold (78%).

On average, *Varroa* levels were lower in sideliners' colonies compared to hobbyists' colonies (*p*=0.027) and commercial colonies (*p*=0.012). Yet mite levels in commercial colonies were not significantly different from levels in colonies belonging to hobbyists (Figure 6). Moreover, *Varroa* levels were lower for colonies in Central New York, on average, compared to colonies in Northern New York (*p*=0.040) and colonies in Western New York (*p*=0.010). There was no significant difference in *Varroa* levels between the Western and Northern regions (Figure 6).

Figure 6. Average Varroa mite levels (mean S.E.) by operation size and by region.
Red line shows economic threshold of 3 mites per 100 bees.

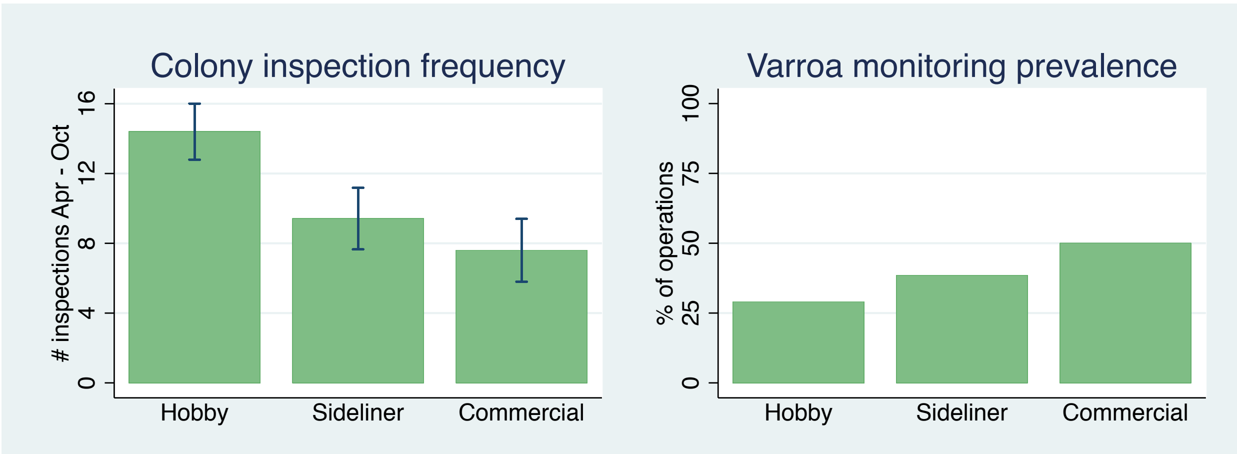


Varroa Monitoring

Although the vast majority of beekeepers in our sample (91%) reported conducting regular colony inspections during the active beekeeping season, only 36% monitored for *Varroa* using one of three reliable methods: powdered sugar roll, alcohol wash or ether roll. Hobbyists inspected their colonies more frequently than commercial beekeepers (*p*=0.06), but hobbyists were the least likely to monitor for *Varroa* (Figure 7). Only 29% of hobbyists reported monitoring for *Varroa* in 2016, compared to 38% of sideliners and 50% of commercial beekeepers.

Controlling for beekeeper experience, operation size and regional location, we find that the likelihood of monitoring for *Varroa* is positively associated with measured *Varroa* levels and summer colony losses. In other words, ***beekeepers who have high* Varroa *mite levels, or who experience high summer losses, are more likely to monitor for* Varroa.** These findings suggest that beekeepers tend to implement *Varroa* monitoring as a reactive management practice when they suspect a colony health problem.

Figure 7. Inspection frequency (mean ± S.E.) and *Varroa* monitoring rates (%) by operation size.



Varroa Prevention and Treatment

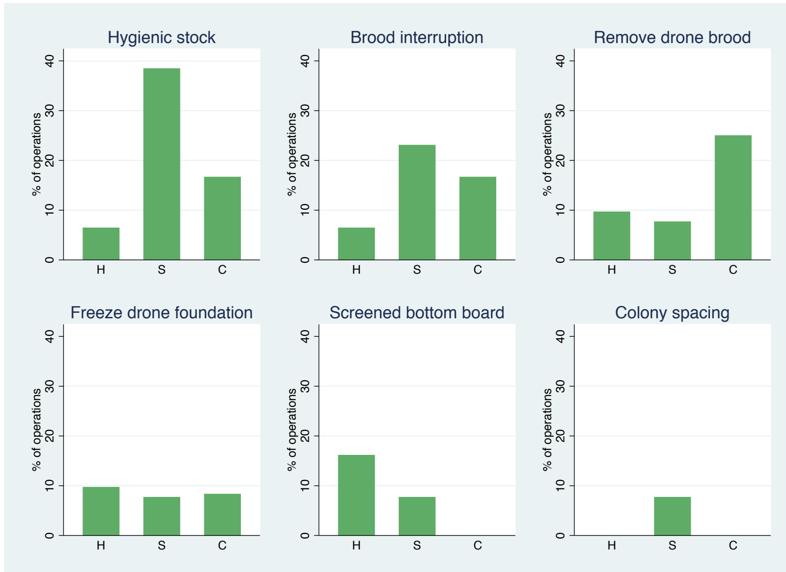
Genetic and Cultural Management Practices

Genetic and cultural management practices include a range of biological and physical strategies that beekeepers use to control *Varroa* mite populations. Genetic and cultural management techniques are essential for reducing *Varroa* pressure in operations that choose not to use any chemicals, yet many beekeepers choose to use these practices in conjunction with chemical treatments.

Across our entire sample, 38% of beekeepers report using one or more genetic or cultural methods. The prevalence of such practices increases with operation size. Just 29% of hobbyists report using genetic or cultural management for *Varroa*, compared to 46% of sideliners and 50% of commercial beekeepers. Most of the operations that use genetic or cultural management practices (71%) also use chemical treatments. Nine out of the 56 beekeepers who responded to our survey reported using no genetic, cultural or chemical management practices for *Varroa*; all nine of them were hobbyists.

Figure 8 shows the prevalence of six specific genetic and cultural management practices for hobbyists (H), sideliners (S), and commercial (C) beekeepers (see pages 36-37 for a description of theses practices). Adopting a screened bottom board was the most popular strategy among hobbyists, although only 16% of hobbyists adopted it in 2016. Selecting a hygienic stock was the most common strategy among sideliners (39% adoption rate), followed by brood interruption (23%). Among commercial beekeepers, removing drone brood was the most prevalent cultural practice (25%), followed by brood interruption (17%) and using hygienic stock (17%).

Figure 8. Prevalence of Varroa cultural management practices by operation size.



Chemical Treatments

Participants in our study reported a total of five different chemical treatments used to combat Varroa mites, which can be grouped into three categories: organic acids, essential oils and synthetic compounds. Across the entire sample, organic acids are the most common chemical treatment type, as 43% of respondents used oxalic acid in 2016, while 30% used formic acid. Synthetic compounds and essential oils are used infrequently. Among synthetic treatment options, 11% of respondents reported using amitraz (Apivar©), while only 3% used fluvalinate (Apistan©). Just 7% of the sample (4 operations) used thymol (Apiguard©), an essential oil. Despite the high prevalence and intensity of *Varroa* across our sample, fully 27% of survey respondents reported using no chemical treatments in 2016.

In Figure 9 we group *Varroa* treatments into four categories to compare treatment approaches across operations of different sizes. The "natural" treatment category includes operations that used organic acids (oxalic and formic) and/or essential oils (thymol), but no synthetic chemical treatments (159 colony samples from 32 operations).[a] The "synthetic" treatment category includes operations that used Apistan© and/or Apivar©, but no organic acids or essential oils (25 colony samples from 3 operations). The "both" category includes operations that used one or more natural treatments and one or more synthetic treatments (53 colony samples from 6 operations), while the "none" category includes only those operations that used no chemical treatments whatsoever (24 colony samples from 15 operations).[b]

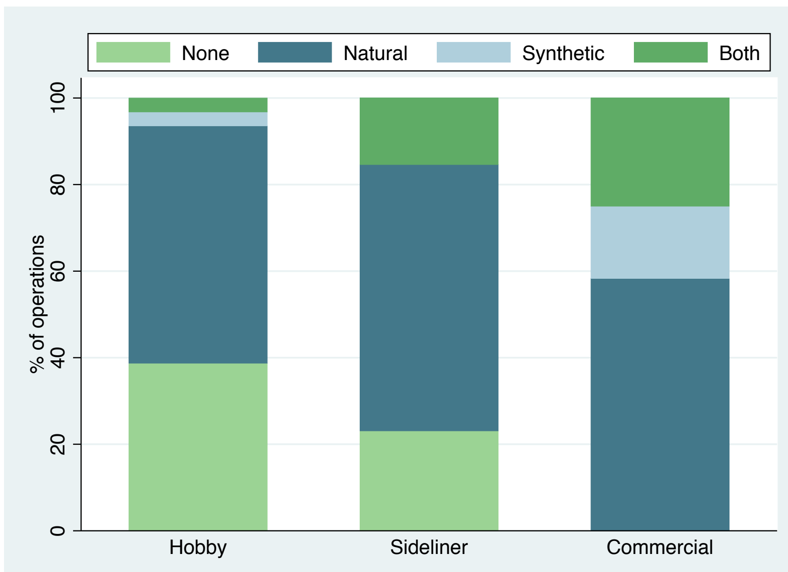
Results show that the natural treatment approach is popular among operations of all sizes, as more than half of hobbyists, sideliners and commercial operators, respectively, report using only natural chemicals (organic acids and/or essential oils) to control *Varroa*. The treatment-free

[a] Within this group, one operation used essential oils only, one operation used essential oils and organic acids, and the remaining 30 operations used organic acids only.
[b] A total of 261 colony samples from 56 operations are used to analyze associations between *Varroa* levels and treatment approaches because we lack treatment information from the remaining 4 operations (48 colony samples).

approach, which rejects both natural and synthetic chemicals, is popular among hobbyists, yet it becomes less prevalent as operation scale increases. About 40% of hobbyists and 20% of sideliners report using no chemical treatments, but none of the commercial beekeepers use this strategy. A surprisingly high number (29%) of hobbyists report using no genetic, cultural or chemical *Varroa* management strategies whatsoever.

On the other hand, the use of synthetic compounds becomes more prevalent as the size of the operation increases. Just 3% of hobbyists report using a synthetic treatment approach, compared to 17% of commercial operations. The trend is similar for the approach that combines natural and synthetic chemicals: 3% of hobbyists report using this strategy, compared to 15% of sideliners and 25% of commercial beekeepers. Fully 42% of commercial beekeepers use synthetic chemicals as part of their *Varroa* control strategy.

Figure 9. Prevalence of four different chemical treatment approaches by operation size.

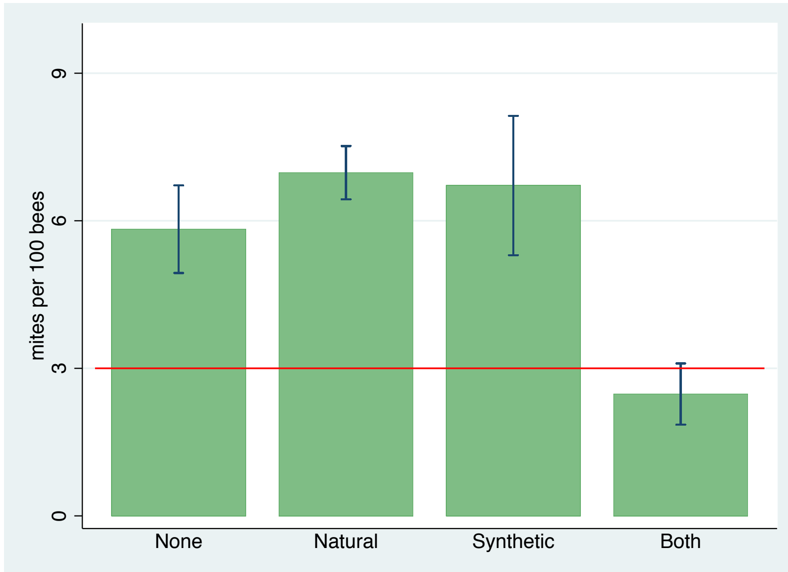


Varroa Levels by Treatment Strategy

Using the same treatment categories described above, Figure 10 presents average *Varroa* mite levels for operations using no chemical treatments, only natural treatments, only synthetic treatments, and both natural and synthetic treatments. There was no evidence of any significant difference in mite levels among the "none," "natural" and "synthetic" treatment categories. All three of these categories had average *Varroa* levels that were significantly greater than the economic threshold of three mites per 100 bees (p<0.01).

However, colonies belonging to operations that used both natural and synthetic treatments had fewer mites, on average, compared to colonies from operations that used natural treatments only (p<0.001) or synthetic treatments only (p=0.034). This was the only treatment group with a mean *Varroa* level that did not exceed the economic threshold of three mites per 100 bees. These results suggest that ***beekeepers who use at least one natural treatment and at least one synthetic treatment as part of their annual*** **Varroa** ***management strategy have colonies with lower*** **Varroa** ***levels going into the winter***.

Figure 10. Varroa levels (mean ± S.E.) by chemical treatment approach.
Red line shows economic threshold of 3 mites per 100 bees.



Beekeepers who reported using both natural and synthetic chemical treatments treated their colonies significantly more frequently (5 times per year, on average) compared to operations that used only natural chemicals or only synthetic chemicals (2 times per year, on average). We observed a high degree of variation in mite levels for all treatment frequencies. However, due to the observational nature of our data, when it comes to *Varroa* levels we cannot isolate effects of treatment frequency from effects of treatment type. Experimental research that controls for initial mite levels, and for treatment timing, duration and application, is needed to evaluate the relative effects of treatment type and treatment frequency on *Varroa* mite levels.

Prevalence and Intensity of Viruses

We tested each of the 208 colonies in our sample for eight different viruses. Every colony sampled had at least one virus present. The most common virus was deformed wing virus (DWV), which we found in 96% of the colonies and 100% of the operations that we sampled. Black queen cell virus (BQCV) was present in 86% of colonies and in 86% of operations, while acute bee paralysis virus (ABPV) was found in 52% of colonies across 68% of operations. Fifteen percent of colonies and 25% of operations were affected by Lake Sinai virus 2 (LSV-2). Chronic bee paralysis virus (CBPV) was present in 10% of colonies and 12% of operations, while Israeli acute paralysis virus (IAPV) was found in 10% of colonies and 11% of operations. Just 3 colonies in one operation tested positive for Kashmir bee virus (KBV). Slow bee paralysis virus (SBPV) was not present in any of the colonies in our sample, and is currently not thought to be in the U.S.

Because *Varroa* mites are known to vector several viruses, we test whether virus levels increase as *Varroa* levels rise. Results indicate a positive relationship between *Varroa* levels and levels of both DWV (p<0.001) and ABPV (p=0.011), two of the three most prevalent viruses in the sample. Other studies have shown *Nosema* levels to be positively correlated with some viruses, although the mechanism underlying this relationship is unknown. In our sample, *Nosema* levels were positively associated with levels of CBPV (p=0.002) and BQCV (p=0.010).

Figure 11. Virus levels (mean ± S.E.) by operation size.
H = Hobbyist; S = Sideliner; C = Commercial

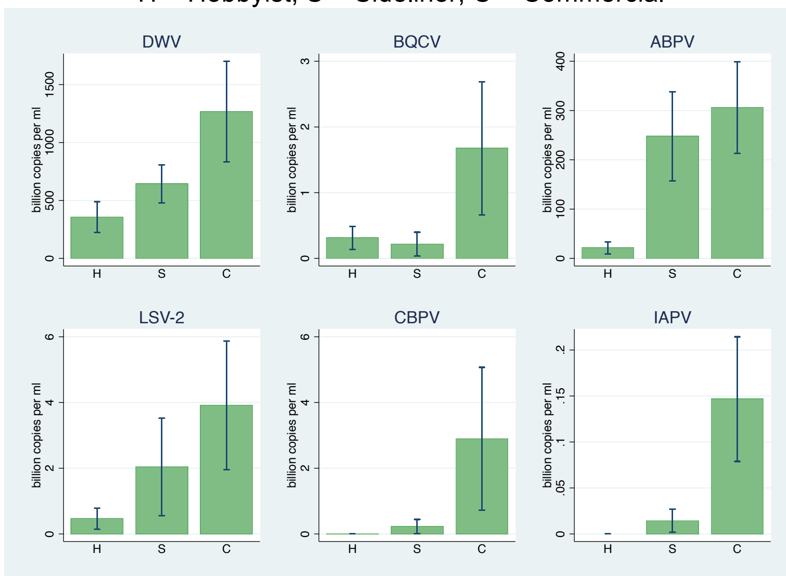


Figure 12. Virus levels (mean ± S.E.) by region.
N = Northern; C = Central; W = Western

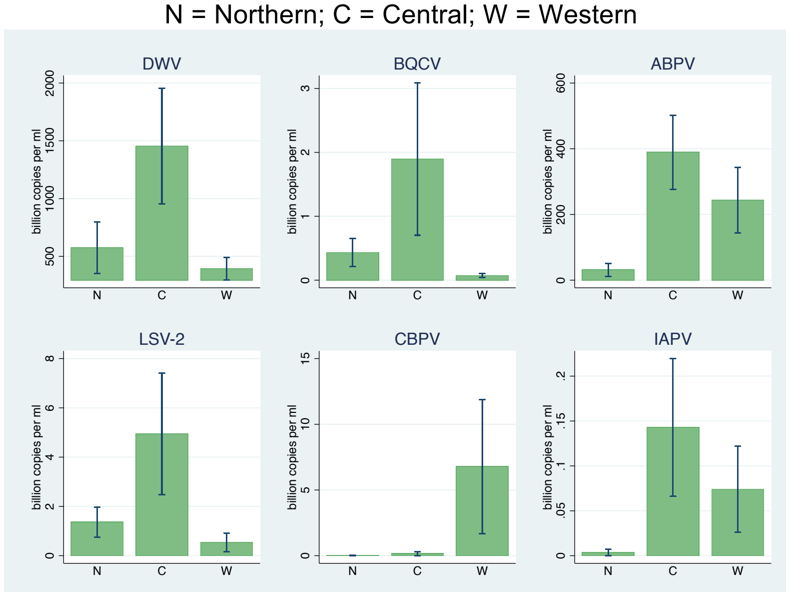
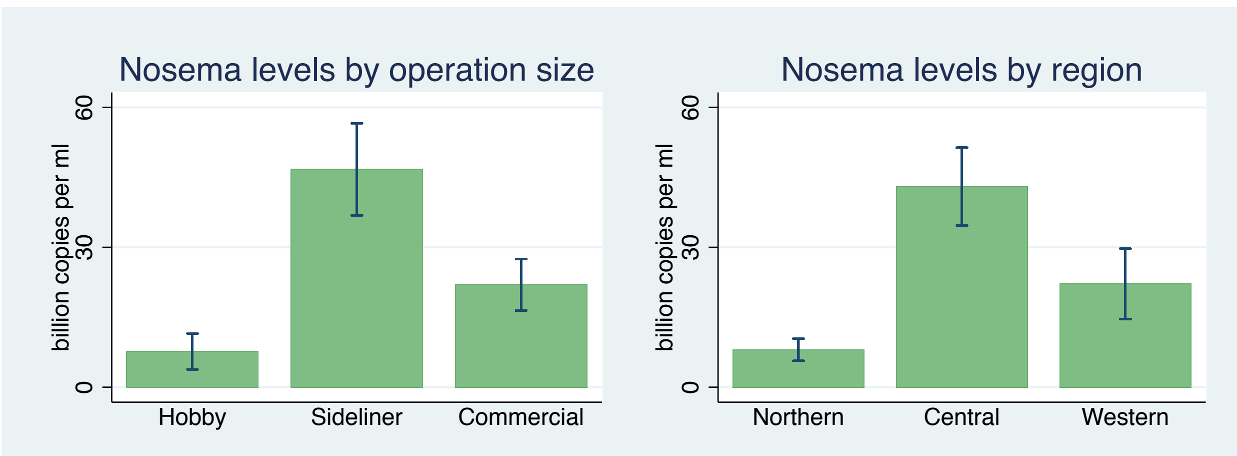


Figure 11 shows average virus levels for hobbyist (H), sideliner (S), and commercial (C) beekeepers (KBV and SBPV not shown). Commercial operations had the highest average levels for all six viruses; yet, for the most part, differences in virus levels across the three groups are not statistically significant. Colonies belonging to hobbyists had lower levels of ABPV compared to colonies belonging to sideliners or commercial beekeepers. Yet there were no significant differences in virus levels by operation size for any of the remaining viruses. We present average virus levels for operations in the Northern (N), Central (C) and Western (W) Regions in Figure 12. Colonies in the Central Region had higher ABPV levels, on average, compared to colonies in the Northern Region. None of the other differences in virus levels across the three regions were statistically significant.

Nosema Prevalence and Intensity

Nosema spores were present in 89 out of 208 colonies (43%), and 39 out of 60 operations (65%). Yet *Nosema* levels were above the economic threshold in just 6 colonies (3%) from 3 operations (5%), including two sideliners and one commercial beekeeper. Colonies managed by sideliners had significantly higher *Nosema* levels, on average, compared to colonies managed by hobbyists (p=0.014) or by commercial beekeepers (p=0.035) (Figure 13). *Nosema* levels were significantly higher for colonies in the Central Region compared to colonies in the Northern Region (p=0.002), yet *Nosema* levels in the Western Region were not significantly different from the other two.

Figure 13. Nosema levels (mean ± S.E.) by operation size and by region.



Other Pests and Diseases

The Tech Team's main focus this year was sampling for *Varroa*, *Nosema*, viruses and pesticides. However, we did inspect 139 colonies from 30 operations for American foulbrood (AFB) and several other colony health problems. AFB was not present in any of colonies that we inspected. Among the brood diseases that we did observe, European foulbrood was seen in one (0.7%) of the 139 colonies, chalkbrood was present in 3 (2.2%) of the colonies, and sacbrood was seen in 14 (10.1%) of the colonies. In addition, small hive beetles were present in 21 (15.2%) of the 139 inspected colonies, while wax moths were found in just 3 (2.2%) of the colonies.

Conclusions

Discussion

This report identifies *Varroa* as one of the most widespread and critical threats to colony health that New York State beekeepers face. Sixty-one percent of colonies sampled were above the fall economic threshold of 3 mites per 100 bees, and, for 78% of operations, one or more of the colonies that we sampled exceeded the economic threshold for *Varroa*. Results suggest that *Varroa* monitoring is relatively uncommon, especially for smaller beekeeping operations. When beekeepers do monitor, it tends to be reactive - in response to high *Varroa* levels or summer colony losses - rather than proactive. This approach to monitoring may result in *Varroa* levels that exceed economic thresholds long before the problem is identified and addressed.

Results also indicate that virus levels are positively associated with *Varroa* levels for the three most common viruses in our sample. This finding is consistent with the role that *Varroa* mites play as vectors for several viral pathogens. The transmission of viral diseases magnifies the negative effects of *Varroa* on individual bees and on overall colony health[21].

This study identifies improved *Varroa* management as a top priority for beekeeping operations of all sizes. Genetic and cultural *Varroa* management practices will be invaluable to the 38% of hobbyists and 23% of sideliners in our sample that follow a treatment-free approach. Commercial beekeepers can also benefit from selecting hygienic bees and adopting cultural practices to slow *Varroa* population growth and reduce the use of chemical treatments. These concepts are foundational to Integrated Pest Management (IPM), which is described in the Management Tools and Resources section (Page 35).

While the ideal *Varroa* management strategy may look different for hobbyists, sideliners and commercial operations, it is essential that beekeepers in all three groups develop proactive *Varroa* monitoring and treatment plans. Detailed recommendations for *Varroa* management are provided in the following section (Pages 22-23), and two examples of *Varroa* monitoring and treatment plans are included in the Management Tools and Resources section (Pages 40-41), one for a hobbyist and one for a commercial operation.

Our findings suggest that treatment strategies incorporating multiple chemical treatment types, particularly organic acids and synthetic compounds, may be more effective than using only one or the other. In particular, this approach may be well suited to larger operations in which some of the more labor-intensive cultural management practices are less feasible or desirable. Alternating between different types of chemical treatments offers the additional benefit of reducing the risk of resistance developing within the *Varroa* populations in your colonies. The Management Tools and Resources section of this report includes detailed guidelines for selecting appropriate treatment practices under different conditions (Pages 38-39).

Best practices for *Varroa* and virus management will depend on not only on the scale, but also the unique goals and values of individual beekeepers. For this reason, the Management Tools and Resources section also includes several worksheets to support beekeepers as they develop and refine a mission statement and multiple objectives and goals (Pages 26-31).

Next Steps

2016 Pesticide Analysis

Cornell University has recently hired a new chemist to process the pesticide samples collected in 2016. The chemist will quantify levels of herbicides, fungicides and insecticides (including miticides) in 208 samples, which are from the same colonies that were previously tested for viruses, *Nosema* and *Varroa*. We expect these analyses to be completed by May 2017. We will share individual pesticide level reports with Tech Team program participants this spring, either by mail or when we visit your operation to sample colonies in May.

Beekeeping Business Analysis

Our newly hired agricultural economist will provide support for business planning and development by conducting individualized business analyses for interested sideliner and commercial beekeepers. In February and March of 2017 we collected data from 12 Tech Team program participants who completed a business survey. After a preliminary analysis of this information, the agricultural economist will contact beekeepers to schedule in-person visits.

2017 Colony Sampling

In 2017 we will double our sampling effort to collect data on colony health in the spring and in the fall. Spring sampling will take place during the last week of May and the first week of June. This timing will help beekeepers to identify colony health problems earlier in the season in order to take action sooner. Fall colony sampling will take place in September. We will sample the same colonies that were sampled in 2016, which will allow us to track trends in parasite, pathogen and pesticide levels over time. **We will be in contact shortly to schedule the spring sampling dates.**

2017 Management Survey

We will conduct a management survey in October 2017. Don't forget to keep good records of your management practices and colony losses in 2017 - recordkeeping throughout the season will make the survey easier to complete, and your answers more precise.

Recommendations

VARROA MONITORING

- Strive to monitor *Varroa* mites once a month from April to October. Establish and follow a regular monthly monitoring schedule.
- Use one of 3 reliable monitoring methods to quantify mite loads: powdered sugar roll, alcohol wash or ether roll. Do not rely on visual colony inspections to evaluate mite levels.
- Develop a system to record and track *Varroa* mite levels in your operation (see Page 46 for an example record sheet).
- Hobbyists will benefit from measuring *Varroa* levels in 100% of their colonies; sideliner and commercial beekeepers should strive to monitor *Varroa* levels in at least 10% of colonies in each apiary.
- Use monitoring results to guide and evaluate your treatment decisions. Ensure that you monitor *Varroa* levels before and after applying any chemical treatment. By monitoring after a treatment ends, you can determine the treatment efficacy. If you are following a monthly monitoring schedule, you will automatically capture the 'post-treatment' monitoring period.

VARROA CULTURAL & GENETIC MANAGEMENT PRACTICES

- Consider incorporating cultural management practices as a proactive strategy to reduce *Varroa* mite loads, prolong the time it takes for their population to reach the economic threshold, and limit the need for chemical treatments (see Page 37).
- Effective cultural techniques include timed drone brood removal and brood interruption. Screened bottom boards are not an effective tool on their own to reduce mites, but can be used in combination with other mite control practices, including requeening with hygienic stock or using chemical treatments.
- The following genetic stocks can be used to improve mite tolerance/resistance: Russian, *Varroa*-sensitive hygienic, ankle biter, and grooming behavior. Colonies can be requeened in spring or fall.

VARROA TREATMENTS

- Use only tested and registered chemical treatments to combat *Varroa* (see Page 38).
- Use chemical treatments (natural or synthetic) only when monitoring indicates that mite levels are above the recommended threshold (see Page 39). All colonies in a yard should be treated at the same time, even if only one colony is found to be above the threshold.
- Develop a *Varroa* treatment plan that outlines your specific management goals and identifies your treatment options (see examples on Pages 40-41 of this report).

VARROA TREATMENTS (CONTINUED)

- Alternate between different types of chemical treatments to reduce the chances that your colonies will develop resistance.
- Read the guidelines for applying chemical treatments and follow them carefully. Use the recommended Personal Protective Equipment (PPE) to protect yourself when applying chemical treatments.
- Reduce *Varroa*-transmitted virus levels by maintaining low levels of mites – not only in the fall, but also throughout the entire beekeeping season. These virus levels correlate with mite levels in the colony. If you wait until fall to treat, you will reduce the *Varroa* mites, but your virus levels will be high entering winter.
- Maintain good nutrition in your colony, as *Varroa* mites reduce nutrient levels in honey bees.

NOSEMA

- In addition to services provided by the Tech Team, colony samples can be sent to the USDA Beltsville Bee Lab in Maryland for *Nosema* diagnostics, or the beekeeper can determine *Nosema* spore count with access to a microscope.
- Fumagillin-B can be used with varied effectiveness in colonies with spore counts exceeding one million spores per bee. Fumagillin-B is less effective against *Nosema ceranae* (the main species of *Nosema* in NYS) than *Nosema apis*. Monitor colonies following Fumagillin-B treatment to test efficacy.
- Ensure bees receive adequate nutrition; good nutrition improves bees' ability to tolerate *Nosema* infections.

SMALL HIVE BEETLE

- Small hive beetles can become a problem in colonies with excessive space for bees to defend. Merge weak colonies with stronger colonies and super just prior to or during the honey flow.
- Follow an Integrated Pest Management (IPM) strategy to deal with high small hive beetle populations. Implement cultural management (beetle traps) first to control beetle problems. If unsuccessful, try the following options in this order: 1) introduce beneficial nematodes to the soil surrounding the hive, 2) use a permethrin ground drench pesticide, or 3) use Check Mite+ ™. It must be noted that Check Mite+ ™ can contaminate hive products and has negative impacts on queen and drone reproduction.
- After honey supers have been removed, extract honey within 2-3 days. Stored honey supers can become infested with small hive beetles quickly.

CHALKBROOD

- Chalkbrood can result from colony stress, poor ventilation, and cool temperatures.
- Maintain adequate ventilation in your colony with a screened bottom board, fully open entrance, or an upper entrance.
- Replace moderately-heavily infected frames with frames of fresh foundation or drawn comb.
- Requeen infected colonies.
- Mild chalkbrood infections often clear up without any intervention.

OTHER DISEASES & GENERAL EQUIPMENT MANAGEMENT

- Replace the 2 oldest combs from each hive body with fresh foundation. Old combs can harbor *Nosema* and American Foulbrood spores and pesticides. Rotating 5 or more combs per year can be detrimental to colony productivity.
- If a colony is suspected to have American foulbrood, by law you must report it to Paul Cappy (518-457-2087) and send a brood sample to Beltsville Bee Lab. Wash protective clothing and hive tools with soapy water to dilute the spores immediately after working that colony.
- If working in colonies that are infected with diseases other than AFB, sterilize hive tools with fire (by inserting in a hot smoker) and wash hands/change gloves after working in an infected colony. It is good practice to clean your hive tool and wash hands/change gloves between visiting multiple bee yards.

Management Tools and Resources

This section includes tools and resources that beekeepers can use to improve their colony health and their businesses. Beekeepers are encouraged to modify these resources and recordkeeping sheets to best suit their needs. We also suggest beekeepers archive their colony and business records each year so they can identify trends over time and have easy access to past records. These additional management resources include the following:

1. **Business planning resources**
    a. Mission statement
    b. Objectives and goals

2. **Viruses**
    a. Virus identification

3. ***Varroa***
    a. Integrated pest management
    b. Genetic management practices
    c. Cultural management practices
    d. Treatment decision tool
    e. Example calendar for hobbyist
    f. Example calendar for commercial operation

4. **Recordkeeping templates**

Business Planning Resources

Clarifying your Mission

A mission statement communicates the vision and purpose of your operation in a clear and concise format. The mission addresses the "why?" of your beekeeping enterprise - why does it exist? What purpose does it serve for you and for your family? What value does your business provide for your community and for the natural environment?

By summarizing the key goals and values of your beekeeping enterprise, a strong mission statement can be a North Star for your operation. Using the mission as a point of reference for developing goals and strategies can help you stay true to your original intent. A well-defined mission also facilitates interactions with customers, employees and suppliers by helping your entire community understand exactly where your business or operation is headed.

The following exercises are designed to help you reflect on your vision and values. If you have multiple partners or decision makers involved in the business, each partner should complete the questions individually before working together to draft the mission statement. As the operation grows and develops, you can revisit the mission and update it if necessary[22]

Reflection Questions

1. Chose one to three words that best describe the focus of your business:

2. What core beliefs or values drive your business?

3. What are the main products and services that you provide?

4. Who is your target customer?

5. How does your business add value to the lives of your customers?

6. What do you want your business to be known for?

Mission Statement

Based on your answers on the previous page, write a first draft of your business mission statement below.

The mission of __________________________________ is to:

____

____

____

____

____

____

Articulating Objectives and Setting Goals

How do farmers, beekeepers and other entrepreneurs make decisions about what to produce, and in what quantity? How to produce it? What equipment to purchase? When to buy and when to rent? Whether to expand (or shrink) the business? When to hire employees? Where to market and sell products? Whether or not to take out a loan or a line of credit?

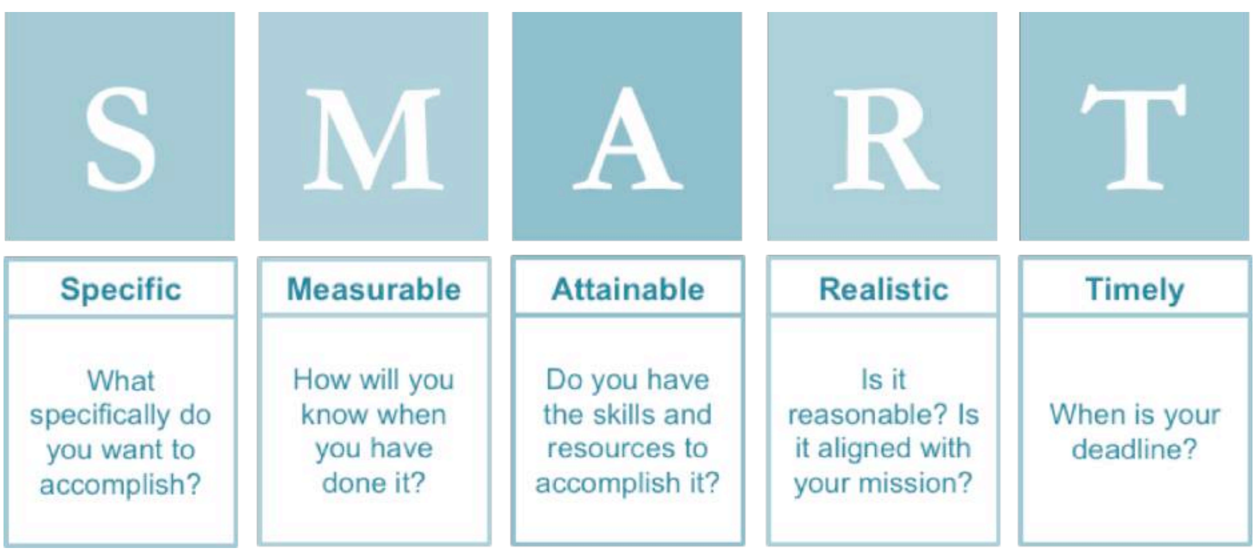
Running a business involves a continuous process of evaluating possibilities and making decisions. In order to make good decisions - decisions that will take your business where you want it to go - you need a clear sense of what the destination looks like and how to get there. With your overall mission in mind, you can articulate objectives and goals. This planning process creates a framework that simplifies decision-making and helps to ensure that day-to-day operations are aligned with the larger business vision.

Objectives

Objectives are general targets for the business that are observable, challenging and untimed. They outline what the owner/operator wants the business to look like in the future. The objectives help to focus the manager's attention on areas of concentration that are needed to fulfill the mission

Goals

Goals are expressed as specific, measurable, attainable, realistic and timely (SMART) tasks that must be completed in order to accomplish an objective. Each objective should have one or more associated goals.



Example Mission Statements

Mt Adams Honey
http://www.mtadamshoney.com

"We are fourth and fifth generation beekeepers, running a sustainable, family-owned apiary. We take great pride in building and maintaining healthy bee hives that produce high quality honey and work hard pollinating a variety of fruit and nut crops. In return we work hard to bring our customers the best products and services we can."

The Carolina Bee Company
http://www.carolinabees.com

"Our mission is to build a sustainable family beekeeping business that engages and enhances our marriage in a positive, productive way. We commit to operate in a manner respecting both our customers and the engine of the business, our friends the honey bees."

Example Objectives and Goals

OBJECTIVES	**GOALS**
Improve labor efficiency so that I'm working fewer hours per week	1. In March I will create a management calendar to schedule all apiary tasks for the 2017 season. 2. The management calendar will clearly define the number of colonies I will work each day (e.g., monitor 50 colonies, remove honey crop from 3 yards, etc). 3. I will recruit an intern through my bee club to assist in the apiary during the month of May (my busiest month).
Reduce the use of synthetic chemical treatments in my operation	1. In February I will create a 2017 monitoring schedule and purchase supplies to perform alcohol washes on 20 colonies every month. 2. In March I will order drone comb frames for each colony to use as a cultural management method. 3. I will also order two natural chemicals in March to have on hand for instances when mite levels exceed the economic threshold.
Diversify my operation by expanding into pollination services	1. In January I will read books and online articles on providing pollination services and create a list of the skills, knowledge and equipment I will need to be successful in this venture. 2. In February I will visit 4 apple orchards in my region and talk to the owners about their pollination services needs. 3. Form one contract for pollination services to be provided in 2017.
Reduce my average colony losses from ~35% to 20%	1. In March I will install an electric fence around my bee yard that experienced bear damage last year 2. Every time I inspect in 2017 I will use record sheets to document and track health problems and trends 3. I will create and follow a *Varroa* management plan for 2017. 4. In 2017 I will send two *Nosema* samples (one in May and one in September) from 10 of my colonies to the Beltsville Bee Lab. 5. I will start fall feeding in August to ensure colonies each weight 100 pounds in November to ensure sufficient winter food stores.

Objectives and Goals Worksheet

Use this worksheet to state the top three to five objectives that will help your business realize its mission. Consider the five categories listed below, but do not feel you need to create an objective for every category. Then state one or more SMART goals for each objective.

Today's date: ___________________ Date to review progress: ___________________

OBJECTIVES	**GOALS**
General business management	
Production	

Finance	
Marketing	
Personal / Family / Lifestyle	

Virus Identification

More than 20 honey bee viruses have been described worldwide[21]. Here in the Northeast, we sampled the six most common, in addition to Slow Bee Paralysis Virus which hasn't been detected yet in the US, but we are monitoring to be aware of its potential arrival.

Varroa-Virus Disease Complex[21,23-29]

Varroa mites are known to transmit five of the viruses we sampled to honey bees: deformed wing virus (DWV), acute bee paralysis virus (ABPV), kashmir bee virus (KBV), slow bee paralysis virus (SBPV), and Israeli acute paralysis virus (IAPV)[21]. Virus levels in the colony can increase quickly as it replicates in both the mites' and bees' bodies. *Varroa* mites feed on honey bee hemolymph (blood), which reduces the nutrient levels in honey bees and suppress their immune systems. A suppressed immune system can increase the susceptibility to other infections. To date, the only way to reduce *Varroa*-transmitted viruses is by maintaining low levels of mites – not only in the fall, but also throughout the entire beekeeping season. If you wait until fall to apply the first treatment, you will reduce the *Varroa* mites, but your virus levels can be high entering winter.

Deformed Wing Virus (DWV)

Deformed Wing Virus is the main virus transmitted by *Varroa* mites. Before the introduction of *Varroa*, DWV was not a major issue and rarely showed symptoms in the honey bee. The prevalence and virulence of the virus has increased with the spread of *Varroa* mites. Today, there are several strains of DWV. When virus levels are high enough, symptoms can be observed. The main symptoms are adults that emerge with deformed wings, bloated, shortened abdomens, and reduced lifespan. Deformed wings can be observed in workers, drones, and queens. When the beekeeper can observe these symptoms, the infection is already at a severe point. Infected honey bees can also transmit the virus to wild bumble bees in nearby areas.

Acute Bee Paralysis Virus (ABPV)

At low levels, ABPV doesn't cause observable symptoms. When virus levels peak, symptoms include trembling, crawling, paralysis, and death. Darkened bodies and hair loss is sometimes observed. Death can occur quickly before the beekeeper notices any signs of bee paralysis. This virus is transmitted orally, through trophallaxis, eating brood, or oral contact with feces. ABPV affects all life stages of honey bees.

Kashmir Bee Virus (KBV)

KPV can be very virulent when *Varroa* is present, with the only observable symptom being quick death. No paralysis is observed. This virus is transmitted through the fecal-oral route. KBV infects all stages of honey bees.

Slow bee paralysis (SBPV)

This *Varroa*-vectored virus is present in Europe but has not yet been found in the US. At low levels, it remains asymptomatic, but at high levels it can cause brood and adult death and paralysis of the front legs.

Israeli Acute Paralysis Virus (IAPV)

At low levels, IAPV does not cause any observable symptoms. When virus levels peak, symptoms include shivering wings, disorientation, crawling, paralysis, and death, which can occur quickly before the beekeeper notices any signs of paralysis. Darkened bodies and hair loss is sometimes observed. The beekeeper may also observe declining colony growth, reduced vigor, and decreased reproduction. IAPV affects honey bees at all life stages.

Black Queen Cell Virus (BQCV)

Black Queen Cell Virus can infect workers, drones, and queens, but to date, observable symptoms have only been witnessed in queens and drones. Queen and drone larvae die and turn brown or black shortly after the cell is sealed. The virus is carried in adult bees where no visible symptoms are observed. This virus is not transmitted by *Varroa* mites, but is very common in North America, with few symptoms observed by beekeepers.

Management is primarily through maintaining ample colony nutrition, keeping sterile and clean queen grafting and hive tools, and removing any evidence of BQCV if observed. Queen breeders should not re-use cell builders where BQCV was previously high.

Chronic Bee Paralysis Virus (CBPV)

There are two strains of CBPV that exhibit different symptoms. In one, bees become bloated and have trembling and crawling behavior. Crawling bees accumulate at the entrance of the hive. In the other strain, bees become greasy, shiny, hairless, and black first, only later showing trembling and crawling behavior. Their black shiny appearance causes them to be occasionally mistaken for robber bees from other hives, and the trembling crawling bees at the entrance may be mistaken for pesticide poisoning. Most transmission occurs through direct body contact, oral transmission (trophallaxis), and likely fecal-oral transmission. CBPV only infects adult bees

Research, Extension and Honey Bee Health Resources

Cornell Pollinator Network

www.pollinator.cals.cornell.edu

- Pollinator News
- Research at Cornell University
- Upcoming workshops, events, and courses
- Information sheets and beekeeping resources

Bee Informed Partnership

www.beeinformed.org

- State and national research on colony losses and management practices
- Pesticide analysis kits and parasite/pathogen analysis kits available for purchase
- Research and extension programs to benefit beekeepers across the US

USDA Beltsville Bee Lab Bee Diagnostic Service

https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-agricultural-research-center/bee-research-laboratory/

- No charge for diagnostic services
- *Nosema, Varroa* mites, tracheal mites, small hive beetle, American foulbrood, European foulbrood, Terramycin and Tylosin resistance test
- Diagnostic reports are sent to the beekeeper and the state apiarist

New York Bee Wellness

http://nybeewellness.org

- Workshops, surveys, and information on honey bee parasites and diseases

NYS Pollinator Protection Plan

https://pollinator.cals.cornell.edu/sites/pollinator.cals.cornell.edu/files/shared/documents/NYS%20Pollinator%20Protection%20Plan.pdf

- New York's living document for how the state plans to protect and conserve pollinators and improve honey bee health

Cornell Master Beekeeper Program

https://www.ecornell.com/certificates/beekeeping/master-beekeeping/

- Four courses of comprehensive honey bee biology and beekeeping topics:
- Honey bee biology, evolution, behavior
- The art and science of beekeeping
- Managing pests and diseases
- The rewards and contributions of beekeeping
- 15 months program, with 10 weeks of online learning

Honey Bee Health Coalition

http://honeybeehealthcoalition.org

- Research, tools and resources for honey bee health with an IPM approach

Honey Bee Veterinarians Near You

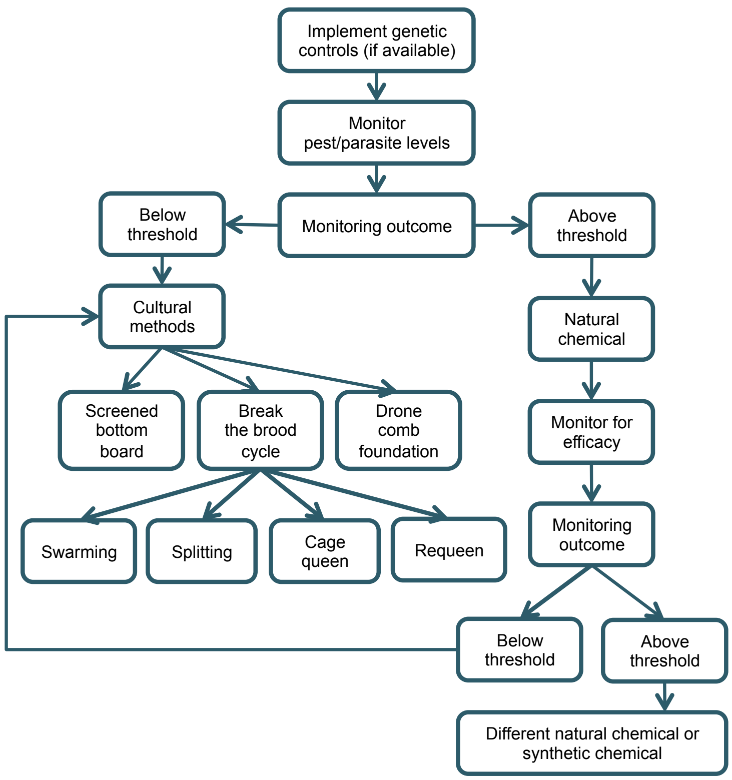
www.beevets.com

- Search for vets that are able to diagnose bacterial infections and prescribe antibiotics near you

Integrated Pest Management

Integrated Pest Management (IPM) is a strategy for maintaining a pest or parasite population below its economic threshold through the coordinated use of one or more methods. The economic threshold is the pest/parasite density at which one can expect economic damage (loss in honey production or colony death) if the beekeeper does not intervene with treatments or other control methods.

IPM Decision Making Tree for *Varroa*



IPM Programs Minimize Treatments

IPM programs seek to minimize the use of chemical treatments and antibiotics and to eliminate their use when possible. Minimizing chemical treatments ensures the purity of hive products, extends the time it takes for parasites to develop resistance to treatments, and limits potential negative impacts on bees and the environment. IPM can prolong the time it takes for pests to reach the economic threshold that requires chemical treatment.

Beekeepers can use genetic controls at all times, regardless of the pest population levels. Monitoring regularly is key to IPM, as treatments should only be applied when colonies need them. Cultural practices can be implemented to reduce parasite and pathogen loads. Finally, chemical treatments (natural or synthetic) should be used only when pest levels exceed the economic threshold.

Monitoring again post-treatment will inform you of the efficacy of the treatment used.

Monitoring Frequency

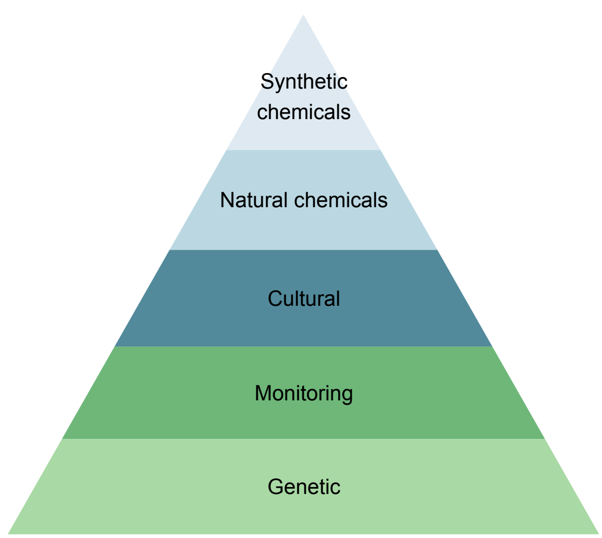
***Varroa* mites:** Monitor once every month between April and October. There are three options that have been shown to reliably correlate with overall mite population in the colony. These methods are the ether roll, the powdered sugar shake, and the alcohol wash.

***Nosema*:** Monitor once in the spring (before supering) and once in the fall (after removing honey crop).

American Foulbrood: Monitor once in the spring, once following honey crop removal, and once before winterizing colonies.

Samples can be sent to the USDA Beltsville Bee Lab in Maryland for a free analysis of *Varroa*, *Nosema* and American Foulbrood.

Pyramid of IPM Practices



Using genetic stocks to reduce *Varroa* mite loads

Stock	Description of the behavior	Institution that selected or imported stock	Mite life stage affected
Varroa-sensitive hygienic (VSH) bees	• Bees uncap and remove or chew infested pupae; immature mites die	USDA Bee Breeding Laboratory in Baton Rouge, Louisiana Minnesota Hygienic Line, University of Minnesota	Reproductive
Grooming behavior bees	• Bees remove mites from their own bodies and/or their nestmates' bodies • Stocks with grooming behavior also tend to express VSH behavior	Clemson University, South Carolina (still in development)	Phoretic
Ankle Biter bees	• Bees remove mites from their bodies and bite mites' legs off; mites can no longer attach onto bees	Purdue University, Indiana	Phoretic
Russian bees	• Russian bees encountered mites nearly a century ago and have had more time to naturally develop tolerance • They have increased VSH behavior and cease brood production (causing a break in the brood cycle) in times of food shortage	Imported by the USDA Bee Breeding Laboratory in Baton Rouge, Louisiana	Reproductive

Notes:
Phoretic mites: adult mites present on bee bodies
Reproductive mites: reproducing mites present in capped pupae

Q. I'm only going to try new stock in some of my colonies. How do I introduce this new stock?

When introducing new stock in a subset of your colonies, it will be most effective if these colonies are kept in a separate yard from colonies with non-*Varroa* tolerant/resistant stock. Having these colonies in the same yard can reduce the stock efficacy as drifting and robbing can introduce high mite pressure into resistant/tolerant stock colonies.

Q. I like my current bees and prefer local stock. Can I select for my own mite resistant stock?

Yes! There are two ways to do this:

Option 1: When monitoring *Varroa* mites in your bee yard, move any colonies that are above the treatment threshold to a separate yard and treat them individually. Keep low mite colonies in your original yard; these low mite colonies will be the ones from which you raise queens. Continue to move high mite colonies to this separate yard for 1-2 years, each time that you find some are above the economic threshold. You will be left with some colonies (now your breeder queen colonies) in your original bee yard that have maintained low levels of mites for 1-2 years.

Option 2: When monitoring *Varroa* mites in your bee yard, move any colonies that are above the treatment threshold to a separate yard - **isolated by a few miles from other colonies** - but do not treat them. Continue to monitor these moved colonies for 1-2 years. Any colonies that are able to survive the mite pressure may have begun developing resistance to mites. Raise queens from these colonies.

Important note for both options: Having colonies with high mite loads near other colonies can be a risk to those colonies with low mite loads. Drifting and robbing can introduce mites into colonies. It is important to keep colonies for breeding separate from your other hives and your neighbors' hives.

Varroa mite cultural practices

Method	How It Works	Months	Notes
Drone comb frame	• Mites prefer to reproduce in drone comb and crawl inside right before cells are capped. • Insert frame in position 2 or 3 of brood nest. Remove while drones are capped (between day 10 and 24). Freeze the frame for 24 hours and reinsert.	April – August	• Don't forget to remove the frame before drones emerge or you will accidentally increase mite levels. • Drones are produced most in spring and early summer and less in late summer and autumn. • This method is not ideal if your goal is queen rearing. A surplus of drones is needed for mating.
Removing drone brood	• Mites prefer to reproduce in drone comb. While inspecting colonies, destroy/scrape off any drone comb with your hive tool.	April – August	• Drones are produced most in spring and early summer and less in late summer and autumn. • This method is not ideal if your goal is queen rearing. A surplus of drones is needed for mating.
Screened bottom board	• Screened bottom board sits beneath the hive in place of bottom board. It catches mites that fall off bees and prevents them from crawling back up onto bees. • This approach is only effective together with other *Varroa* control methods.	April – October	• Screened bottom board provides additional ventilation. • In the Northeast it is recommended to remove screened bottom board before winter. In warmer regions, or areas protected from wind, screened bottom boards may be left on all year round
Small colonies with few honey supers	• Colonies that have small populations in smaller cavities produce less brood and have reduced mite levels.	Year round	• This method is not ideal if your goal is honey production.
Colony spacing	• Drifting bees comprise around 30% of bees in colonies that are close together. Wild colonies are spaced far apart in nature. Crowding hives close together increases mite levels. • Spacing colonies more than 10 feet apart can help reduce mite transmission.	April – November	• This method is dependent on land availability and may be more appropriate for hobbyists or sideliners with fewer hives. • Colonies can be overwintered close together, as there is no drifting/robbing during this time.
Brood interruption techniques			
Swarming	• Allowing colonies to swarm provides a natural break in the brood cycle.	April – June	• Most swarms occur in spring and early summer, fewer occur in late summer and early fall. Swarms must be caught.
Splitting	• Strong colonies can be split into two smaller colonies. The colony without the original queen experiences a brood break. Many beekeepers will requeen both colonies.	April – July	• Colonies split in late summer or early fall might be too small to overwinter successfully.
Requeening	• Requeening colonies offers a break in the brood cycle. The break is longest if a queen cell is introduced instead of a mated queen.	April – July	• Benefits are maximized if requeening with tolerant/resistant stock.
Caging the queen	• Cage queen for 1-2 weeks to break the brood cycle. Release the queen after this time to allow her to return to egg laying.	April – July	• Caging the queen in late summer or early fall can interrupt the production of winter bees.

Varroa mite control options and considerations

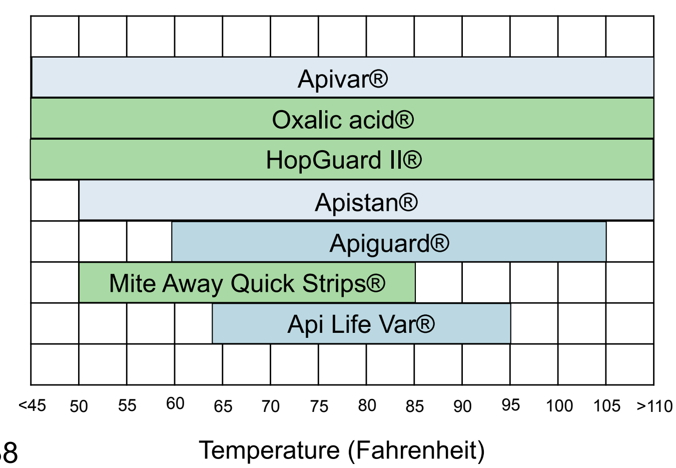
Essential oil   Organic acid   Synthetic chemical

Chemical	Active Ingredient	Method	Efficacy when used appropriately	Cost per colony ($)	Treatment duration	Can you treat with supers on?	Time to wait after treatment ends before you can super
Apiguard®	Thymol	Tray with gel sits on brood frames	74-95%	3.30 - 6.80	28 days (2 times for 14 days each)	No	Can super immediately after treatment ends
Api Life Var®	Thymol, eucalyptus oil, menthol	Tablets placed on the corners of the brood nest	70-90%	4.48 – 7.12	21-30 days (3 times at 7-10 day intervals)	No	1 month
MiteAway Quick Strips®	Formic acid	Pads placed on brood nest	61-98%	4.40 – 7.25	7 days	Yes	Supers can be left on during treatment
Oxalic Acid	Oxalic acid dehydrate	Dribble brood nest or vaporize entrance	82-99%	0.25 – 0.37	10 minutes	No	2 weeks
Hop Guard II®	Hops beta acids	Strips inserted in brood nest	75-99%	3.33 – 3.80	28 days	Yes	Supers can be left on during treatment
Apivar®	Amitraz	Insert strips into brood nest	95%	5.00 – 6.90	42-56 days	No	2 weeks
Apistan®	*Tau*-fluvalinate (pyrethroid)	Insert strips into brood nest	95-99%	4.19 – 6.79	42 days	No	Can super immediately after treatment ends

Notes:

- There have been cases of resistance in Apistan®. Varroa mites can develop resistance to any treatment, therefore is important to rotate treatments, remove treatment strips promptly, and practice Integrated Pest Management to reduce the likelihood of resistance developing. Make sure you monitor following treatment (or regularly every month) to determine efficacy.
- Efficacy levels are cited from **Honey Bee Health Coalition, 2017. Tools for *Varroa* management: a guide to *effective Varroa* sampling and control,** 5th edition.
- Treatment costs per colony vary depending on supply companies and order size.

Treatment Temperature Windows



Varroa mite control options throughout the year

☐ honey supers not present ☐ honey supers present

Month	Colony conditions	Threshold (mites/100 bees)	Cultural/Genetic Options	Natural chemicals	Synthetic chemicals
April	Colony population increase Brood present Drone production	2	Requeen with hygienic stock Drone brood removal Splits/artificial swarms Colony spacing Cage queen	Apiguard® Api Life Var® MiteAway Quick Strips® Oxalic acid (packages only	Apivar® Apistan®
May	Colony population increase Brood present Drone production	2	Requeen with hygienic stock Drone brood removal Splits/artificial swarms Colony spacing Cage queen	Apiguard® Api Life Var® MiteAway Quick Strips® Oxalic acid on packages only	Apivar® Apistan®
June	Colony population increase Brood present Drone production	2	Requeen with hygienic stock Drone brood removal Splits/artificial swarms Colony spacing Cage queen	MiteAway Quick Strips® Hop Guard II®	
July	Colony population peak Brood present Drone brood present	2	Requeen with hygienic stock Drone brood removal Splits/artificial swarms Colony spacing Cage queen	MiteAway Quick Strips® Hop Guard II®	
Aug	Colony population peak Brood present Fewer drones produced	3	Requeen with hygienic stock Colony spacing Cage queen	MiteAway Quick Strips® Hop Guard II®	
Sept	Colony population peak Brood present Fewer drones produced	3	Requeen with hygienic stock Colony spacing Cage queen	MiteAway Quick Strips® Apiguard® Api Life Var® Hopguard II®	Apivar® Apistan®
Oct/ Nov	Population decrease Little to no brood	3	Colony spacing Cage queen	Oxalic acid Hop Guard II®	
Dec - March	Bees are clustering Broodless Too cold to open colonies	3		Oxalic acid (fumigation only)	

Notes:
HopGuard II® and Oxalic acid are most effective when colonies are broodless

Example: Monitoring and Treatment Schedule

Hobby operation: 5 hives, beekeeper prefers natural chemicals & cultural methods

April

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Monitoring results: 1 mite/100 bees; no treatment required. Add a screen bottom board and insert one frame of drone comb foundation on the 13th.

May

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Remove drone frame on 12th, freeze, and reinsert on 14th. Monitoring results: 4 mites/100 bees. Treat with Apiguard.

June

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Monitoring results: 0 mite/100 bees; Apiguard was effective. Remove drone frame on 12th, freeze, reinsert on 14th. Requeen with hygienic stock on the 27th.

July

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Monitoring results: 1 mite/100 bees; no treatment required. Remove drone frame on the 9th, freeze, and reinsert on the 11th.

August

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Monitoring results: 4 mites/100 bees; treat with MAQS (can be used with honey supers). Remove drone frame on the 5th for the rest of the year.

September

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Monitoring results: 2 mites/100 bees. MAQS worked a bit, but they are still close to the threshold and may need to be treated again soon.

October

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Monitoring results: 5 mites/100 bees. Treat with oxalic acid vapor on the 19th. Remove screen bottom board to prepare for winter.

November

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Monitoring results: 1 mite/100 bees. Oxalic was effective. Overwinter bees this month.

December

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Varroa populations remain low when colony is broodless during winter.

January

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

February

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

March

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Key: Monitoring for mites | Genetic action | Cultural action | Treatment

Example: Monitoring and Treatment Schedule

Commercial operation: 600 hives, beekeeper is ok with synthetic chemicals and doesn't have much time to devote to cultural practices.

April

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

Monitoring results: some yards above 2 mites/100 bees; treat these yards with Apivar.

May

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Remove Apivar strips on the 19th. Do not add honey supers until June 10th. Monitoring results: all yards below 2 mites/100 bees. Apivar was effective; no need to add a new treatment this month.

June

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Do not super until the 10th. Monitoring results: all yards below 2 mites/100 bees; no need to treat this month. Requeen with hygienic stock from the 11th-15th.

July

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Monitoring results: all yards below 2 mites/100 bees; no need to treat this month.

August

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Monitoring results: some yards above 3 mites/100 bees; treat these yards with MAQS. Honey supers can be kept on during treatment.

September

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Monitoring results: 2 mites/100 bees; no need to treat this month. MAQS worked a bit, but they are still close to the threshold and may need to be treated again soon.

October

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Monitoring results: some yards are above 3 mites/100 bees. Treat with Hopguard II.

November

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Monitoring results: some yards are still above 3 mites/100 bees. Apply oxalic acid vapor to those yards. Overwinter bees this month if remaining up north.

December

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Varroa populations remain low when colony is broodless during winter.

January

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

February

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

March

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

If your bees are down south, you may begin monitoring *Varroa* in March. If mite counts exceed 2 mites/100 bees, treat with Apivar.

Key: Monitoring for mites | Genetic action | Cultural action | Treatment

Contacts
Last updated: ____________

Title	Name	Email	Phone number	Address	Website
State apiarist	Paul Cappy	Paul.Cappy@agriculture.ny.gov	518-457-2087	NYS Department of Agriculture and Markets 10B Airline Drive Albany, NY 12235	https://www.agriculture.ny.gov/PI/apiary_inspection.html
University extension associate	Emma Mullen	ekm75@cornell.edu	607-379-7798	Dyce Lab for Honey Bee Studies 209 Freese Road Ithaca, NY 14850	https://pollinator.cals.cornell.edu/
State inspector(s)					
Landowners for apiaries/sites					
Local bee club leader(s)					
Pollination contracts					
Staff					
Suppliers					
Beltsville Bee Lab (diagnostics)	Jay Evans	jay.evans@ars.usda.gov	301-504-8205	(to submit samples) Bee Disease Diagnosis Bee Research Laboratory 10300 Baltimore Ave. BARC-East Bldg. 306, Room 316 Beltsville, MD 20705	http://www.ars.usda.gov/main/site_main.htm?modecode=80-42-05-40

Apiary Information

Apiary name or number	**Location or address**	**Contact and contact information**	**Number of hives**	**Date placed**	**Date removed**	**Required maintenance**	**Notes** (nearby apiaries, forage, average honey production, etc.)

Hive information
Year: ____________

This sheet should be updated once a year or as necessary. By contrast, the hive inspection sheet should be updated continually on management, population, occurrence of pests/diseases and subsequent treatment, honey production, and other information.

Hive ID	Origin of hive	Date established or acquired	Origin of queen	Stock of queen	Date(s) (re)-queened			Notes

Hive ID and Apiary: ____________________

Date	Population strength	Brood quality	Brood notes	Queen? / Marked?	Eggs? / Cups, cells?	Honey	Pollen	Empty frames
Population management								
Pests and disease (refer to other records for *Varroa* mite levels)								
Nutrition, hive products								
Additional notes								
Population management								
Pests and disease								
Nutrition, hive products								
Additional notes								
Population management								
Pests and disease								
Nutrition, hive products								
Additional notes								

Additional notes may include external observations, equipment, yard maintenance, weather/temperature, the bees' temperament, etc.

Varroa Mite Monitoring and Treatment
Monitoring method: ____________________________________

Hive ID	Date	Mite count 300 bees = ½ cup		Treatment method(s)	Date applied	Date to be removed	Date removed	Notes (dosage, conditions)
		per 300 bees	per 100 bees					

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