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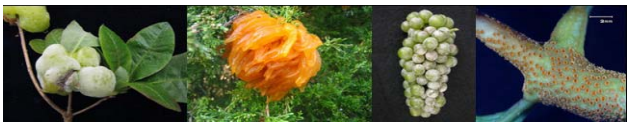


REPORT

Managing the Varroa Mite for Honey Bees in Connecticut

Report of the State Entomologist to the General Assembly

EXECUTIVE SUMMARY

Pollinators, including the domesticated honey bee, *Apis mellifera* Linnaeus, serve a critical function in natural and agricultural ecosystems, both for the reproduction of native plants and for crop production, where they are essential to fruit set or seed production of approximately one-third of all human crop plants. Bees pollinate about 66% of the world's 1,500 crop species, responsible for 15 to 30% of our food production. It is estimated that honey bee pollination accounts, either directly or indirectly, for one-third of the food we eat. Based conservatively only on the value of apples, peaches, and pears in Connecticut, the value of the pollination services by honey bees to Connecticut agriculture is estimated at nearly $15 million. There are over 1,500 beekeepers with over 7,600 hives registered with the Office of the State Entomologist at The Connecticut Agricultural Experiment Station (CAES) with an estimated value of at least $4 million. We are in the process of enabling online registrations to make the process easier for beekeepers and CAES.

Under Public Act No. 16-17, AN ACT CONCERNING POLLINATOR HEALTH, the State Entomologist shall report not later than January 1, 2017, in accordance with section 11-4a of the general statutes, to the joint standing committee of the General Assembly having cognizance of matters relating to the environment on the conditions that cause an increase in the presence of Varroa mites that affect honey bee and other pollinator populations in the state. Such report shall include, but not be limited to, any recommendations for legislation to assist in limiting or offsetting the effects of such conditions, including, but not limited to, any required authority for the development of a Varroa mite management strategy that includes: (1) The creation of a line of local bees from survival stock that show levels of resistance to such mites and that are acclimated to the state's environment, and (2) development of queen bees with a high level of tolerance to Varroa mites for the purpose of limiting the need for imported bees.

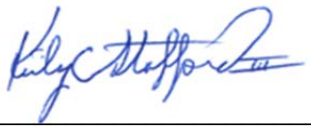
The Varroa mite, *Varroa destructor*, has been largely responsible for the recent decline of managed honey bee colonies and the virtual disappearance of feral (wild) honey bee colonies. The mite was first detected in Connecticut in 1991. Mites attack larval, pupal, and adult honey bees and are present to varying degrees in virtually all colonies we have inspected in Connecticut. Without treatment or management, a mite infestation can devastate a colony, and left uncontrolled, will ultimately result in death of the colony. Combining winter and summer data, beekeepers in the United States lost an estimated 44.1% of their colonies between April 2015 and March 2016 (54.2% in CT for the previous year). Some of the heaviest impact from Varroa mites comes from viruses vectored by or associated with the mites. As part of our honey

bee surveys funded through the USDA, we have detected six different viruses in Connecticut honey bees. Increased virus levels due to Varroa mite parasitism can further decrease the life span of honey bees. Other pest and disease issues that detrimentally affect honey bee health include American foulbrood caused by a bacterium, *Paenibacillus larvae*, *Nosema* infections, and the small hive beetle, *Aethina tumida*.

Varroa mites can be most effectively managed through integrated pest management (IPM) approaches that include the use of chemicals, cultural, mechanical, and behavioral methods that can help lower mite populations. Development and use of Russian bees, other mite resistant stock, or hygienic bees (i.e., bees capable of recognizing and removing mites) can also help. Unfortunately, honey bee resistance to chemical pesticides is widespread and some earlier compounds are no longer effective. Currently, there are eight pesticide compounds registered for use in Connecticut. However, to avoid contamination of harvested honey, most of these compounds cannot be used during honey flow. Nevertheless, unmanaged or untreated hives for Varroa mite will ultimately be lost.

Breeding honey bees resistant to Varroa mite is a long-term research objective and while some progress has been made with certain strains, more research is clearly needed. Bee strains with hygienic traits are resistant to Varroa infestations because their worker bees detect mite-infested pupae and quickly remove them from the hive. Unfortunately, existing queen breeding programs to enhance this trait can lead to excessive inbreeding, as this hygienic trait is recessive. The CAES has recently been awarded a small specially crop grant from the Connecticut Department of Agriculture to initiate the assembly of multiple populations of hygienic bees of diverse origin, including feral populations that may have survived in our state forests, to produce queens that will support populations of hygienic and genetically diverse workers within each colony.

Finally, a Varroa mite management plan will require education of beekeepers, particularly those new to beekeeping, inspections of honey bee colonies, proper use of legally registered products for Varroa mite control, and ultimately the development of honey bees resistant to or capable of removing this pest.



Signature

December 12, 2016
Date

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"Many people, when they think of pollinators at all, think of honey bees."
Stephen L. Buchmann and Gary Paul Nabhan, *The Pollination Crisis* (Buchmann and Nabhan 1996)

Section 1 – The Value of Beekeeping and Pollination

Pollinators serve a critical function in natural and agricultural ecosystems, both for the reproduction of native plants (Biesmeijer and al 2006) and for crop production, where they are essential to the fruit set or seed production of human crop plants (National Research Council 2007). Bees pollinate about 66% of the world's 1500 crop species, responsible for 15 to 30% of our food production. Managed honey bees, mainly the European or western honey bee *Apis mellifera* Linnaeus, pollinate more than 100 commercially grown crops in North America with a value of $14 billion (Morse and Calderone 2000). It is estimated that honey bee pollination may account, either directly or indirectly, for one-third of the food we eat. Therefore, the economic importance of honey bees is huge, largely because honey bees are generalists, capable of pollinating many agricultural crops. Honey bee management is highly developed and equipment is widely available. Although other species like alfalfa leafcutter bees, bumble bees, squash bees, and mason bees are often more efficient pollinators for specific plants, honey bees are the pollinator of choice for most crops grown on a large scale because they build large colonies of thousands of bees that can be transported at the time of bloom to pollinate large tracts of commercial crops. Most beekeepers in the United States (about 94%) are hobbyists with 25 or fewer colonies. Roughly 5% of beekeepers manage 25-300 colonies and only about 1% are commercial beekeepers with 300 to 60,000 colonies.

Most of the beekeepers in Connecticut are hobbyists with 2-3 hives, sometimes a few more, although there are more beekeepers expanding to 10-15 hives. These are people who enjoy the hobby and like producing their own honey. Some will sell the honey they produce at local farm markets. A few beekeepers own 50 to a few hundred colonies that are rented for pollination. The benefit to Connecticut agriculture is huge, with beekeepers servicing apples, pears, peaches, and many other crops. Many local gardens benefit from the presence of local hives. In addition, many colonies pass through Connecticut on trucks from Florida on their way to Maine for blueberry, Massachusetts for cranberry, and some apple pollination. When the blueberries are completed in late May, the colonies are shifted south to pollinate cranberries in Massachusetts, followed perhaps by apples in New York State.

Like many states, Connecticut has an apiary inspection law requiring registration of the beekeeper and the hives, allowing inspection of hives for diseases, and certification of inspection and health for transported bees. Most beekeepers, although not all, register annually with the Office of the State Entomologist. This assists our ability to assist individual beekeepers, inspect for disease, and tabulate the importance of beekeeping to Connecticut agriculture. Registration is a prerequisite for assistance from the State Apiary Inspector and registration is free. A one page form is available on The Connecticut Agricultural Experiment Station website (www.ct.gov/caes) or at www.ct-clic.com. We are in the process of enabling online registrations to make the process easier for beekeepers and CAES. A list of registered beekeepers by town and name is available on the website. In September 2016, there were 1,571 registered beekeepers

with 7,628 colonies in Connecticut (Appendix 1). Unofficial estimates suggest that there could be another 400 beekeepers/800 colonies that have yet to register.

Pollination of Connecticut agricultural crops, gardens, and even wildlife habitat is the most important and valuable contribution made by Connecticut's beekeepers and their honey bees. Up until very recently, our beekeepers met all the commercial pollination needs for growers in the state. Blueberries, cranberries, apples, pears, plums, strawberries, raspberries, and various cucurbits (i.e., squash, muskmelon, cucumber, watermelon, and pumpkins) are some of the crops in the northeast for which honey bees play an important role. In 2015, the value of utilized production for apples, peaches, and pears in Connecticut was $18,114,000 (New England Agricultural Statistics, 2015 survey; 2008 data for pears). Based conservatively only on the value of these three commodities in the state and the relative role of honey bees (vs. other pollinators) in their pollination (Morse and Calderone 2000), the value of the pollination services to Connecticut agriculture is at least $14,805,990 (Appendix 2).

Colonies brought in for blueberry and related production may transverse Connecticut and return to southern states during the winter months to provide needed pollination in those states, to decrease over-winter colony losses, and to ensure colonies are sufficiently strong to meet northern fruit and vegetable producers' spring and summer pollination needs. The current extent of the pollination provided by our wild pollinators, while undoubtedly extensive, is not well documented. Pollinators are important to backyard vegetable gardens and a lack of pollination will be reflected in reduced yield and seed set. While bees are important pollinators for Brassicas, onions, carrots, garlic and other garden crops, the seed or fruit is not the consumable product. Bees are necessary for sunflower seed production. The impact of honey bees on backyard and community gardens is unclear as there is little or no readily available data on what is grown. Nevertheless, many local gardens benefit from the presence of local hives.

The USDA National Agricultural Statistic Service reported 5,639 honey producing hives from 291 operations in Connecticut during 2012 producing 155,991 pounds of honey with a value of $609,000. The number for 2007 was 143 operations and 143,092 pounds of honey. Overall, honey production was up in 2012 over the 2007 census, but this is probably due to increased interest in beekeeping as the number of beekeepers has steadily increased since 2004 (Appendix 1). The major impact has been on pollination services as honey bees had to be brought into the state to meet pollination needs for the first time in 2014.

Section 2 - The Varroa Mite

The Varroa mite, initially named *Varroa jacobsoni*, parasitized the Asian honey bee, *Apis cerana*, switched to *Apis mellifera* around a century ago, and then spread to Europe in the 1970s and the U.S. in the 1980s. The mite, now known as *Varroa destructor* (Anderson & Trueman), was detected on honey bees in Wisconsin in 1986, although it may have already been present in Florida. It soon spread throughout North America. The Varroa mite has been largely responsible for the recent decline of managed honey bee colonies and the virtual disappearance of feral (wild) honey bee colonies. State quarantines may have delayed its appearance in Connecticut as the Varroa mite was not detected in Connecticut until fall 1990 (Appendix 3). By 2007, these mites were present in virtually all inspected Connecticut colonies, whether treated or not. It represents the one of the greatest threats to beekeeping today. Without treatment or management of the mite, an infestation can devastate a colony, and left uncontrolled, the mites will result in the death of the colony, and infestation of nearby hives.

This mite feeds externally on the hemolymph (blood) of adult honey bees and in the brood (larvae and pupae). Female mites lay eggs in the brood cells with young larval bees. After the cells are capped, the mites feed on the larvae, lay eggs, and the female mite and her progeny feed on the maturing bee. The impact depends on the level of infestation. Emerging adult bees can suffer malnutrition and blood loss, be notably crippled, or die in their cells and never emerge. Emerging mites generally attach to nurse bees, but may shift to foraging bees in the fall, infesting new hives or increasing the mite population in current hives (DeGrandi-Hoffman et al. 2016).

Some of the heaviest impact from Varroa mites appears to be not just from the mites, but from viruses vectored by or associated with the mites such as deformed wing virus. Increased virus levels due to Varroa mite parasitism will decrease the life span of honey bees (Yang et al. 2005) and affect learning and memory (Li et al. 2013). Varroa mites have been largely controlled through the use of chemical treatments, though some non-chemical management approaches can be incorporated into an integrated pest management (IPM) program. There are eight acaricide products registered for use in Connecticut (Appendix 4). Pesticide resistance is widespread and some compounds are no longer effective. In addition, to avoid contamination of harvested honey, most compounds cannot be used during honey flow. Treatments have to be delayed until honey flow ends and honey supers are removed. Treatments will kill the mites on adult honey bees, but the mites are often present and reproducing under capped brood and a chemical needs to be present as mites emerge with newly emerging bees to provide the most effective control.

Another parasitic mite similar to the *Varroa* mite represents a potential threat to U.S. beekeeping. *Tropilaelaps* species are parasitic mites native to Asia and Indonesia that feed on honey bee brood (larvae and pupae) causing deformed and dead bees, but unlike Varroa do not feed on adult bees. The natural hosts are the giant honey bees *A. dorsata* and *A. laboriosa*. Their parasitic feeding vectors viruses, weakens or kills parasitized brood, and can cause infected colonies to abscond, which spreads the mites to new areas. *Tropilaelaps* mites can complete their lifecycle in one week, and thus can out-compete *Varroa* when both mites are present in a hive. Adult mites move very quickly on brood combs and can be seen moving in and out of cells; they are about 1/3 the size of *Varroa* mites, so they are just visible to the naked eye. Currently, there are no known *Tropilaelaps* species in the U.S. These mites are a federally regulated pest and the USDA-APHIS-PPQ would be involved with any detections, quarantines, and eradication efforts.

As previously noted, the smaller Asian honey bee, *A. cerana*, is the original host for our Varroa mite. The Asian honey bees, unlike our European honey bees, rapidly remove mites from each other and from the hive, and mite infestations have little effect. However, a mite closely related to the Varroa mite, *V. jacobsoni*, that does feed on the Asian honey bee appears to again be shifting to European honey bees. This early detected potential host shift in the bees in Papua New Guinea represents another possible threat should it spread (Andino et al. 2016). Other potential exotic pest is the sap beetle, *Brachypeplus basalis* Erichson, which has been found several times in Oregon and California since 2010. The sap beetle appears to feed on pollen stores in the beehive.

Section 3 – National Honey Bee Survey

A national survey of honey bee pests and diseases began in 2009 as a pilot survey in 3 states by the USDA Animal Plant Health Inspection Service (APHIS). It is conducted in collaboration with the University of Maryland, USDA Agricultural Research Service (ARS) and State Apiary Specialists. There was little or no funding to states in 2014 and the survey was conducted in 20

states and CAES submitted samples in 2014 (lack of funding or a full time apiary inspector prevented earlier participation), 2015 and 2016. With funding from the USDA Farm Bill for 2015, CAES was one of 39 states participating in the survey. The survey was again funded for 2016 (analysis results pending). This national survey is being conducted in an attempt to document which bee diseases, parasites, or pests of honey bees are present and/or likely absent in the U.S. Specifically, this survey will attempt to verify the absence of the parasitic mite *Tropilaelaps* and other exotic threats to honey bee populations (e.g., *Apis cerana* and slow bee paralysis virus). To maximize the information gained from this survey effort, collected samples are analyzed for other honey bee diseases and parasites known to be present in the U.S. and in Connecticut (Appendix 5).

Section 4 – Discussion of Economic Loss and Connecticut Inspections

Economic conditions in the beekeeping industry have become increasingly adverse since the Varroa mite was introduced into the U.S. in 1987. Control of Varroa in the colony became an added cost to beekeeping. First detected in Connecticut in 1991, beekeepers continue to suffer large colony losses due to Varroa. Colony Collapse Disorder (CCD) added complexity to the recent decline in U.S. numbers. The cause of CCD is considered to be due to a combination of multiple factors; parasites (like Varroa), pathogens, poor nutrition, pesticides, and poor bee management practices. Annual colony losses in the U.S. have been greater than 30% per year in most recent years (vanEngelsdorp et al., 2014). While these losses are not entirely due to Varroa, Dr. Jeff Pettis (USDA-ARS) estimates that Varroa mites could account for as much as 75% of those annual losses. In Connecticut, the majority of colony losses occur during late fall and winter months. Connecticut beekeepers suffered colony losses greater than 45% during 2010-2011 (vanEngelsdorp et al., 2012) and reported a winter loss of 48% in 2013-2014 (Steinhauer 2014).

Inspection of honey bee colonies has indicated that Varroa mite infestation and likely the viral complex associated with Varroa as the primary reason for colony mortality. CT beekeepers continue to lose colonies overwinter in higher numbers; the Bee Informed Winter Loss report for CT in 2015 was 57.5 % (an increase of 18%). These losses are slightly higher than regional and nationwide trends. The viral pathogens that cause deformed wing virus (DWV), Israeli acute paralysis virus (IAPV), acute bee paralysis virus (ABPV), and even the rare chronic bee paralysis virus (CPBV) and Lake Sinai virus-2 (LSV-2) were detected in Connecticut as part of the USDA Honey Bee Pests and Diseases Survey (Appendix 5). A number of these viruses have been detected in native bees (Dolezal et al. 2016), although virus loads were low in this case and there is no evidence these viruses cause mortality in other bee species.

Due to high winter losses in 2015, local beekeepers struggled to replace losses with package bees from southern states. American foulbrood was detected in three hives; these were destroyed by burning. There were no suspected Africanized honey bee detections (suspect bees would be sent to the USDA for testing). Unofficial estimates indicate that over 4000 packages of honey bees were imported into Connecticut for sales to new beekeepers and to replace losses. Despite these challenges, beekeeping interest is still strong with over 900 new beekeepers being trained this winter. There were one hundred twenty Apiary Certificates of Health issued. Three certificates were issued for export out of CT, and one hundred seventeen certificates for interstate movement of honey bees.

Commercial beekeepers have three methods to replace lost colonies:

(1) Buy full strength replacement colonies for a cost of approximately $300-400 each, which is the most expensive, but quickest method.
(2) Buy nucleus colonies for a cost of approximately $200 apiece. A nucleus colony is five frames of bees and a queen that are placed into an empty brood chamber. Over time, a nucleus colony will become a full strength colony.
(3) Split existing parent colonies for a cost of approximately $90 each. This method involves buying a queen (estimated cost for a queen in 2017 is $40) and taking half of the brood frames from an existing parent colony and put these frames into an empty brood chamber. Over time, a split colony will become a full strength colony.

The replacement cost for hives managed hobby beekeepers in Connecticut is greater than commercial beekeeper costs. The price for a nucleus colony ranges from $175 to $230, package bees at $120, and full strength colonies at ~$300-400. Colony losses due to Varroa greatly influence the beekeeper's pollination income according to the need for replacement colonies by one or all of the aforementioned methods. When many colonies are split or "nuced" in order to compensate for losses, income is lost by way of replacement cost and pollination income since the nuclei hives and split hives are of lower quality. For example, the national survey reported that colony mortality in 2010-11 was approximately 45%. If 75% of these losses are attributed to Varroa then approximately 1,500 of the 2,000 hives used to pollinate Connecticut apples and other stone fruits needed replacement (2,000 x 45% loss = 900 mortality x 75% due to Varroa = 675 hives). Assuming the colonies are replaced via the three methods previously stated: hive purchase ($300/colony), splitting ($90/colony), and nuclei hives ($200/colony); the cost of replacement would be up to around $1,350,000 if all were replaced with nucleus colonies and vary depending on the method used. This cost does not include the reduced pollination or honey income.

Section 5 – Integrated Pest Management for Varroa Mite

With the advent of the Varroa mite, beekeepers have largely relied on the regular application of acaricides (pesticides or insecticides that kill mites and ticks) for Varroa mite management with resulting dependency on chemicals and ongoing propagation of mite-susceptible colonies (Meixner et al. 2015). As with any IPM program, the first step is to monitor for a pest and pest levels. Varroa mite populations increase and decrease in synchrony with the season and pattern of honey bee development. As we educate beekeepers, the first question from the apiary inspector with any issues beekeepers have is "what is your mite load?" Honey bee colonies can tolerate some mites and the goal is to manage mite populations below injury thresholds (ca. 3% infestation level or 3 mites per 100 bees). There are a number of techniques for estimating mite densities in a hive. The steps in implementing a honey bee IPM program are: 1) monitor and identify the problem (often Varroa mites, but could be lack of food reserves or other factors); 2) determine the threshold; 3) assess options (IPM generally uses multiple tactics including cultural practices); 4) select and apply controls (e.g., rotation of chemical treatments to minimize resistance); and 5) evaluate success and record results (Collison et al. 2007).

There are 24 "races" of the European honey bee, *Apis mellifera* L., with characteristics that differ in their gentleness or aggressiveness, foraging ability, overwintering survival, honey production, disease resistance, instinct to swarm, and ability to build robust populations. Many have been cross-bred for disease resistance, hardiness, and gentleness (Sammataro and Avitable

1998). Non-chemical tactics for Varroa mite management include restricting brood rearing, trapping mites in drone brood (drone brood is more heavily favored and infested by the mites) and freezing the frames, and using screened bottom boards and trapping mites on a sticky bottom board. Another component of an IPM program to manage Varroa mites is to use honey bees that are resistant or capable of handling the mites such as Russian bees or resistant and hygienic stock developed by the USDA and some bee breeders. Bees with hygienic traits are resistant to Varroa infestations because worker bees detect infested bee pupae and remove them from the hive. Researchers at the USDA Agricultural Research Service and universities have been working on developing mite resistant or hygienic bees for a couple of decades. Some lines of bees have been developed such as the Minnesota hygienic bee, but none have seen wide acceptance and use and there is a need for a regional approach. Any breeding for varroa mite resistance must also maintain other desirable characteristics.

Existing queen breeding programs to enhance hygienic traits can lead to excessive inbreeding, as the hygienic trait is recessive, and each bee breeding program originated from populations with limited genetic variability, and few are oriented towards characteristics needed in bees for the northeast. Increased within-hive genetic variability benefits colonies by improving their ability to respond to stressors. CAES has received a small ($59,254) grant for the CT Department of Agriculture to initiate a breeding program and further funding sources will be needed to sustain the research. CAES plans to assemble multiple populations of hygienic bees of diverse origins, including feral populations surviving in our state forests, to produce queens that will support populations of hygienic and genetically diverse workers within each colony. Queens produced through this breeding program will be evaluated relative to existing hygienic bee strains to quantify their hygienic behavior, resistance to Varroa mite infestation, colony health, gentle behavior, honey yields, and over-wintering survival. The ultimate goal is that the best hybrids could be used to replace queens kept by beekeepers throughout Connecticut, to thereby improve profitability, sustainability, and competitiveness of our apicultural industry. However, state-bred queens are perceived as a potential commercial threat to existing queen breeders and producers. At the end of this project, the concept is to turn the queen rearing and breeding program over to a new local, non-profit queen rearing association.

Section 6 – Requested Recommendations for Legislation

The current honey bee statutes are summarized in Appendix 6 along with the section of Public Act 16-17 relevant to this report. CAES has had an Africanized honey bee plan since 2009. Varroa mites are widespread and well-established. Current management practices are well documented in various beekeeping texts and in published research studies. Because Varroa mite is firmly established and management plans are widely available, a state specific plan has not been posted. Legislatively, it is unclear what would limit or offset the existing impact of this well-established mite or enhance a mite management plan. Research on better managing the mite, including further development of resistant or hygienic bees, is needed. However, current practices are not often followed correctly and continued education of beekeepers is important to properly following those practices. The current statute, GS. Sec. 22-90 Inspection of bees for contagious diseases (Appendix 6), is well-written and covers inspection, regulation, quarantine and health certificates of honey bee pests and diseases, but does largely focus on contagious diseases particularly American foulbrood. It does not specifically address the presence of Africanized honey bees, new mites or other pests of high regulatory concern, and undesirable species or subspecies of bees. Suggested language is presented in Appendix 7 and modeled on similar regulations in other states.

Appendix 1

Number of honey bee colonies in Connecticut registered with the Office of the State Entomologist, 1995-2016.

Year	No. of Colonies*	Est. value per Colony*	Total Value All Colonies
2016	7,628	540	$4,119,120
2015	6,335	540	3,420,900
2014	5,336	325	1,734,200
2013	5,343	325	1,736,475
2012	5,443	325	1,768,975
2011	5,340	325	1,735,500
2010	3,993	325	1,297,725
2009	3,523	325	1,144,975
2008	3,583	325	1,164,475
2007	2,628	325	854,100
2006	3,000	150	450,000
2005	1,974	150	296,100
2004	1,197	150	179,550
2003	2,841	150	426,150
2002	1,554	150	233,100
2001	3,717	150	557,550
2000	2,372	150	355,800
1999	3,418	150	512,700
1998	2,368	150	355,200
1997	2,473	125	309,125
1996	2,950	100	295,000
1995	2,218	90	199,620

*Cost for just the hive and bees (nucleus colony rather than package for 2016), does not include equipment, any treatments or labor, replacement cost estimate had not been upgraded for several years.

Appendix 2

The value of utilized production for apples, peaches, and pears in Connecticut; the relative role of honey bees in their pollination, and the value of the pollination services to Connecticut agriculture.

Crop	**Utilized Production**	**2015 value**	**Dependence on pollination**	**Dependence on honey bees**	**Value due to honey bees**
Apples	1,800 ac	$14,212,000	1.0	0.9	$12,790,080
Peaches	1,365 tons	$4,375,000	0.6	0.8	$1,357,920
Pears (2008)	800 tons	$1,073,000	0.7	0.9	$657,990
Total		$18,114,000			$14,805,990

Appendix 3

Survey for Varroa mite, *Varroa destructor*, on honey bees in Connecticut, 1986-1992. Number collected and examined are individual honey bees except where otherwise noted.

Year	No. apiaries	Season	No. towns pos./exam.	No. bees collected & examined	No. or % Varroa mite
1986	51	summer	0/32	7,090	0
1987	52	summer	0/40	7,697	0
1988	109	summer	0/49	43,573	0
	37[a]	summer	0/37	37[a]	0
1989	64	summer	0/19	51,770	0
	-	fall	-	31,025	0
1990	-	summer	-	80,270	0
	45[b]	fall	37/45	45[b]	37 hives
1991	31	summer	0/26	5,700	0
	60[c]	fall	9/nd	60[c]	9 locations
1992	49[d]	summer	8/nd	49[d]	8 locations

[a]1988 statewide survey for *V. destructor* conducted with Apistan strips in 37 sites.

[b]1990 statewide survey for *V. destructor*; ether roll method used for 80,270 bees – all negative; fall sampling using Apistan strips found the mite in Connecticut for the first time at 5 locations in Fairfield County (Newtown and Monroe); 32 of 42 hives within 3 mile radius of the five sites were found infested and treated with Apistan strips.

[c]1991 statewide survey for *V. destructor* conducted with Apistan strips in 60 apiaries with the mite found at 9 towns in Fairfield, Litchfield, New London, Tolland, and Windham Counties. All 135 colonies at 47 apiaries within a 3-mile radius of the 9 locations were treated with Apistan strips.

[d]1992 statewide survey for *V. destructor* conducted with Apistan strips in 49 sites with the mite found at 8 towns in Litchfield, Hartford, Tolland, Windham, and New Haven Counties. The mites were now found in at least 21 towns in all counties except Middlesex County. The Varroa mite quarantine was repealed on November 19, 1992.

Appendix 4 - Products for the control of Varroa mites.

Product Name	EPA Reg. No.	Registered CT	Active ingredient (AI)	% AI
Apistan® Mite Strip	2724-406 2724-406-62042	Yes	Tau-fluvalinate	10.25
Api Life Var®	73291-1	Yes	Menthol Oil of eucalyptus Thymol	3.73 16.00 74.09
Apiguard™	79671-1	Yes	Thymol	25.00
Apivar®	87243-1	Yes	Amitraz	3.33
CheckMite +® *	11556-138 11556-138-61671	Yes	Coumaphos	10.00
Hopguard® II	83623-2	Yes	Hop beta acid resin	16.00
Mite-Away® Quick Strips	75710-2	Yes	Formic acid	46.70
Oxalic Acid	912661-1 91266-1-73291 91266-1-91832	Yes	Oxalic acid dehydrate	97.00
Sucrocide™ **	70950-2-2205	NA	Sucrose octanoate esters	40.00
Powdered sugar	NA	NA	Sucrose (aka 10x sugar)	100.00

*Also labeled for small hive beetle.
**Sucrocide is approved for use during honey flow; very labor intensive and not very effective.

The pesticide products listed in this Appendix are registered by EPA at the federal level for use against Varroa mites. Rotating products to combat Varroa mites is an important tactic to prevent resistance development and to maintain the usefulness of individual pesticides. Primary registered products in the list have 2-part EPA registration numbers and are listed in bold. Distributor products have a 3-part EPA registration number, with the first two numbers reflecting the primary registered product's registration number. Distributors may market their products under different names, but the formulations and uses are identical to the primary registered (Source: EPA). Not all distributor products listed.

Appendix 5. Summary of Results for Connecticut from the National Honey Bee Survey, 2014-2015.

PEST[a]	SCIENTIFIC NAME	POS	NEG	TOTAL[b]
Acute Bee Paralysis (ABPV)	Aparavirus, Acute Bee Paralysis Virus	1	30	31
American Foulbrood	*Paenibacillus* larvae	0	24	24
Asian Honey Bee	*Apis cerana*	0	31	31
Chalk Brood	*Ascosphaera apis*	0	24	24
Chronic Bee Paralysis (CBPV)	*Incertae sedis* Chronic Bee Paralysis Virus	5	25	30
Deformed Wing (DWV)	Iflavirus Deformed Wing Virus	19	12	31
European Foulbrood	*Melissococcus plutonius*	1	23	24
Greater Wax Moth	*Galleria mellonella*	1	23	24
Israeli Acute Bee Paralysis (IAPV)	Aparavirus, Israeli Acute Paralysis Virus	1	29	30
Kashmir Bee (KBV)	Aparavirus, Kashmir Bee Virus	0	30	30
Lake Sinai Virus-2 (LSV-2)	Incertae sedis Lake Sinai Virus-2	6	24	30
Nosema Disease	*Nosema* sp./spp.	20	11	31
Parasitic mite	*Tropilaelaps* sp./spp.	0	31	31
Parasitic Mite Syndrome	Parasitic Mite Syndrome (PMS)	2	22	24
Sackbrood	Iflavirus Sackbrood Virus	1	23	24
Slow Bee Paralysis (SPBV)	Iflavirus Slow Bee Paralysis Virus	0	30	30
Small Hive Beetle	*Aethina tumida*	1	23	24
Varroa Mite	*Varroa destructor*	30	1	31
TOTAL PROCESSED		88	416	504

[a]Five viruses have been detected in CT honey bees. Acute bee paralysis virus and chronic bee paralysis virus are rare in the U.S.; Deformed wing virus is very common and associated with Varroa mites; Slow bee paralysis is not yet known to occur in the U.S. While no mites were detected in one sample, 35% (11/31) of the samples exceeded the 3% threshold for treatment (≥ 3 VM/100 bees).

[b]Composite samples consisted of 24 apiaries with 8 hives sampled per apiary (7 for 2014 and 24 for 2015); total sample sizes per apiary ranged from 825 to 1766 bees (n = 40,824 bees). An estimated 57,000 bees for the 24 apiaries were submitted in 2016 for the Honey Bee Survey. Results are pending.

Appendix 6

Current Connecticut Statutes and Laws Related to Registration, Inspection, and Reporting of Honey Bees

General Statutes of Connecticut, Title 22 (Agriculture. Domestic Animals), Chapter 426 (Agricultural Experiment Stations), Section 22-89 and Section 22-90.

Sec 22-89. Registration of honey bees. Each person owning one or more hives of bees shall, annually, on or before the first day of October, make application to the State Entomologist for the registration of bees. The State Entomologist shall issue to such applicant a certificate of registration without fee. The State Entomologist shall (1) keep accessible to the public a record of the registration, the name and place of residence of the registrant and the definite location in the municipality where the bees are kept and (2) transmit a copy of such information to the town clerk of the municipality in which the registrant resides. Any owner of bees who fails to register as required by the provisions of this section shall be fined not more than five dollars.

Sec. 22-90. Inspection of bees for contagious diseases. The State Entomologist shall, to such extent as he deems necessary or expedient, examine apiaries and quarantine such as are diseased and treat or destroy cases of the disease known as foul brood. The State Entomologist may appoint such inspectors as he deems necessary or expedient, and he or any person whom he appoints for that purpose shall have access at reasonable times to any apiary or place where bees are kept or where honeycomb and appliances are stored. He is authorized to make suitable regulations regarding inspections and quarantine and to prescribe suitable forms for permanent records which shall be on file and open to public inspection, and to make reasonable rules for the services of such inspectors, and may pay a reasonable sum for such services. No person or corporation shall remove bees under quarantine to another locality without obtaining the written permission of an authorized inspector. No person or transportation company shall receive for transportation any colony or package of bees, unless such colony or package is accompanied by a certificate of good health, furnished an authorized inspector. No person or transportation company shall deliver any colony or package of bees brought from any other country, province, state or territory unless accompanied by a certificate of health furnished by an authorized inspector of such country, province, state or territory. Any person or transportation company receiving a shipment of bees from without the state, unaccompanied by such certificate, shall, before delivering such shipment to its consignee, notify the State Entomologist and hold such shipment until inspected by an authorized inspector. If contagious diseases are found therein, such shipment shall be returned to the consignor or delivered to an authorized inspector of this state for treatment or destruction, provided the requirements of this section shall not apply to shipments of brood comb, with or without bees, suspected of being diseased and consigned to the State Entomologist, the Agricultural Experiment Station or any authorized apiary inspector of the state or to the Bureau of Entomology of the United States or the United States Department of Agriculture, and provided there shall be no destruction of any shipment of bees as herein provided in the absence of reasonable notice to the consignee thereof. No person shall resist or hinder the State Entomologist, or any inspector whom he appoints, in the performance of the duties imposed by this section. No person or corporation shall sell, to be removed to another location, bees, brood comb, frames or hives that have been in use, with or without combs, until they have been inspected by an authorized inspector, who shall issue a certificate of health if

they are found free of contagious disease. Any person violating any provision of this section shall be fined not more than fifty dollars.

Public Act No. 16-1; AN ACT CONCERNING POLLINATOR HEALTH.

Sec. 7. (*Effective from passage*) [Section pertaining to the State Entomologist] Not later than January 1, 2017, the State Entomologist shall report, in accordance with section 11-4a of the general statutes, to the joint standing committee of the General Assembly having cognizance of matters relating to the environment on the conditions that cause an increase in the presence of Varroa mites that affect honey bee and other pollinator populations in the state. Such report shall include, but not be limited to, any recommendations for legislation to assist in limiting or offsetting the effects of such conditions, including, but not limited to, any required authority for the development of a Varroa mite management strategy that includes: (1) The creation of a line of local bees from survival stock that show levels of resistance to such mites and that are acclimated to the state's environment, and (2) development of queen bees with a high level of tolerance to Varroa mites for the purpose of limiting the need for imported bees.

Appendix 7

Suggested Revisions (additions underlined and deletions stroked-through) to Connecticut Statutes and Laws Related to Registration, Inspection, and Reporting of Honey Bees

Sec 22-89. These suggestions would update the registration process to when honey bee colonies are acquired rather than waiting for up to a year to receive the registration, clarify that all colonies be reported even if housed in different locations, delete the notification of town clerks as the information is posted on the Experiment Stations website. Fines are updated.
Sec. 22-90. These suggestions would expand the inspection beyond contagious diseases to include insects, mites, or parasitic organisms adversely affecting bees, or species or subspecies of bees. Fines are updated.

Sec 22-89. Registration of honey bees. Each person owning one or more hives of bees shall upon acquisition of the hives of bees[,] and annually thereafter, on or before the first day of October, make application to the State Entomologist for the registration of bees. The State Entomologist shall issue to such applicant a certificate of registration without fee. The State Entomologist shall ~~(1)~~ keep accessible to the public a record of the registration, the name and place of residence of the registrant and the definite location in the municipality where the all bees are kept ~~and (2) transmit a copy of such information to the town clerk of the municipality in which the registrant resides.~~ Any owner of bees who fails to register as required by the provisions of this section shall be fined not more than [five] twenty-five dollars.

Sec. 22-90. Inspection of bees for contagious diseases[.], parasitic organisms, species or subspecies of bees that cause injury. The State Entomologist shall, to such extent as he deems necessary or expedient, examine apiaries and quarantine such as are diseased, harboring insects, mites, or parasitic organisms adversely affecting bees, or species or subspecies of bees, which have been determined by the State Entomologist to cause injury, directly or indirectly, to the bee population, crops or other plants, and treat or destroy cases of the disease known as foul brood[.], insects, mites, or parasitic organisms, or species or subspecies of bees, which have been determined by the State Entomologist to cause injury, directly or

indirectly, to the bee population, crops or other plants. The State Entomologist may appoint such inspectors as he deems necessary or expedient, and he or any person whom he appoints for that purpose shall have access at reasonable times to any apiary or place where bees are kept or where honeycomb and appliances are stored. He is authorized to make suitable regulations regarding inspections and quarantine and to prescribe suitable forms for permanent records which shall be on file and open to public inspection, and to make reasonable rules for the services of such inspectors, and may pay a reasonable sum for such services. No person or corporation shall remove bees under quarantine to another locality without obtaining the written permission of an authorized inspector. No person or transportation company shall receive for transportation any colony or package of bees, unless such colony or package is accompanied by a certificate of good health, furnished an authorized inspector. No person or transportation company shall deliver any colony or package of bees brought from any other country, province, state or territory unless accompanied by a certificate of health furnished by an authorized inspector of such country, province, state or territory. Any person or transportation company receiving a shipment of bees from without the state, unaccompanied by such certificate, shall, before delivering such shipment to its consignee, notify the State Entomologist and hold such shipment until inspected by an authorized inspector. If contagious diseases, insects, mites, or parasitic organisms, or species or subspecies of bees, which have been determined by the State Entomologist to cause injury, directly or indirectly, to this states useful bee population, crops or other plants are found therein, such shipment shall be returned to the consignor or delivered to an authorized inspector of this state for treatment or destruction, provided the requirements of this section shall not apply to shipments of brood comb, with or without bees, suspected of being diseased and consigned to the State Entomologist, the Agricultural Experiment Station or any authorized apiary inspector of the state or to the Bureau of Entomology of the United States or the United States Department of Agriculture, and provided there shall be no destruction of any shipment of bees as herein provided in the absence of reasonable notice to the consignee thereof. No person shall resist or hinder the State Entomologist, or any inspector whom he appoints, in the performance of the duties imposed by this section. No person or corporation shall sell, to be removed to another location, bees, brood comb, frames or hives that have been in use, with or without combs, until they have been inspected by an authorized inspector, who shall issue a certificate of health if they are found free of contagious disease, insects, mites, or parasitic organisms, or species or subspecies of bees, which have been determined by the State Entomologist to cause injury, directly or indirectly, to this states useful bee population, crops or other plants. Any person violating any provision of this section shall be fined not more than [fifty] one-hundred dollars[.] for the first violation, $300 for the second violation, and $500 for the third and subsequent violations.

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