THE COMMONWEALTH OF MASSACHUSETTS

EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS

Department of Agricultural Resources

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MDAR MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

CHARLES D. BAKER	KARYN E. POLITO	KATHLEEN A. THEOHARIDES	JOHN LEBEAUX
Governor	Lt. Governor	Secretary	Commissioner

TO: Commissioner Monica Bharel (DPH)
Commissioner John Lebeaux (MDAR)
Commissioner Martin Suuberg (DEP)
Commissioner Leo Roy (DCR)

FROM: State Reclamation and Mosquito Control Board

DATE: *Approved by the Board on Thursday, August 20, 2020*

RE: Final Summary Report: Aerial adulticiding intervention response to Eastern Equine Encephalitis virus (EEEV), Massachusetts, 2019

Introduction

During August and September of 2019, the State Reclamation and Mosquito Control Board ("Board"), operating within the Massachusetts Department of Agricultural Resources ("MDAR"), in collaboration with regional Mosquito Control Districts and Projects ("MCDs"), and the Massachusetts Department of Public Health ("DPH") planned, implemented, and supervised six (6) aerial mosquito control spray operations. The aerial spray took place within Bristol, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, and Worcester counties in Massachusetts, in order to reduce the risk of Eastern Equine Encephalitis ("EEEv") throughout the Commonwealth. As outlined in the "Massachusetts Emergency Operations Response Plan for Mosquito-Borne Illness," the Board hereby submits its final summary report concerning the emergency response during the summer of 2019.

The 2019 emergency mosquito response followed 5 years of extremely low levels of EEEv activity, driven in part by drought conditions during 2016 and 2017:

Mosquito testing and arbovirus levels, 2019-2012:

Year	# Pools Submitted	# WNV+	# EEEv+	Total Mosquitoes Submitted for Testing	% pools WNV+	% pools EEEv+
2019	8275	87	428	240,244	1%	5%
2018	5917	579	2	170,568	10%	less than 0.1%
2017	5381	290	1	154,284	5%	less than 0.1%
2016	6386	189	4	186,947	3%	0.1%
2015	4527	164	1	137,253	4%	less than 0.1%
2014	5038	56	33	132,776	1%	1%
2013	6090	335	61	171,390	6%	1%
2012*	6746	305	262	150,565	5%	4%

*Last time an emergency response aerial spray was performed.

Populations of the primary driver of the EEEv disease cycle, the bird-biting mosquito *Culiseta melanura*, started to increase starting in 2017, and during 2018 reached peaks that were far above the 10-year averages calculated by MA DPH at long-term trapping sites. This put the Board, MCDs, and DPH on high alert to monitor for the presence of EEEv in this species. However, there remained virtually no detection of EEEv in 2018, leaving it unclear as to whether the virus would make a strong showing in the 2019 season.

In general, mosquito activity in general is driven by a combination of both temperature and weather, with population increases typically depending on both warmer temperatures that speed up the time it takes for a mosquito to go from egg to adult, and precipitation making more larval habitat available. Though temperatures were about average in June, they were above average across the state for July. Precipitation levels, typically driven in summer by unpredictable and localized storm events, varied greatly, with a significant rain event at the start of June, followed by little precipitation in known active areas for EEEv (the Southeast) until the second week of July (Epi Week 28, the week before the first EEEv+ mosquitoes were found), when parts of the Southeast received more than 5 inches of rain. Records indicate a departure from normal precipitation of 1-3 inches in July 2019 for most of the eastern half of the state and parts of Plymouth and Bristol counties receiving in excess of 5 inches more precipitation than normal (see Fig 1 below). This variation in both temperature and rainfall made it challenging to predict both mosquito population levels and the potential for an increase in risk of EEEv.

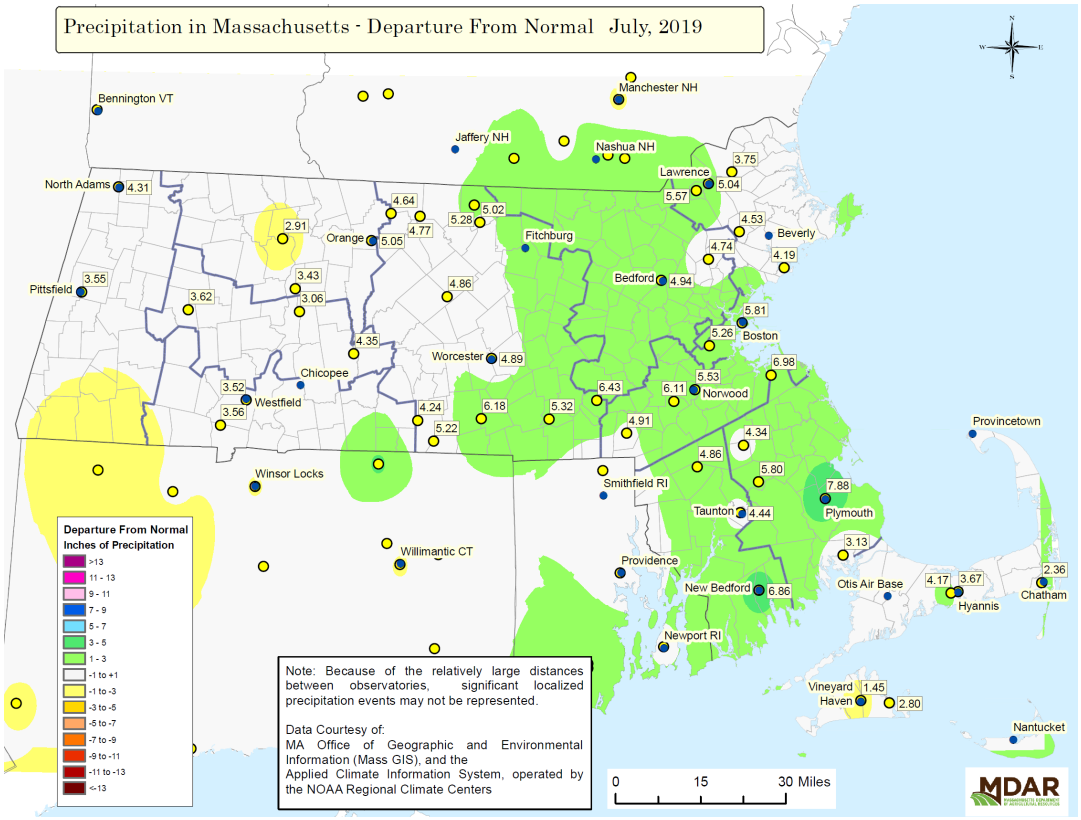


Fig. 1: Departure from Normal Rainfall for July 2019.

As DPH and the MCDs began mosquito monitoring for the 2019 season, levels of *Culiseta melanura* at long-term trapping sites started off historically high at the beginning of June, and though they dropped significantly towards the end of June, they stayed above the 10-year average almost the entire season.

Data from MCDs in Plymouth and Bristol counties also reflected this. Combined submissions of *Culiseta melanura* samples for testing (by MCDs and DPH) were the highest they have been since 2012 (the last year an aerial spray was needed to combat EEEv) but did not detect presence of EEEv in mosquitoes until the second half of July, with the first 4 EEEv+ mosquito pools all found in Bristol County in mosquitoes collected during Epi Week 29 (July 14-20).

Following the verification of the presence of EEEv in mosquitoes in the Southeast, MCDs in both Plymouth and Bristol counties commenced adulticide treatments in areas surrounding the traps where the positives were found. In addition, both the MCDs and DPH increased surveillance and mosquito testing efforts, with over 1400 pools of mosquitoes collected for testing the final two weeks of July (Epi Week 30 and 31). There were 53 EEEv+ mosquito pools confirmed for Epi Week 30, in both Bristol and Plymouth counties, and 132 for Epi Week 31, again mainly in Bristol and Plymouth counties. While many of these positives were *Culiseta melanura*, there were also a large number of other EEEv+ species being found, including Coquillettidia perturbans, which feeds on humans and other mammals and is considered the major "bridge vector" that brings EEEv from birds to people.

It is important to keep in mind that DPH processes mosquito samples as quickly as possible, but there can still be a delay of several days between when samples are collected and when results are known, depending on when they arrive at the lab. The sharp increase from 4 EEEv+ pools one week to 53 the next was in part driven by an increase in sampling, but in hindsight, we can see that it was still a very big increase. By the end of July, it was clear that truck-based adulticiding in the Southeast was not sufficient enough to keep EEEv from spreading within existing mosquito populations, and that the risk of EEEv spreading to humans and other mammals was high. Additional finds at this time of EEEv+ mosquitoes in Worcester County and Barnstable County (5 pools each) meant that risk levels were raised in those areas as well.

As a result, DPH announced and issued a "*Certification of Public Health Hazard that Requires Pesticide Application to Protect Public Health"* (**see Appendix 1**) on three occasions, August 6, August 21, and September 9, 2019. These documents certified that the aerial application was necessary to protect the public, in portions of Bristol, Plymouth, Hampden, Hampshire, Worcester, Middlesex, and Norfolk counties where infected and infectious adult mosquitoes were most prevalent. In response, the Board held emergency meetings on August 6, August 21, and September 10, 2019 and approved aerial adulticide intervention to reduce the abundance of adult mosquitoes infected with EEEv. The Board, operating through MDAR and contractors, immediately began to carry out the logistics of the aerial adulticide spray operations, including procuring planes and insecticides, coordinating GIS mapping, obtaining the Massachusetts Endangered Species Emergency Authorization Permit, facilitating extensive communications between agencies following the declaration of public health hazard, and providing onsite oversight of the actual operation at the airport/staging area of the operation. Aerial treatment for mosquitoes took place on 6 spray events; covering 111 municipalities in Massachusetts (**see Appendix 5**). The public health certifications remained in effect until September 30, 2019.

Clarke Mosquito Control Products, Inc. ("Clarke") was the contractor used for the aerial adulticide intervention. Clarke provided 3 services during the aerial intervention: pesticide products, efficacy testing, and airport logistics. The pesticide used was Anvil 10+10 ULV, EPA Registration number 1021-1688-8329. Anvil 10+10 ULV contains the active ingredients d-phenothrin (sumithrin) and the synergist piperonyl butoxide (PBO) (**see Appendix 2**). Dynamic Aviation, the subcontractor used during the event,

provided aviation solutions and GIS work services. Prior to the actual operation, a two-step calibration and characterization procedure was conducted on each airplane to ensure that the desired aerial spray application parameters (such as amount of active ingredient dispensed per acre and the optimum droplet size) were achieved for maximum efficacy and to be consistent with the product label. During the applications, representatives from MDAR's pesticide program enforcement team were present. The entire contractor cost of the 6 aerial mosquito control spray event operations was $5,085,636 (**see Appendix 3**).

In accordance with National Pollutant Discharge Elimination System ("NPDES") permit requirement pursuant to the Clean Water Act ("CWA"), MDAR/the Board filed a "Notice of Intent" to comply with current federal requirements. The Board filed a "Notice of Intent" for an NPDES permit on both August 30, 2019 and October 8, 2019.

Detailed Descriptions of the Aerial Spray Events

The 2019 emergency mosquito response took place on 6 different spray events. The first event of aerial mosquito control spraying operations began on Thursday evening of August 8, 2019 and the final spray event ended on September 24, 2019. It took a total of 26 days of spraying, with 2,048,865 total of acres treated, and 9,939 gallons on Anvil 10+10 applied **(see Appendix 4).** Approximately 1.5 million people were located within the spray boundaries.

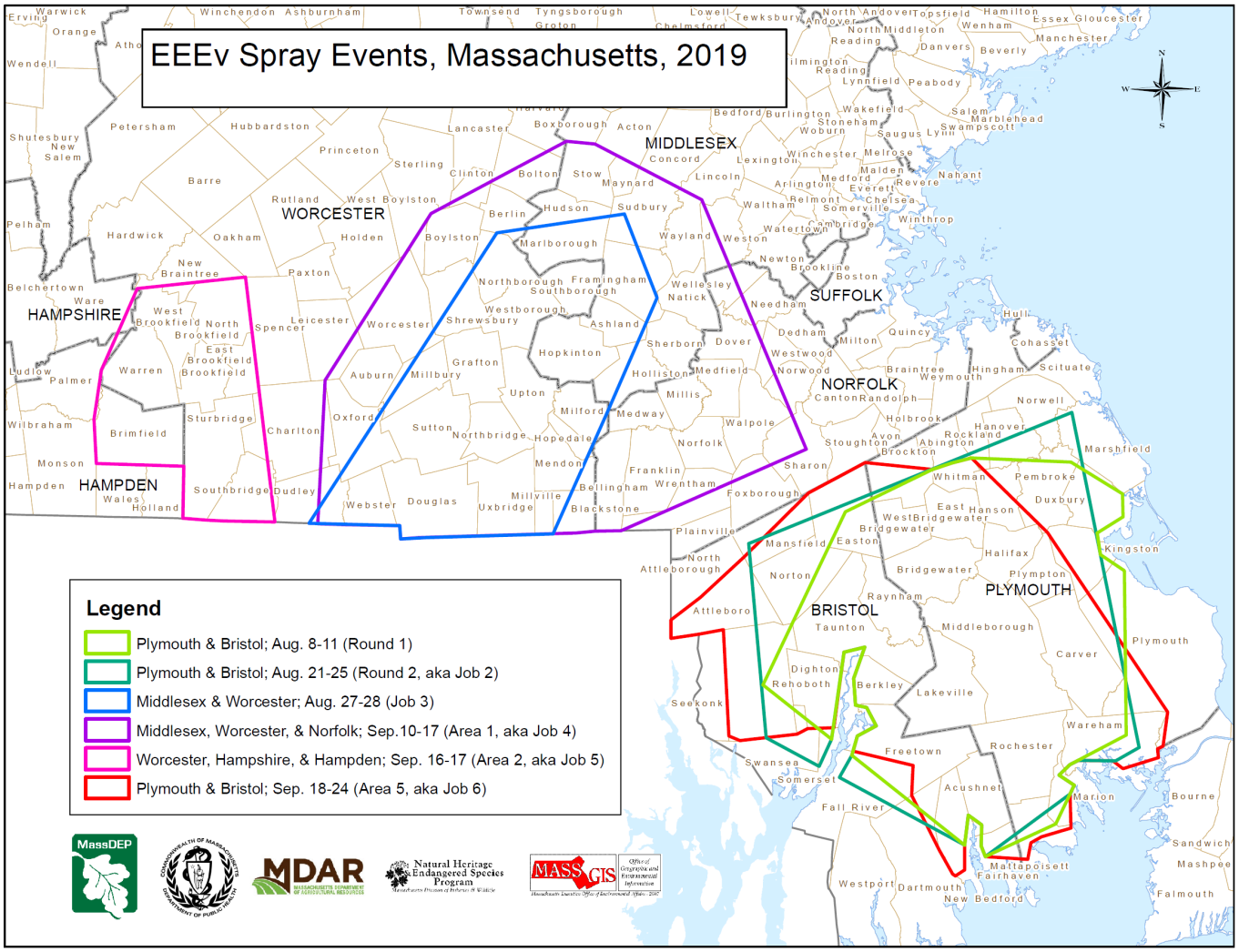


Table 1 shows the efficacy calculated for each spray event (data and calculations provided by MDPH). In addition to showing total reduction in mosquito populations, the table also breaks down the data to show reductions of the two mosquito species that drive the EEEv cycle, *Culiseta melanura* (the bird-biting species that ramps up viral activity in birds) and *Coquillettidia perturbans* (the mammal-biting "bridge vector" that is most likely to spread EEEv to humans). The unprecedented duration and breadth of spray events meant that there was a lot of variation in mosquito activity and weather conditions, which led to a wide range of treatment efficacy.

Table 1: Spray Efficacy

Spray Event (Counties)	Dates	Total Reduction in Mosquitoes Trapped	Reduction in *Cq. perturbans*	Reduction in *Cs. melanura*
#1 (Bristol/Plymouth)	8/8-8/11	58%	66%	11%
#2 (Bristol/Plymouth)	8/21-8/25	25%	91%	NR
#3 (Middlesex/Worcester)	8/26-8/27	20%	38%	NR
#4 (Middlesex/Norfolk/Worcester)	9/10-9/18	NR*	NR	NR
#5 (Hampden/Hampshire/Worcester)	9/15-9/17	NR	NR	NR
#6 (Bristol/Plymouth)	9/18-9/24	53%	NR	59%

Data Source: MDPH

*NR = No reduction in population levels observed (e.g. sample sizes were too small for effective calculations, or control showed equal or greater reduction in population levels due to weather conditions or other factors)

Calculations corrected using the Henderson-Tilton formula, see http://www.ehabsoft.com/ldpline/onlinecontrol.htm

Environmental Monitoring:

Environmental monitoring is valuable to detect the extent of pesticide deposition to soil, water and other receptors, and for potential collateral effects to non-targets organisms. Bees, drinking water supplies, and cranberries surveillance have been standard for monitoring potential impacts during prior mosquito-borne public health emergencies

Apiary monitoring:

Communication to beekeepers consisted of a variety of media outlets including phone calls, emails, Facebook posts, and Mass.gov website notifications that took place pre-application, during and post-application. The Honey Bee Monitoring Protocol for Aerial Mosquito Adulticide Application from The Mosquito Emergency Operations Response Plan for Mosquito-Borne Illness was utilized for monitoring with modification, as needed. Beekeepers were selected for monitoring based on their geographic location and colony health. Selected apiaries were either categorized as those within (treatment group) or outside (control group) the application area based on their geographic location and inspection prior to application.

The visual observations of the MDAR Apiary Program Team combined with that of the beekeepers whose apiaries were visited and consistently monitored for colony health, indicate that overall honey bee colonies were not acutely impacted by the aerial application. Beekeepers contacted in follow up communication whose colonies were not monitored or investigated in this report but located in spray areas also reported no observable health issues resulting from the aerial application. Data analysis indicates that the pesticide residue levels in the bee and pollen samples were well below the level that would cause lethal effects in adult honey bees. Given this, it can be concluded that the exposure to d-Phenothrin and PBO from the aerial application was not a major cause of the bee mortality observed in these monitoring events and investigations. Many of the viruses found in samples are documented to cause bee mortality. Given this, the most likely cause of any higher than normal observed bee mortality from samples taken during these monitoring efforts were likely caused by a combination of the negative impacts of viruses detected in samples and that associated with standard daily bee mortality. For the full Apiary program report, see Appendix 7.

Cranberry Sampling:

In making the determination as to whether or not cranberries needed to be sampled during the 2019 event, the Board, with the assistance of MDAR, reviewed past documents to try to understand the reasoning behind this action. It found that cranberry sampling begun taking place during the 2006 aerial spray. At that time, Anvil 10+10 ULV did state that it could be used over agricultural settings. At that time the Board, through MDAR, filed for a Section 18 with EPA which would allow the off-label use of the product due to a public health emergency. As part of the findings, there was a determination that sampling of cranberries would be conducted. In 2009, the manufacturer of the product added that use pattern onto the label. It was unclear as to why DPH continued to collect samples, but they did so for subsequent years.

During the early stages of organizing the 2019 spray event, the DPH indicated that they did not see a need to test cranberries as they had done in the past. Due to the fact that the Board was still in the stages of discovering the history of cranberry sampling, it was determined that MDAR would conduct the sampling. MDAR used guidance provided by DPH when sampling.

Results of 4 samples that took place on August 8th, 15th, 21st and 28th of cranberries testing for sumithrin revealed no detectable levels of sumithrin in any sample, whether taken prior to or after either spray event Since no measurable residues of sumithrin were detected in any of the cranberry samples, the consumption of cranberries harvested from bogs located in the spray areas would not be expected to pose health concerns.

Due to resources issues, allowances made by the pesticide label and the sample results the 2019 samples and previous years' results, the Board, in consultation with MDAR, determined to discontinue the practice of sampling cranberries.

Surface Water Quality Sampling:

The Massachusetts Department of Environmental Protection ("MassDEP") conducted an extensive monitoring program to ensure that public water supplies were safe for human consumption and that surface waters were safe for public use. MassDEP conducted monitoring before and after each aerial spraying event, with assistance from public water suppliers who performed water quality testing of their water supplies, to ensure that the public was not exposed to the short-lived Sumithrin pesticide and piperonyl butoxide synergist.

Sumithrin was detected in 5 of 58 samples collected from surface water bodies that are not drinking water sources of the non-public water supplies water samples and the synergist PBO was detected in 53 of the non-public water supplies water samples. However, all detected concentrations were far below the U.S. EPA Aquatic Life Benchmark Concentrations for fish and invertebrates. The highest concentration of Sumithrin was 0.051 ug/L, detected in a sample collected from Manchaug Pond in Sutton, MA in Spray Event 3 in Middlesex and Worcester Counties. The highest concentration of PBO was 0.334 ug/L, detected in a sample from Lake Nippenicket in Bridgewater, MA during Spray Event 2.

MassDEP conducted extensive monitoring throughout August and September of 2019 in response to aerial spraying conducted by the Board. Analytical results for the 277 samples collected during the six spray events conducted during this period indicate that concentrations of Sumithrin and its PBO synergist

were far below the U.S. EPA Benchmarks for human health risk level of concern and the U.S. EPA Aquatic Life Benchmark Concentrations for fish and invertebrates. For the full report, see https://www.mass.gov/doc/response-to-eastern-equine-encephalitis-virus-mosquito-control-aerial-spray-events-2019/download

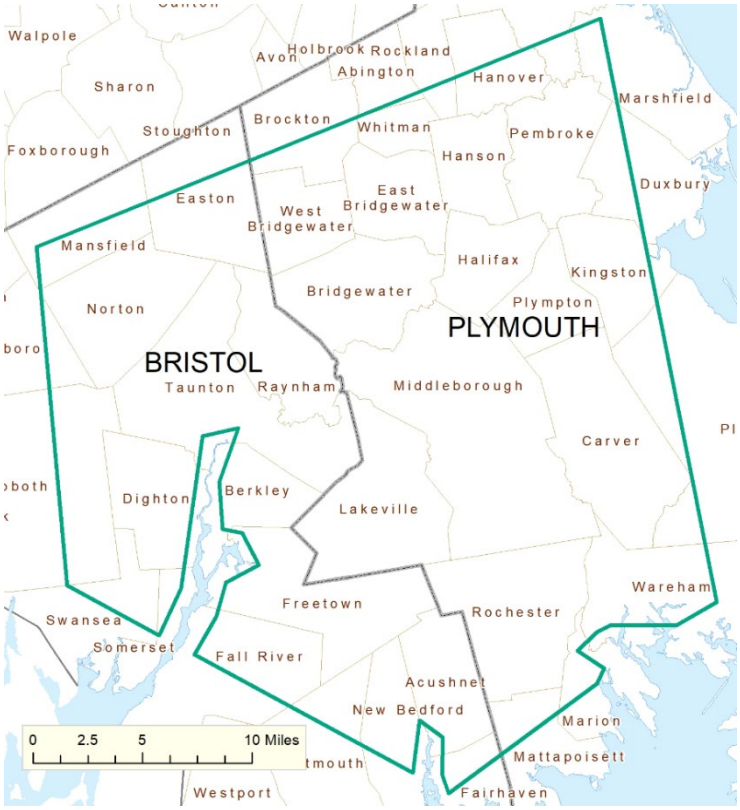
Spray Event 1: August 8-11, 2019

As the operation began in Bristol and Plymouth Counties, significant efforts commenced to bring all parts of the operation together, including insuring timely delivery of sufficient insecticide, deployment of adequate aircraft to cover the approved application area, GIS mapping with exclusion zones, public communication/messaging, and ultimately, the conducting of the application itself. Two (2) aircraft were requested by the Board to cover the region as quickly as possible. With 2 aircraft deployed from Dynamic Aviation Company, Clarke coordinated the immediate shipment of Anvil 10+10 ULV to Plymouth Municipal Airport. Issues with planes and also pilot availability limited the operation to the use of only 1 plane at both the beginning and end of the spray event.

The first spray event occurred over 4 nights **(See Appendix 5)** and covered a total of 372,080 acres. The aircraft applied a total of 1,796 gallons of Anvil 10+10 ULV during spray event 1. Over the course of the operation, Anvil 10+10 ULV was applied at a rate of 0.62 oz./acre (the maximum allowable amount permitted by the pesticide product label), and at an approximate height of 300 feet above the ground.

Weather conditions during the August 8-11 aerial application ranged from good to less than ideal; though all-weather parameters remained within ranges compatible with the pesticide product label (pesticide labeling for Anvil 10+10 ULV states that air temperature should be greater than 50° F), lows for the nights of August 10-11 dipped into the 50s, meaning mosquitoes were less active **(See Appendix 6)**. Wind speeds were inconsistent during the hours of operation, particularly when unexpected storms developed during the first night. Efficacy testing showed that there was an overall 58% reduction in mosquito populations, with a significant reduction in levels of *Coquillettidia perturbans* (66%), though only a minimal (11%) reduction in levels of *Culiseta melanura* (Table 1).

Spray Event 2: August 21-25, 2019

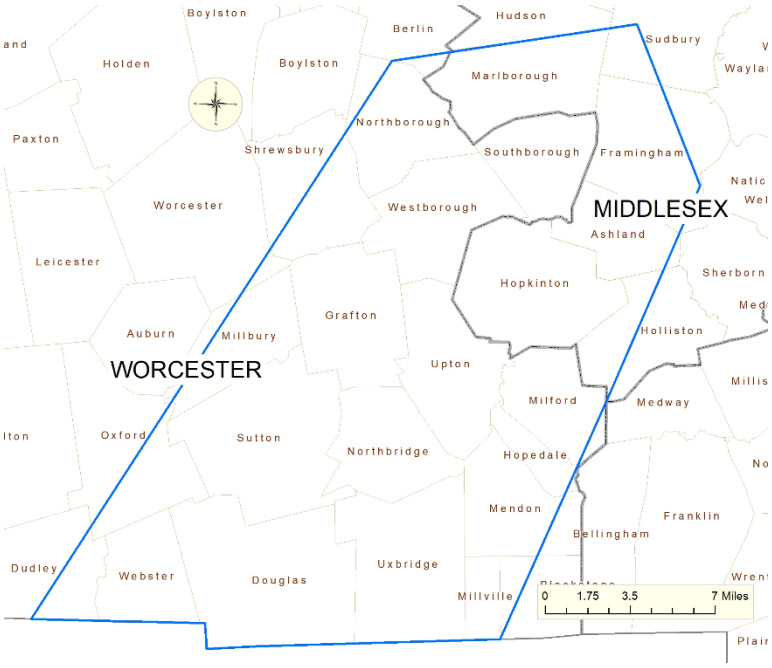


With continued EEEv detections in mosquitoes following Spray Event 1, the risk of EEEv transmission remaining of significant concern in both bird- and mammal-biting mosquitoes. Because of this, a second spray in Bristol and Plymouth counties was initiated approximately 2 weeks after Spray event 1. Contractors ensured timely delivery of insecticide and adequate aircraft to cover the approved application area. New GIS mapping with exclusion zones were generated, and new towns were included in the public communication/ messaging stage. Dynamic Aviation provided a single aircraft to cover the region but was able to get two aircrafts for two of the nights.

Spray event 2 occurred over 5 spray nights **(See Appendix 5)** and covered a total of 406,808 acres. Aircraft applied a total of 1,982 gallons of Anvil 10+10 ULV during this spray event, at a rate of 0.62 oz./acre and at a height of approximately 300 feet above the ground.

Reported weather conditions during the August 21-25 aerial application were acceptable, though again, we saw nighttime temperatures dip into the low 50s towards the end of the spray (August 23-25) **(See Appendix 6)**. Operations conducted during this spray event achieved positive results despite less than optimal weather conditions, in that a significant reduction in levels of the primary mammal-biting carrier of EEEv (*Cq. perturbans*) was achieved (91%), though overall mosquito control was only 25%, and control of *Cs. melanura* (the bird-biting mosquito) was considered minimal because control sites also showed a significant reduction in populations of this species.

Spray Event 3: August 26-27, 2019

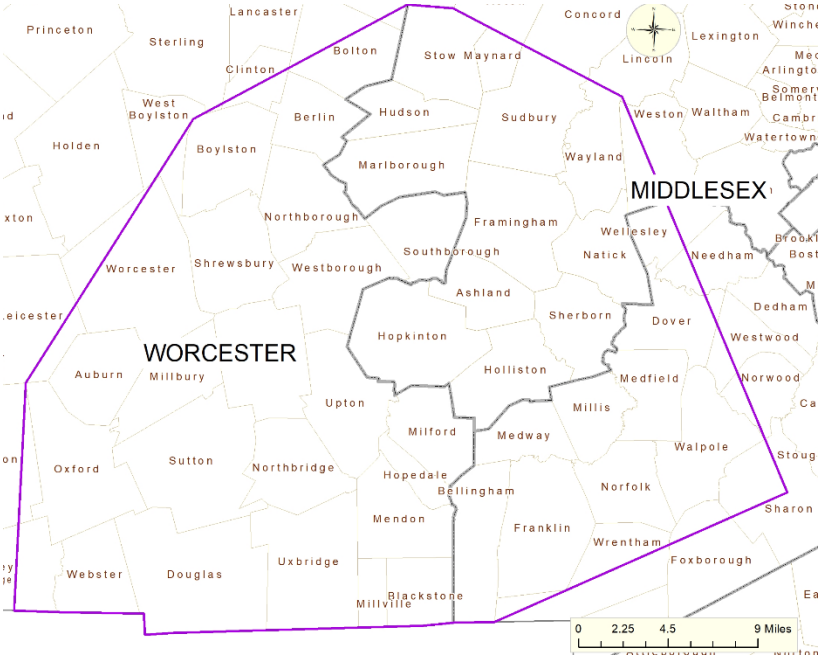


On August 21, 2019 DPH issued a second Certification of Public Health Hazard, covering Middlesex and Worcester counties **(See Appendix 1)** and a third spray event was initiated. Contractors ensured timely delivery of insecticide and adequate aircraft to cover the approved application area, new GIS mapping with exclusion zones was generated, and new towns were included in the public communication/messaging stage.

Spray event 3 occurred over 2 spray nights **(See Appendix 5)** and covered a total of 243,181 acres. Originally, spray event 3 was supposed to begin on August 25th, but due to cold temperatures, it was postponed until August 26th. The aircraft applied a total of 1,177 gallons of Anvil 10+10 ULV at a rate of 0.62oz/acre (the maximum allowable amount permitted by the pesticide product label), at a height of approximately 300 feet above the ground.

Weather conditions during the August 26-27 aerial application were colder than average, with a high of only 72°F and lows near 50°F. While nighttime temperature were still within the temperature range on the pesticide product label **(See Appendix 6)**, mosquito activity was likely suppressed. Overall efficacy for Spray Event 3 was fairly low (20%), though *Cq. perturbans* still saw a 38% reduction. *Cs. melanura* efficacy was not able to be accurately calculated because of extremely small trap collections in both control and treatment areas, both before and after the spray, again likely due to lower than average temperatures.

Spray Event 4: September 10-18, 2019

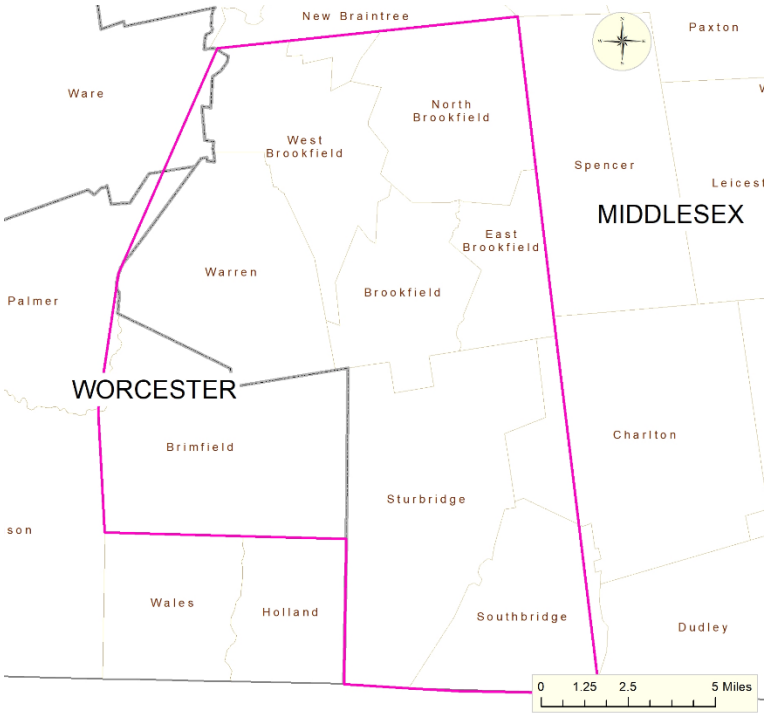


On September 9, 2019 DPH issued the third and final Certification of Public Health Hazard that covered portions of Bristol, Essex, Franklin, Hampshire, Hampden, Middlesex, Norfolk, Plymouth, and Worcester Counties **(See Appendix 1)**. Contractors ensured timely delivery of insecticide and adequate aircraft to cover the approved application area. New GIS mapping with exclusion zones was generated, and new towns were included in the public communication/messaging stage. Dynamic Aviation provided two (2) aircraft to cover the region, but due to some pilot/plane issues, only one plane was available for several days of the spray event.

Spray event 4 occurred over 9 spray nights **(See Appendix 5)** and covered a total of 453,799 acres. The aircraft applied a total of 2,196 gallons of Anvil 10+10 ULV, applied at a rate of 0.62oz/acre (the maximum allowable amount permitted by the pesticide product label), at a height of approximately 300 feet above the ground. Weather conditions during the September 10-18, 2019 aerial application were less than ideal, though acceptable during certain windows **(See Appendix 6)**. Daytime and nighttime temperatures remained quite cool, except for Sept. 11 and Sept. 15th. This lengthened the duration of the spray event and made it challenging to effectively treat mosquito populations. It was challenging because temperatures limited the amount of acreage that could be covered in a single night and because mosquito activity was decreased. All weather parameters remained within ranges listed on the pesticide product label.

Overall, while trap collections from treatment areas for Spray event 4 did show a decrease in mosquito populations after the spray event, this decrease did not differ enough from a similar decrease in trap collections from control areas to show efficacy, in part because trap collections were quite small due to the lack of mosquito activity.

Spray Event 5: September 16-17, 2019



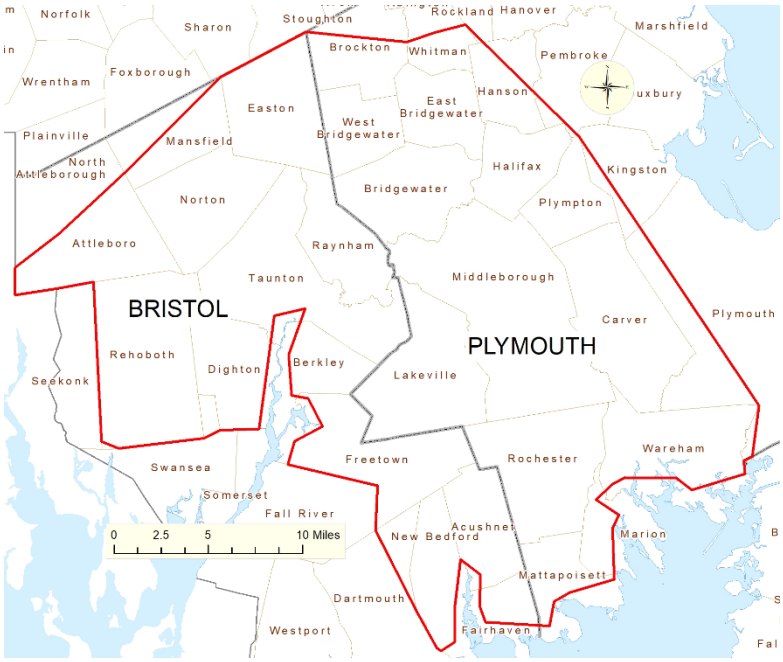
Spray event 5 took place in parts of Hampden, Hampshire, and Worcester counties. Contractors ensured timely delivery of sufficient insecticide and deployment of adequate aircraft to cover the approved application area. New GIS mapping with exclusion zones was generated, and new towns were included in the public communication/messaging stage. Dynamic Aviation provided two aircraft to cover the region for most of the spray event. Spray event 5 was conducted in conjunction with spray event 4 due to temperature fluctuations in these two areas.

The operation was divided into 2 spray nights **(See Appendix 5)** and covered a total of 184,968 acres. During this process, Dynamic Aviation communicated to the department that there was an issue with their FlightOps scheduling and would only have one aircraft and 2 pilots available on the second night of the spray.

The aircraft applied a total of 911 gallons of Anvil 10 +10 ULV, applied at a rate of 0.62 oz./acre (the maximum allowable amount permitted by the pesticide product label), and at a height of approximately 300 feet above the ground. Weather conditions September 16-17 unfortunately remained less than ideal **(See Appendix 6)**, with highs below 70°F and lows around 51°F, though all weather parameters remained within ranges listed on the pesticide product label.

Similar to Spray Event 4, trap collections from both treatment and control areas were quite small due to the lack of mosquito activity. While treatment areas for Spray event 5 did show a decrease in mosquito populations after the spray event, this decrease did not differ enough from a similar decrease in control areas to show efficacy.

Spray Event 6: September 18-24, 2019



The final spray event took place in Bristol and Plymouth counties. Contractors ensured timely delivery of sufficient insecticide and deployment of adequate aircraft to cover the approved application area. New GIS mapping with exclusion zones was generated, and new towns were included in the public communication/messaging stage.

Spray event 6 occurred over six spray nights **(See Appendix 5)** and covered a total of 388,029 acres. The aircraft applied a total of 1,877 gallons of Anvil 10+10 ULV, applied at a rate of 0.62 oz./acre (the maximum allowable amount permitted by the pesticide product label), and at a height of approximately 300 feet above the ground. Weather conditions from September 18-24 were improved over the previous 2 spray events but were still less than ideal; though daytime temperatures were hot, nighttime temperatures remained quite cool until the last two nights (Sept. 23-24) **(See Appendix 6)**, and operations on the evening of Sept. 19 were suspended due to the low temperatures. The unexpected increase in temperatures towards the end of the spray event is likely what contributed to the 53% overall reduction in mosquito levels for this aerial application, and though levels of *Cq. perturbans* were too low to show any measurable efficacy, we did see a 59% decrease in *Cs. melanura* levels.

Conclusion of Aerial Mosquito Control Spray operations

In 2019, Massachusetts experienced a historically bad mosquito season with record numbers of human and animal cases of EEEv virus. Twelve (12) people across the state were diagnosed with the rare infection, which claimed the lives of three patients. EEEv was also confirmed in nine (9) animal including eight (8) horses and one (1) goat.

Massachusetts mosquito control programs faced a challenging season: excessive levels of the mosquito that drives the EEEv cycle (*Culiseta melanura*); new areas within the state with significant mosquito activity and human cases of EEEv at a level that required aerial applications; unprecedented nationwide EEEv activity that limited our contractors' ability to respond; and variable weather patterns. These challenges made it difficult to provide a consistent and effective response and pushed aerial operations into a time of year where weather patterns and mosquito behavior made it even more difficult to effectively reduce the EEEv risk level.

The Board, MDAR, MCDs, DPH, and MassDEP leadership have initiated a plan to support the prevention, intervention, and risk communications activities in 2020. Based on the 2019 Arbovirus

Season Response, leadership has identified essential elements to improve and those include communication to stakeholders, aerial spraying operations, coordination of procedures and templates, distributions lists, additional workforce, and a critical timeline.

Appendix 1

Certification of Public Health Hazard 8.6.19

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
250 Washington Street, Boston, MA 02108-4619

CHARLES D. BAKER
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KARYN E. POLITO
Lieutenant Governor

MARYLOU SUDDERS
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MONICA BHAREL, MD, MPH
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Tel: 617-624-6000
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CERTIFICATION OF PUBLIC HEALTH HAZARD THAT REQUIRES PESTICIDE APPLICATION TO PROTECT PUBLIC HEALTH

Public health surveillance information indicates an increased risk of eastern equine encephalitis (EEE) in humans in certain parts of Massachusetts. In response to this increased risk, the Department of Public Health has determined that aerial application of pesticides in certain areas is necessary to protect public health. In order to apply pesticides in certain legally protected areas, the certification below is necessary.

Property Owner Exclusions

The Massachusetts Pesticide Regulations prescribe the methods by which persons living in or legally in control of lands may designate such lands for exclusion from the application of pesticides (333 CMR 13.03). However, 333 CMR 13.03(3)(b) provides that requests for exclusion shall not be honored in those cases in which "The Commissioner of Public Health has certified that the application is to be made to protect the Public Health." The effect of this certification is that the applicators engaged in aerial pesticide applications are not required to honor designations for exclusion made by persons living in or legally in control of lands to which the pesticides may be applied.

Endangered Species

Division of Fisheries and Wildlife (DFW) regulations prohibit the taking of any state or federally listed animal or plant species, with limited exceptions specified in 321 CMR 10.04. One exception is to protect human health during the period and within the geographic area of a public health hazard as certified in writing by the Commissioner of Public Health (321 CMR 10.04(3)(e)). Under such circumstances, DFW may issue a permit to take endangered species if it has found that all reasonable efforts have been undertaken to avoid the removal, capture or destruction of such species.

Commissioner Certification

I hereby certify, pursuant to 333 CMR 13.03(3)(b) and 321 CMR 10.04(3)(e), that a public health hazard exists in the areas of Massachusetts specified below and that application of pesticides by aerial spraying in areas known to harbor mosquitoes carrying the EEE virus is necessary to protect the public health.

The areas covered by this certification are those areas of Bristol and Plymouth Counties determined by Department of Public Health surveillance data to warrant aerial pesticide application to protect public health. This certification shall remain in effect until August 31, 2019.

8/6/19
Date

Lindsey Tucker
Associate Commissioner

Certification of Public Health Hazard 8.21.19

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Department of Public Health
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The Massachusetts Pesticide Regulations prescribe the methods by which persons living in or legally in control of lands may designate such lands for exclusion from the application of pesticides (333 CMR 13.03). However, 333 CMR 13.03(3)(b) provides that requests for exclusion shall not be honored in those cases in which "The Commissioner of Public Health has certified that the application is to be made to protect the Public Health." The effect of this certification is that the applicators engaged in aerial pesticide applications are not required to honor designations for exclusion made by persons living in or legally in control of lands to which the pesticides may be applied.

Endangered Species

Division of Fisheries and Wildlife (DFW) regulations prohibit the taking of any state or federally listed animal or plant species, with limited exceptions specified in 321 CMR 10.04. One exception is to protect human health during the period and within the geographic area of a public health hazard as certified in writing by the Commissioner of Public Health (321 CMR 10.04(3)(e)). Under such circumstances, DFW may issue a permit to take endangered species if it has found that all reasonable efforts have been undertaken to avoid the removal, capture or destruction of such species.

Commissioner Certification

I hereby certify, pursuant to 333 CMR 13.03(3)(b) and 321 CMR 10.04(3)(e), that a public health hazard exists in the areas of Massachusetts specified below and that application of pesticides by aerial spraying in areas known to harbor mosquitoes carrying the EEE virus is necessary to protect the public health.

The areas covered by this certification are those areas of Middlesex and Worcester Counties determined by Department of Public Health surveillance data to warrant aerial pesticide application to protect public health. This certification shall remain in effect until September 15, 2019.

8/21/19
Date

Monica Bharel, MD, MPH
Commissioner

Certification of Public Health Hazard 9.9.19

The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
250 Washington Street, Boston, MA 02108-4619

CHARLES D. BAKER
Governor
KARYN E. POLITO
Lieutenant Governor

MARYLOU SUDDERS
Secretary
MONICA BHAREL, MD, MPH
Commissioner
Tel: 617-624-6000
www.mass.gov/dph

CERTIFICATION OF PUBLIC HEALTH HAZARD THAT REQUIRES PESTICIDE APPLICATION TO PROTECT PUBLIC HEALTH

Public health surveillance information indicates an increased risk of eastern equine encephalitis (EEE) in humans in certain parts of Massachusetts. In response to this increased risk, the Department of Public Health has determined that application of pesticides in certain areas is necessary to protect public health. In order to apply pesticides in certain legally protected areas, the certification below is necessary.

Property Owner Exclusions

The Massachusetts Pesticide Regulations prescribe the methods by which persons living in or legally in control of lands may designate such lands for exclusion from the application of pesticides (333 CMR 13.03). However, 333 CMR 13.03(3)(b) provides that requests for exclusion shall not be honored in those cases in which "The Commissioner of Public Health has certified that the application is to be made to protect the Public Health." The effect of this certification is that the pesticide applicators are not required to honor designations for exclusion made by persons living in or legally in control of lands to which the pesticides may be applied.

Endangered Species

Division of Fisheries and Wildlife (DFW) regulations prohibit the taking of any state or federally listed animal or plant species, with limited exceptions specified in 321 CMR 10.04. One exception is to protect human health during the period and within the geographic area of a public health hazard as certified in writing by the Commissioner of Public Health (321 CMR 10.04(3)(e)). Under such circumstances, DFW may issue a permit to take endangered species if it has found that all reasonable efforts have been undertaken to avoid the removal, capture or destruction of such species.

Commissioner Certification

I hereby certify, pursuant to 333 CMR 13.03(3)(b) and 321 CMR 10.04(3)(e), that a public health hazard exists in the areas of Massachusetts specified below and that application of pesticides in areas known to harbor mosquitoes carrying the EEE virus is necessary to protect the public health.

The areas covered by this certification are those areas of the Commonwealth, including portions of Bristol, Essex, Franklin, Hampshire, Hampden, Middlesex, Norfolk, Plymouth, and Worcester Counties, determined by Department of Public Health surveillance data to warrant pesticide application to protect public health. This certification shall remain in effect until September 30, 2019.

9/9/19
Date

Lindsey Tucker
Associate Commissioner

Appendix 2

ANVIL® 10+10 ULV

Contains an Oil Soluble Synergized Synthetic Pyrethroid for Control of Adult Mosquitoes (Including Organophosphate-Resistant Species) Midges, and Black Flies in Outdoor Residential and Recreational Areas.

ACTIVE INGREDIENTS:	
3-Phenoxybenzyl-(1RS, 3RS; 1RS, 3SR)-2,2-dimethyl-3-(2-methylprop-1-enyl) cyclopropanecarboxylate	10.00%
*Piperonyl Butoxide	10.00%
**OTHER INGREDIENTS	80.00%
	100.00%

Contains 0.74 lbs. Technical SUMITHRIN®/Gallon and 0.74 lbs. PBO/Gallon

*(butylcarbityl)(6-propylpiperonyl) ether and related compounds

**Contains petroleum distillate

KEEP OUT OF REACH OF CHILDREN

CAUTION

PRECAUCION AL USUARIO: Si usted no lee ingles, no use este producto hasta que la etiqueta haya sido explicado ampliamente

FIRST AID	
IF SWALLOWED:	• Immediately call a poison control center or doctor. • Do not induce vomiting unless told to do so by a poison control center or a doctor. • Do not give **any** liquid to the person. • Do not give anything by mouth to an unconscious person.
IF ON SKIN OR CLOTHING:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
NOTE TO PHYSICIAN Contains petroleum distillate - vomiting may cause aspiration pneumonia.	
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For information regarding medical emergencies or pesticide incidents, call 1-888-740-8712.	

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION. Harmful if absorbed through the skin. Avoid contact with skin, eyes and clothing. In case of contact, flush with plenty of water. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some materials that are chemical-resistant to this product are: barrier laminate, nitrile rubber, neoprene rubber or Viton. Mixers, loaders, applicators, and other handlers must wear long-sleeved shirt, long pants, shoes and socks. In addition, all handlers except for applicators using motorized ground equipment, pilots, and flaggers, must wear chemical-resistant gloves. See engineering controls for additional requirements.

USER SAFETY REQUIREMENTS

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent material that have been drenched or heavily contaminated with the product's concentrate. Do not reuse them.

USER SAFETY RECOMMENDATIONS

Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. User should remove clothing/PPE immediately if pesticide gets inside, then wash thoroughly and put on clean clothing. User should remove PPE immediately after handling this product. As soon as possible, wash thoroughly and change into clean clothing.

ENGINEERING CONTROLS

Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(6)]. Human flagging is prohibited. Flagging to support aerial applications is limited to use of the Global Positioning System (GPS) or mechanical flaggers.

ENVIRONMENTAL HAZARDS

This product is toxic to aquatic organisms, including fish and invertebrates. Runoff from treated areas or deposition of spray droplets into a body of water may be hazardous to fish and aquatic invertebrates. Before making the first application in a season, it is advisable to consult with the state or tribal agency with primary responsibility for pesticide regulation to determine if other regulatory requirements exist. Do not apply over bodies of water (lakes, rivers, permanent streams, natural ponds, commercial fishing ponds, swamps, marshes or estuaries), except when necessary to target areas where adult mosquitoes are present, and weather conditions will facilitate movement of applied material away from the water in order to minimize incidental deposition into the water body. Do not contaminate bodies of water when disposing of equipment rinsate or wash waters.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

PHYSICAL OR CHEMICAL HAZARDS

Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

USE RESTRICTIONS:

For use by federal, state, tribal, or local government officials responsible for public health or vector control, or by persons certified in the appropriate category or otherwise authorized by the state or tribal lead pesticide regulatory agency to perform adult mosquito control applications, or by persons under their direct supervision.

IN CALIFORNIA: This product is to be applied by County Health Department, State Department of Health Services, Mosquito and Vector Control or Mosquito Abatement District personnel only.

IN FLORIDA: Aerial applications of this product require trained personnel to perform industry accepted assays to monitor resistance formation in targeted mosquitoes.

Do not treat a site with more than 0.0036 lbs of Sumithrin® or 0.0036 lbs of PBO per acre in a 24-hour period. Do not exceed 0.1 lb of Sumithrin® or PBO per acre in any site in any year. More frequent applications may be made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.

NOTE: When rotating products with other insecticides containing PBO, do not exceed 2 lbs PBO per acre per year.

Not for use in outdoor residential misting systems.

USE INFORMATION

ANVIL 10+10 ULV is approved for application as a thermal aerosol and an Ultra Low Volume (ULV) nonthermal aerosol (cold fog) in mosquito adulticiding programs involving outdoor residential and recreational areas where adult mosquitoes are present in annoying numbers in vegetation surrounding parks, woodlands, swamps, marshes, overgrown areas and golf courses. ANVIL 10+10 ULV may be applied over agricultural areas for the control of adult mosquitoes within or adjacent to the treatment areas.

For best results, apply when mosquitoes are most active and weather conditions are conducive

AL0398

to keeping the fog close to the ground. Application in calm air conditions is to be avoided. Apply only when wind speed is greater than or equal to 1 mph. All types of applications should be conducted at temperatures above 50 °F.

NOTE: ANVIL 10+10 ULV cannot be diluted in water. Dilute this product with light mineral oil if dilution is preferred.

SPRAY DROPLET SIZE DETERMINATION

Ground-based, wide area mosquito abatement application: Spray equipment must be adjusted so that the volume median diameter is less than 30 microns (Dv 0.5 < 30 µm) and that 90% of the spray is contained in droplets smaller than 50 microns (Dv 0.9 < 50 µm). Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

Aerial Equipment, wide area mosquito abatement application: Spray equipment must be adjusted so that the volume median diameter produced is less than 60 microns (Dv 0.5 < 60 µm) and that 90% of the spray is contained in droplets smaller than 80 microns (Dv 0.9 < 80 µm). The effects of flight speed and, for non-rotary nozzles, nozzle angle on the droplet size spectrum must be considered. Directions from the equipment manufacturer or vendor, pesticide registrant, or a test facility using a wind tunnel and laser-based measurement instrument must be used to adjust equipment to produce acceptable droplet size spectra. Application equipment must be tested at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated.

GROUND ULV APPLICATION

Apply ANVIL 10+10 ULV through a standard ULV cold aerosol or non-thermal aerosol (cold fog) generator. Consult the following table for examples of various dosage rates using a swath width of 300 feet for acreage calculations. Vary flow rate according to vegetation density and mosquito population. Use higher flow rate in heavy vegetation or when populations are high.

Dosage Rate of each a.i. (Lbs. Sumithrin® and PBO per acre)	Fl.oz. ANVIL 10+10 ULV per Acre	Flow Rates in fluid oz./minute at truck speeds of:			
		5 MPH	10 MPH	15 MPH	20 MPH
0.0036	0.62	1.9	3.8	5.7	7.6
0.0024	0.42	1.3	2.5	3.8	5.1
0.0012	0.21	0.6	1.3	1.9	2.5

ANVIL 10+10 ULV may also be applied with non-thermal, portable, motorized backpack equipment adjusted to deliver ULV particles of less than 100 microns VMD. Use 0.21 to 0.62 fl. oz. of the undiluted spray per acre (equal to 0.0012 to 0.0036 lb. a.i./acre) as a 50 ft. (15.2 m) swath while walking at a speed of 2 mph (3.2 kph). Dilute with a suitable mineral oil if dilution is preferred. Do not exceed 0.62 fl. oz. of the undiluted spray per acre. Do NOT use portable backpack equipment for application in enclosed spaces.

ANVIL 10+10 ULV may be applied through truck mounted thermal fogging equipment. Do not exceed the maximum rates listed above. May be applied at speeds of 5 to 20 mph. To reduce oil requirement and sludge buildup in equipment, use a 60 - 100-second viscosity mineral "fog" oil, or other fuel-type oil. Use a clean, well-maintained and properly calibrated fogger. Do not wet foliage since oil base formulations may be phytotoxic. For use with hand carried foggers, use same rates of active ingredient per acre and a swath width of 50 ft with a walking speed of 2 mph. Fog downwind, with the wind at your back. Do NOT use hand-carried foggers for application in enclosed spaces.

AERIAL APPLICATION

ANVIL 10+10 ULV may be applied at rates of 0.21 to 0.62 fluid ounces ANVIL 10+10 ULV per acre by fixed wing or rotary aircraft equipped with suitable ULV application equipment. ANVIL 10+10 ULV may also be diluted with a suitable solvent such as mineral oil and applied by aerial ULV equipment so long as 0.62 fluid ounces per acre of ANVIL 10+10 ULV is not exceeded. Do not apply by fixed wing aircraft at a height less than 100 feet above the ground or canopy, or by helicopter at a height less than 75 feet above the ground or canopy unless specifically approved by the state or tribe based on public health needs.

STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

PESTICIDE STORAGE: Store in a cool, dry place. Keep container closed.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER HANDLING: Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with mineral oil and recap. Shake for 10 seconds. Pour rinsate into application equipment or a rinse tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

CONTAINER HANDLING: Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into rinsate collection system. Repeat this rinsing procedure two more times. Offer for recycling if available or reconditioning if appropriate, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

NOTICE: To the extent provided by law, seller makes no warranty, expressed or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use and/or handling of this material when use and/or handling is contrary to label instructions.

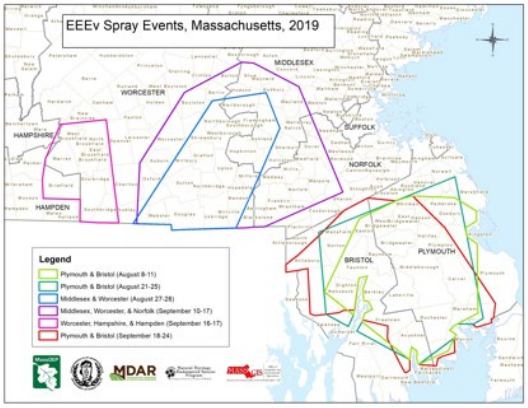
Manufactured For
CLARKE MOSQUITO CONTROL PRODUCTS, INC.
159 N. GARDEN AVENUE
ROSELLE, ILLINOIS 60172 U.S.A
FOR MORE INFORMATION CALL: 1-800-323-5727

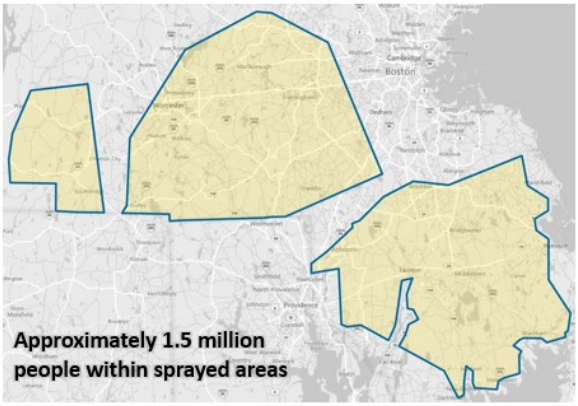
EPA Reg. No.: 1021-1688-8329
EPA Est. No: 8329-IL-01
NET CONTENTS: [ ] 2.5 GAL [ ] 30 GAL [ ] 55 GAL [ ] 275 GAL
LOT NO.:
AL0398

Appendix 3

Total Costs of 2019 Aerial Mosquito Control Spray Operation in Massachusetts	
Aerial Service	$2,028,377
Product	$2,590,939
Police Detail	$9,212
Ground spray	$215,830
Travel/Reimbursement	$28,367
Lab testing	$15,020
AGR staff overtime	$11,407
DEP costs (staff, supplies, testing)	$153,134
Supplies	$3,798
Late fees	$29,552
TOTAL	**$5,085,636**

Appendix 4





AUGUST 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				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

SEPTEMBER 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
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					

Online Aerial Spray Map https://massnrc.org/spray-map/

Google Map Use Statistics >20% of population within sprayed areas checked the online map

AUGUST:	Total map requests	330,218
	Address lookup requests	119,218
SEPTEMBER:	Total map requests	303,305
	Address lookup requests	104,815

Appendix 5

Communities by spray event					
Spray event #1 Aug 8-11	**Spray event #2 Aug 21-25**	**Spray event #3 Aug 26-27**	**Spray event #4 Sept 10-18**	**Spray event #5 Sept 16-17**	**Spray event #6 Sept 18-24**
Acushnet	Abington	Ashland	Ashland	Brimfield	Acushnet
Berkley	Acushnet	Berlin	Auburn	Brookfield	Attleboro
Bridgewater	Attleboro	Blackstone	Bellingham	Charlton	Berkley
Brockton	Berkley	Douglas	Berlin	East Brookfield	Bridgewater
Carver	Bridgewater	Dudley	Blackstone	New Braintree	Brockton
Dartmouth	Brockton	Framingham	Bolton	N. Brookfield	Carver
Dighton	Carver	Grafton	Boylston	Palmer	Dartmouth
Duxbury	Dartmouth	Holliston	Charlton	Southbridge	Dighton
East Bridgewater	Dighton	Hopedale	Clinton	Sturbridge	East Bridgewater
Easton	Duxbury	Hopkinton	Douglas	Ware	Easton
Fairhaven	East Bridgewater	Marlborough	Dover	Warren	Fairhaven
Fall River	Easton	Mendon	Dudley	West Brookfield	Freetown
Freetown	Fairhaven	Milford	Foxborough		Halifax
Halifax	Fall River	Millbury	Framingham		Hanson
Hanover	Freetown	Millville	Franklin		Kingston
Hanson	Halifax	Northborough	Grafton		Lakeville
Kingston	Hanover	Northbridge	Harvard		Mansfield
Lakeville	Hanson	Oxford	Holliston		Marion
Marion	Kingston	Shrewsbury	Hopedale		Mattapoisett
Mattapoisett	Lakeville	Southborough	Hopkinton		Middleborough
Middleborough	Mansfield	Sudbury	Hudson		New Bedford
New Bedford	Marion	Sutton	Leicester		Norton
Norton	Marshfield	Upton	Lincoln		Pembroke
Pembroke	Mattapoisett	Uxbridge	Marlborough		Plymouth
Plymouth	Middleborough	Webster	Maynard		Plympton
Plympton	New Bedford	Westborough	Medfield		Raynham
Raynham	Norton	Worcester	Medway		Rehoboth
Rehoboth	Norwell		Mendon		Rochester
Rochester	Pembroke		Milford		Rockland
Rockland	Plymouth		Millbury		Swansea
Somerset	Plympton		Millis		Taunton
Swansea	Raynham		Millville		Wareham
Taunton	Rehoboth		Natick		W. Bridgewater
Wareham	Rochester		Needham		Whitman
W. Bridgewater	Rockland		Norfolk		
Whitman	Somerset		Northborough		
	Swansea		Northbridge		

	Taunton		Norwood		
	Wareham		Oxford		
	W. Bridgewater		Sharon		
	Whitman		Sherborn		
			Shrewsbury		
			Southborough		
			Sterling		
			Stow		
			Sudbury		
			Sutton		
			Upton		
			Uxbridge		
			Walpole		
			Wayland		
			Webster		
			Wellesley		
			West Boylston		
			Westborough		
			Weston		
			Westwood		
			Worcester		
			Wrentham		

Appendix 6

Weather by spray event						
	Spray event #1 Aug 8-11	**Spray event #2 Aug 21-25**	**Spray event #3 Aug 26-27**	**Spray event #4 Sept 10-18**	**Spray event #5 Sept 16-17**	**Spray event #6 Sept 18-24**
	August 8:	August 21:	August 26:	September 10:	September 16:	September 18:
High temperature:	86F	86F	72F	67F	69F	64F
Low Temperature:	70F	60F	50F	55F	51F	38F
Average Temp:	78F	73F	61F	61F	60F	51F
Precipitation:	0.28"	0.21"	N/A	N/A	N/A	Trace
	August 9:	August 22:	August 27:	September 11:	September 17:	September 19:
High temperature:	88F	91F	72F	80F	67F	70F
Low Temperature:	61F	74F	51F	64F	51F	35F
Average Temp:	74.5F	82.5F	61.5F	72F	59F	52.5F
Precipitation:	Trace	0.08"	N/A	Trace	N/A	N/A
	August 10:	August 23:		September 12:		September 20:
High temperature:	83F	78F		68F		82F
Low Temperature:	55F	55F		50F		35F
Average Temp:	69F	66.2F		59F		58.5F
Precipitation:	Trace	0.09"		0.26"		N/A
	August 11:	August 24:		September 13:		September 21:
High temperature:	82F	76F		64F		86F
Low Temperature:	50F	50F		48F		47F
Average Temp:	66F	63F		56F		66.5F
Precipitation:	N/A	N/A		N/A		N/A
		August 25:		September 14:		September 22:
High temperature:		70F		65F		84F
Low Temperature:		52F		47F		50F
Average Temp:		61F		56F		67F
Precipitation:		0.05"		Trace		N/A
				September 15:		September 23:
High temperature:				73F		85F
Low Temperature:				60F		69F
Average Temp:				66.5F		77F
Precipitation:				N/A		0.03"

High temperature: **Low Temperature:** **Average Temp:** **Precipitation:**				September 16: 69F 51F 60F N/A		September 24: 78F 53F 66.5F 0.49"
High temperature: **Low Temperature:** **Average Temp:** **Precipitation:**				September 17: 67F 51F 59F N/A		
High temperature: **Low Temperature:** **Average Temp:** **Precipitation:**				September 18: 60F 44F 52F N/A		
The designation of a “trace” rather than zero is used to indicate that precipitation did fall, but not enough to be measured reliably.						
Taunton and Worcester weather stations used for weather data						

Appendix 7

Apiary Report:

Aerial Application – The statewide aerial applications for mosquito control occurred during August 8-27, 2019 and September 10-18, 2019 in 7 Massachusetts counties (Bristol, Hampden, Hampshire, Middlesex, Norfolk, Plymouth and Worcester) during the peak honey bee activity season. At the time of the applications, these counties consisted of a total of 259 registered beekeepers managing apiaries in the application areas which represents only a fraction of the total apiaries in these areas given that apiary registration is voluntary in the Commonwealth. A total of 34 beekeepers registered during the time of the aerial applications representing a 12% increase in overall in current statewide registration.

The mosquito adulticide product used in the aerial applications was Anvil 10+10® ULV[1] containing the active ingredient Sumithrin® (d-Phenothrin) and synergist piperonyl butoxide (PBO), that increases its potency and duration of effectiveness. d-Phenothrin is a synthetic pyrethroid insecticide[2] and has been registered by EPA since 1976 for use to control adult mosquitos and other nuisance insects indoors and outdoors in residential yards and public recreational areas. The product Anvil 10+10® ULV is labeled for use in residential and recreational areas. d-Phenothrin is classified as being highly toxic to honey bees[3]. Risk mitigation language on the product label for Anvil 10+10® ULV includes the following Environmental Hazard statement as it relates to honey bees:

> *This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the area, except when applications are made to prevent or control a threat to public and/or animal health determined by a state, tribal or local health or vector control agency on the basis of documented evidence of disease causing agents in vector mosquitoes, or the occurrence of mosquito-borne disease in animal or human populations, or if specifically approved by the state or tribe during a natural disaster recovery effort.*

Relative to the risk to honey bees from the aerial applications, it should be noted that the potential hazard to direct application exposure from the aerial application was minimized since sprays occurred at night when honey bees are typically inside the hive box. However, the following conditions may cause honey bees to congregate on the outside of hive boxes at night (i.e. bee bearding), therefore potentially increasing the likelihood of some limited exposure to honey bees in spray areas:

1. Large colony population inside hive box;
2. Outside temperature above 85°F; and
3. Beekeeper applied miticide treatment to the hive box interior.

Stakeholder Communication – Communication to beekeepers consisted of a variety of media outlets including phone calls, emails, Facebook posts, and Mass.gov website notifications that took place pre-application, during and post-application. Individual pre-application notification was sent via email to a total of 803 beekeepers located in the counties of the spray areas. These beekeepers consisted of those voluntarily registered, with past inspection records with the Apiary Program and to the officers of the

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[1] U.S. EPA. Multicide Mosquito Adulticiding Concentrate 2705: https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:1021%2D1688

[2] U.S. EPA. Permethrin, Resmethrin, d-Phenothrin (Sumithrin®): Synthetic Pyrethroids for Mosquito Control: https://www.epa.gov/mosquitocontrol/permethrin-resmethrin-d-phenothrin-sumithrinr-synthetic-pyrethroids-mosquito-control

[3] National Pesticide Information Center (NPIC). d-Phenothrin Technical Fact Sheet: http://npic.orst.edu/factsheets/archive/dphentech.html#references

state and county level beekeeping associations within the application areas. Each email consisted of links to the *EEE in Massachusetts* Mass.gov service pages as well as a Frequently Asked Questions (FAQ) list containing general recommendations tailored specifically for beekeepers. Additional communication included responding to the many stakeholder phone calls, phone messages, text messages, Facebook messages, and emails received during this time period. Beekeepers were also contacted post-application to determine status of colony health following spray events. All follow up communication and investigations of suspected Bee Kills were conducted in a timely manner. In addition to this final report, beekeepers were emailed a final report of their individual sample results taken from their apiaries.

Honey Bee Monitoring Methods – *The Honey Bee Monitoring Protocol for Aerial Mosquito Adulticide Application* from *The Mosquito Emergency Operations Response Plan for Mosquito-Borne Illness*[4] was utilized for monitoring with modification, as needed. Beekeepers were selected for monitoring based on their geographic location and colony health (Fig. 1). Selected apiaries were either categorized as those within (treatment group) or outside (control group) the application area based on their geographic location and inspection prior to application. The MDAR State Apiaries in Amherst and Danvers were amongst those monitored outside the application area (control group). Monitored apiaries inside the application areas which received multiple applications were monitored for each spray application, when possible. Some apiaries had to be removed from these repeated monitoring attempts given the application of miticides on hives as part of seasonal management. Colony health was determined by health inspections of colonies to ensure the absence of visible issues (i.e. queenright, no visible signs of pesticide-related Bee Kill, no visible pathogens, and low Varroa mite levels) which could confound potential negative impacts of the aerial applications. Only colonies that were found to be visibly healthy during these inspections were included in monitoring efforts. Commercial, hobby and sideliner classified beekeepers comprised the monitored apiaries accurately representing the diversity of apiculture in Massachusetts.

The monitoring protocol was defined by a series of visits to apiaries where inspectors performed health inspections on both the interior and exterior of honey bee colonies. These health inspections consisted of a combination of the standard health inspection procedures utilized by the MDAR Apiary Program Team for routine annual inspections, health emergencies and those involved in Bee Kill investigations where colony death is investigated due to suspected impacts of pesticide mis-use. Interior health assessments included evaluating queen, brood, food stores, and population levels to determine impacts of pesticides or presence of other health issues. Exterior monitoring consisting of evaluating foraging activity at colony entrances and dead bee accumulation outside of the hive boxes. Dead bee monitoring was conducted using clear plastic (drop cloth) and light colored canvas (drop cloth) or cotton (twin XL size sheet) cloths situated on the ground in front of hive boxes (Fig. 2). To prevent contamination in apiaries monitored repeatedly during multiple spray events, cloths were replaced prior to additional application(s). Each apiary and honey bee colony were visited a total of 3 times throughout the monitoring process during pre-set time intervals of pre-application (0-2 days) and post-application (1-3 days and 7-10 days). Inspectors also relied on beekeepers to continuously monitor hive health and provide immediate reports of suspected negative impacts to MDAR during times outside of monitoring visits.
During each apiary visit, the following data were collected, when possible: photo of apiary, counts of dead bees in front of hive and sample of bees. Dead bee counts were not consistently possible given the following un-anticipated issues that occurred at some locations:

- Weather conditions removing cloths from in front of hives;

[4] Massachusetts Emergency Operations Response Plan for Mosquito-Borne Illness: https://www.mass.gov/massachusetts-emergency-operations-response-plan-for-mosquito-borne-illness

- Predators consuming or inclement weather conditions removing dead bees away from hives or cloths;
- Colony hygiene behavior of worker bees removing dead bees away from hives or cloths;
- Cloths removed due to beekeeper concerns about damaging vegetation around hives or need for land management of area around apiary;
- Beekeeper hive management which increased dead bee populations given exposure to in-hive applied miticides; and
- Beekeeper installed hive covers were not made of, installed or removed properly therefore caused colony stress.

Given these challenges, a few protocol changes were made during the monitoring. The first was using landscape staples to affix cloths in front of hives therefore allowing them to remain stationary throughout monitoring. Next, the initial plastic and canvas drop cloths were replaced with cotton cloths and this resulted in reduced damage to vegetation hives and less water retention. Some beekeepers of monitored apiaries elected to cover their hives as a pre-cautionary measure to provide protection during applications. This practice varied widely among beekeepers and could have imposed additional risk on honey bee health depending on the type of cover material, configuration, and duration of coverage time. We recommended in the FAQ sent to beekeepers that if used, covers should be made of cotton material, configured loosely over the hive box being careful to not restrict access of hive entrances and removed swiftly after application.

Despite the inability to record dead bee counts for each apiary during the monitoring period, inspectors were able to assess hives given foraging activity and interior health of hives. Pre-application samples of adult bees were taken of apiaries, when possible. Post-application samples of adult bees were only taken when deemed necessary (i.e. if hives presented visible symptoms indicating a possible Bee Kill resulting from pesticide use given the occurrence of large amounts of dead bees in front of hive or on cloths). After collection, samples were stored in the freezer at -10°C and evaluated at the end of the monitoring event to determine if collected quantities warranted lab analysis. Samples deemed necessary for lab analysis were those that contained higher than anticipated quantities of dead bees and were sent for both viral and pesticide analysis. Virus samples were analyzed by the National Agricultural Genotyping Center (NAGC) and pesticide samples were analyzed by the Massachusetts Pesticide Analysis Laboratory (MPAL).

The estimated populations of hives during the monitoring events ranged between 40-65,000 individuals of which the forager population comprises an estimated 25% (Seeley, 1995)[5]. The daily forager mortality rate in an active honey bee colony can range from 1-5% since the average lifespan of a foraging honey bee is only 7.7 days, but ranges between two (2) to 17 days (Visscher and Dukas, 1997)[6]. This equates to a minimum estimated daily forager mortality rate of 100-163 individuals. Dead bees are removed from the hive box through the hygiene behavior of undertaker bees (Seeley, 1985)[7]. If a colony is stressed or weakened from a health issue, it will also modify the hygiene behavior of undertaker bees to either not remove the dead or dying from the interior of the hive box or deposit them right outside the entrance instead of greater distances. This modification in behavior allows for ease in determining acute honey bee kills given the presence of large amounts of dead or dying bees.

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[5] Seeley, T.D. 1995. The Wisdom of the Hive. Harvard University Press, Cambridge, MA, USA.
[6] Visscher, P.K. and Dukas, R. 1997. Survivorship and foraging of honey bees. Insectes Society 44,(1). https://link.springer.com/article/10.1007/s000400050017
[7] Seeley, T.D. 1985. Honeybee Ecology: A Study of Adaptation in Social Life. Princeton University Press, Princeton, NJ, USA.

Inspections were also conducted of apiaries not part of the monitoring protocol for beekeepers who reported conditions consist with a potential Bee Kill suspected to be due to pesticide exposure. These complaints were followed up on with apiary visits and inspection by the MDAR Apiary Program team using the standard Bee Kill protocols. Samples from these investigations were evaluated in the same manner as those from the monitoring program in that only those samples that warranted pesticide analysis were submitted to MPAL. However, all these investigated apiaries were sampled for viruses and sent for analysis to NAGC.

The acute risk of measured pesticide residues to honey bees was assessed by comparing the measured residue levels in bees with the acute toxicity endpoints (50% Lethal Dose values; LD_{50} values) for d-Phenothrin and PBO. The LD_{50} values were obtained from the Sanshez-Bayo and Goka (2014)[8] and EPA risk assessment documents[9]. The risk of residues in pollen was assessed by using the BeeRex model[10].

Honey Bee Monitoring Results – A grand total of 36 beekeepers managing 39 apiaries consisting of 535 colonies were monitored (Table 1). Of these, 436 colonies managed by 30 beekeepers were located inside (treatment) and 99 colonies managed by six (6) beekeepers were located outside (control) the application areas. Many of the monitored apiaries were in towns that received repeated aerial applications located in Plymouth, Bristol, and Worcester counties. Apiaries located inside the application area included 24 towns: Berlin, Brimfield, Dartmouth, Duxbury, East Taunton, Hopkinton, Lakeville, Marlborough, Milford, Millbury, Northborough, Northbridge/Whitinsville, North Dighton, North Grafton, Needham, Raynham, Shrewsbury, Southborough, Southbridge, Upton, Walpole, Westborough, West Bridgewater, West Brookfield. Apiaries located outside the application area included seven (7) towns: Amherst, Berlin, Danvers, Ware, Charlton, New Braintree, Sudbury.

A total of 37 samples (15 pesticide and 22 viral) were lab submitted for virus and pesticide analysis (Tables 2 and 3). Of these, a total of 16 samples were from monitored apiaries and 21 samples (3 pesticide samples and 18 virus samples) were taken from investigations of Bee Kill complaints from apiaries not monitored during the spray events. Samples for pesticides and viruses were submitted from the same five (5) counties (Bristol, Hampden, Norfolk, Plymouth and Worcester), whereas virus samples were submitted for only Middlesex county.

Results from the pesticide analysis (Table 2) revealed that 10 samples were positive for one or both pesticides and five (5) samples were Non-Detect (ND) at the Limit of Detection (d-Phenothrin was 6.5-20.7 µg/kg (ppb) and 1.3-4.1 µg/kg (ppb) for PBO). A total of five (5) samples (33%) were positive for both d-Phenothrin and PBO, and a total of five (5) samples (33%) were only positive for PBO (Fig. 3). No samples were found to be positive only for d-Phenothrin. Plymouth county had the highest amount of positive samples for PBO with four (4), but the lowest amount of samples positive for d-Phenothrin with one (1) (Fig. 4). Norfolk and Worcester counties had the highest amount of positive samples for d-Phenothrin with two (2), but lower positive PBO samples (two (2) for Norfolk and three (3) for Worcester). Only a single pollen sample was taken from Worcester county and it was positive for both d-Phenothrin and PBO, but the dead bee samples analyzed from this same sampled colony only tested positive for PBO.

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[8] Sanchez-Bayo, F. and Goka, K. 2104. Pesticide residues and bees – A risk assessment. PLoS One, 9(4). https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0094482#pone.0094482.s002

[9] U.S. EPA, 2017. Piperonyl Butoxide (PBO): Preliminary Ecological Risk Assessment for Registration Review. https://www.regulations.gov/document?D=EPA-HQ-OPP-2010-0498-0025

[10] U.S. EPA, BeeRex model and guidance: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment

The contact and oral LD_{50} values for these pesticides are listed in Tables 4 and 5. To allow comparison of the measured pesticide levels in bees with toxicity endpoints, the standard LD_{50} values were converted to LD_{50} values in ppb relative to body weight[11]. These LD_{50} values in ppb relative to body weight are listed in Table 4.

A comparison of the measured ppb residue levels in Table 2 with the LD_{50} values for honey bees expressed in ppb relative to bee body weight in Table 4 indicates that the measured levels are much lower than the LD_{50} values and therefore not likely to cause acute effects. A formal risk assessment is based on Risk Quotient (RQ) values and comparison with EPA established Levels of Concern (LOC). Risk quotients were calculated by dividing the measured residue levels in bees with the LD_{50} value (ppb) and are included in Table 4.
The LOC is 0.4 for acute risk.[12] The calculated RQ values in Table 4 are well below the acute LOC. Therefore, it is very unlikely that the measured residues of d-Phenothrin and PBO caused lethal effects to the bees. Regarding the pollen sample, the risk quotient of 0.15 for d-Phenothrin is below the level of concern for acute lethal effect to bees (Table 5). The very low risk quotient for PBO is consistent with its low toxicity to bees.
Viruses were prevalent in all samples, with a majority of samples positive for three (3) or more (Table 3). The most common viruses were Sacbrood Virus (SBV) and Varroa Destructor Virus 1 (VDV1), which occurred in 100% and 86% of samples, respectively (Fig. 5). Plymouth county had the highest incidence of viruses while Hampden county had the lowest (Fig. 6). The most detrimental parasitic mite, *Varroa destructor*, is a major vector of the following detected honey bee viruses: Deformed Wing Virus (DWV), Varroa Destructor Virus 1 (VDV1), and Israeli Acute Paralysis Virus (IAPV) (Brutscher et al. 2016)[13]. Of the viruses detected, Chronic Bee Paralysis Virus (CBPV), Israeli Acute Paralysis Virus (IAPV) and Lake Sinai Virus 1 (LSV1) which were found in 21 samples, sometimes as multiple-infections, can present symptoms similar to a pesticide related Bee Kill. The occurrence of CBPV is linked with crowding of honey bee colonies in concentrated geographic areas (Genersch & Aubert, 2010)[14] and was detected in the most samples from Plymouth county.

Conclusion – The visual observations of the MDAR Apiary Program Team combined with that of the beekeepers whose apiaries were visited and consistently monitored for colony health, indicate that overall honey bee colonies were not acutely impacted by the aerial application. Beekeepers contacted in follow up communication whose colonies were not monitored or investigated in this report but located in spray areas also reported no observable health issues resulting from the aerial application. Data analysis indicates that the pesticide residue levels in the bee and pollen samples were well below the level that would cause lethal effects in adult honey bees. Given this, it can be concluded that the exposure to d-Phenothrin and PBO from the aerial application was not a major cause of the bee mortality observed in these monitoring events and investigations. Many of the viruses found in samples are documented to cause bee mortality. Given this, the most likely cause of any higher than normal observed bee mortality

[11] Multiplying the standard LD_{50} values (ug/bee) using a factor of 10,000 (assumes an average bee weight of 0.1g) (see Mullin et al. 2010: http://journals.plos.org/plosone/article/asset?id=10.1371%2Fjournal.pone.0009754.PDF
[12] U.S. EPA. 2014. Guidance for Assessing Pesticide Risks to Bees. https://www.epa.gov/sites/production/files/2014-06/documents/pollinator_risk_assessment_guidance_06_19_14.pdf
[13] Brutscher, L.M., McMenamin, A.J., and Flenniken, M.L. 2016. The buzz about honey bee viruses. PLoS Pathogens, 12(8). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4990335/
[14] Genersch, E. and Aubert, M. 2010. Emerging and re-emerging viruses of the honey bee (*Apis mellifera* L.). Veterinary Research, 41(6). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2883145/

from samples taken during these monitoring efforts were likely caused by a combination of the negative impacts of viruses detected in samples and that associated with standard daily bee mortality.

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11. U.S. EPA. Multicide Mosquito Adulticiding Concentrate 2705: https://iaspub.epa.gov/apex/pesticides/f?p=PPLS:102:::NO::P102_REG_NUM:1021%2D1688
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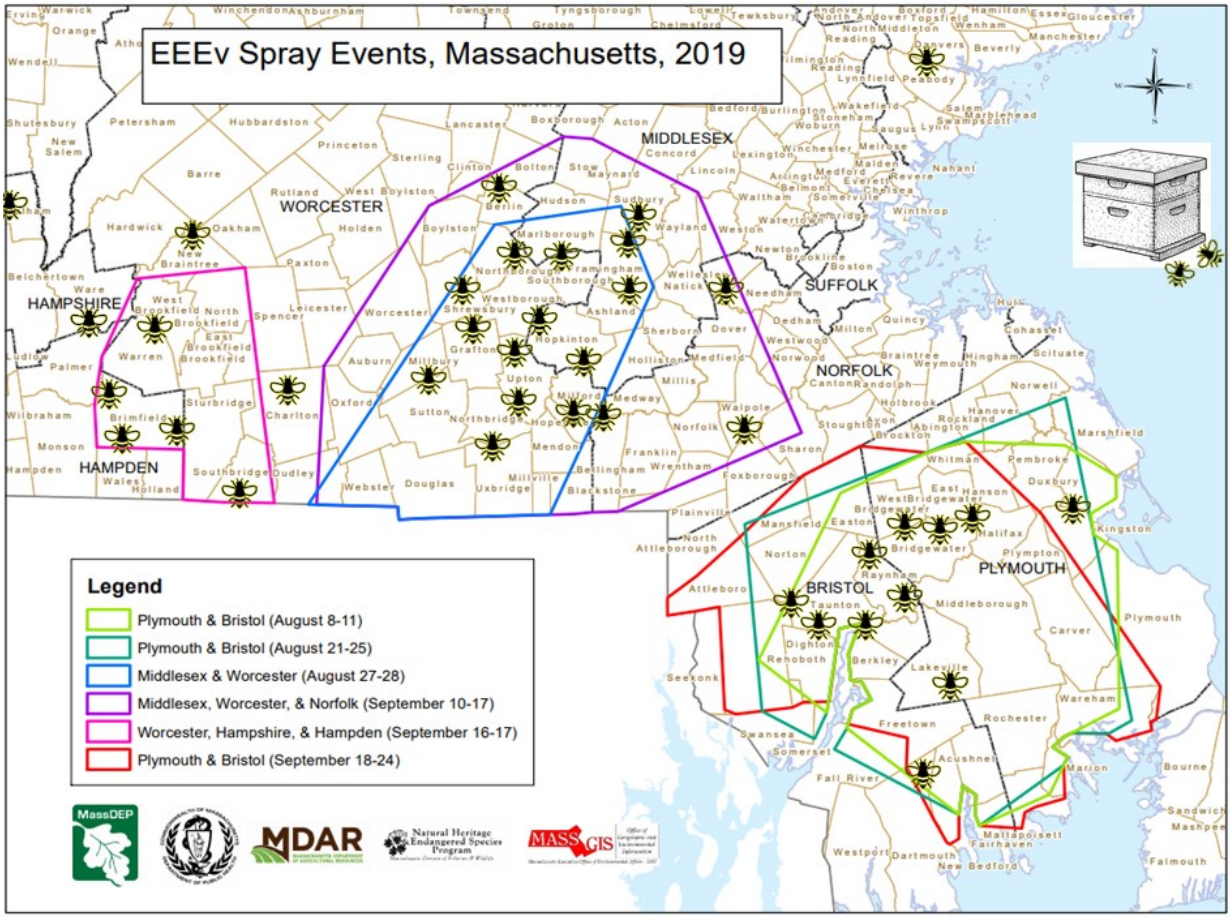

Figure 1. Map showing aerial applications with majority of monitored apiary locations indicated by the bee symbols. Note that given scale, apiaries are mapped based on town and general location.

Figure 2. Hobby and commercial beekeeper monitored apiaries with cloths installed.

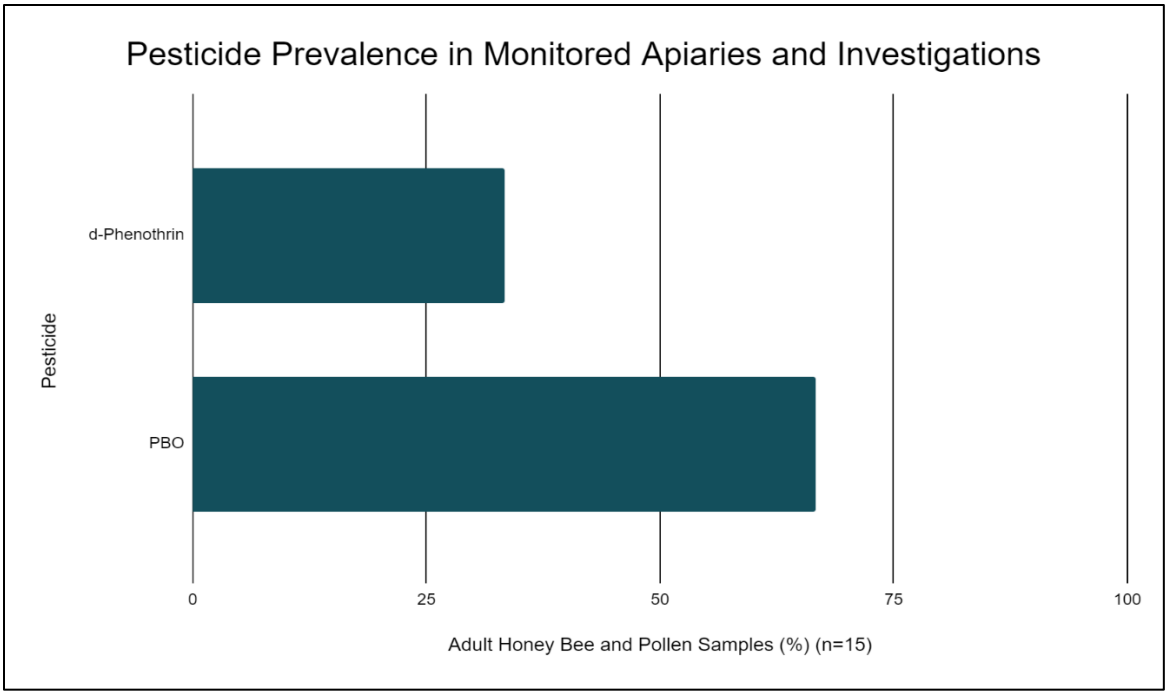

Figure 3. Pesticide prevalence in dead adult honey bees and pollen (n=15).

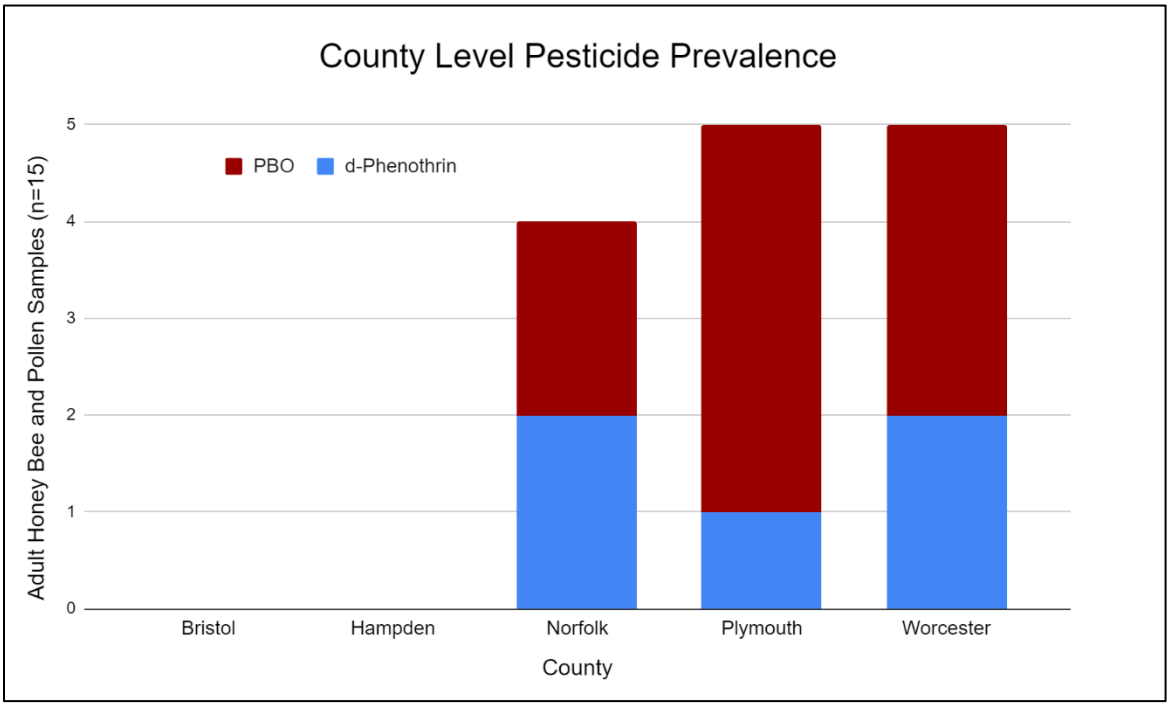

Figure 4. Pesticide prevalence in dead adult honey bees and pollen by county (n=15).

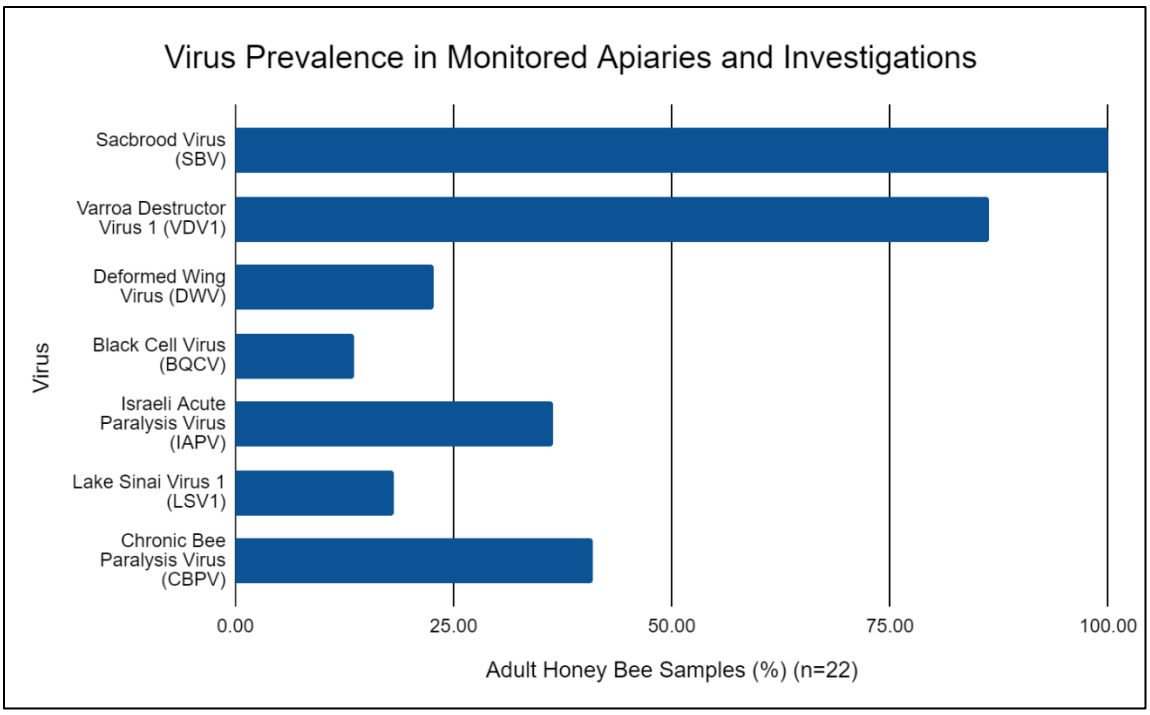

Figure 5. Virus prevalence in dead adult honey bees (n=22).

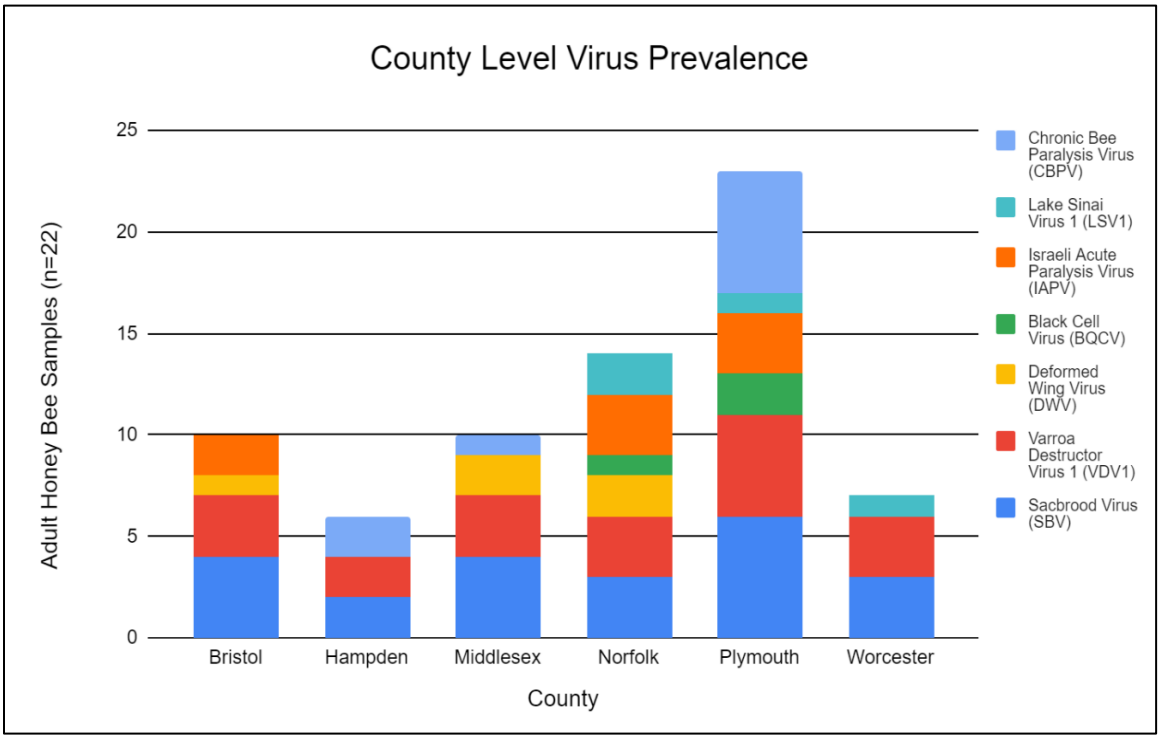

Figure 6. Virus prevalence in dead adult honey bees by county (n=22).

Table 1. Honey bee monitoring sites inside (treatment) and outside (control) the aerial application area.

	Metric	Bristol/Plymouth			Middlesex/ Worcester	Middlesex /Norfolk/ Worcester	Hampden/ Hampshire/ Worcester	Total
		8/8-8/11/19	8/21-8/25/19	9/18-9/24/19	8/26-8/27/19	9/10-9/18/19	9/16-9/17/19	
inside application area (treatment)	beekeepers	9	8	3	12	14	6	30
	apiaries	11	10	5	12	14	6	32
	colonies	125	122	69	45	55	20	436
	towns	7	7	3	11	13	3	24
	counties	2	2	2	2	3	2	7
outside application area (control)	beekeepers	1	1	1	3	1	3	6
	apiaries	2	2	2	4	1	3	7
	colonies	20	19	17	31	5	7	99
	towns	2	2	2	3	1	3	7
	counties	2	2	2	2	1	2	5

Table 2. Measured pesticide residues in samples of dead honey bees and pollen.

Sample ID	Sample County	MDAR Monitored Apiary	Apiary Location (i.e. inside or outside spray area)	Aerial Application Date (2019)	Sample Type	Sample Date (2019)	d-Phenothrin (µg/kg or ppb)	PBO (µg/kg or ppb)
WA	Bristol	no	inside	8/10; 8/24	bees	8/28	ND	ND
BM	Hampden	no	outside	N/A	bees	9/25	ND	ND
					bees	9/25	ND	ND
DS	Norfolk	yes	inside	9/15	bees	9/18	27	97.9
					bees	9/25	ND	ND
SS	Norfolk	yes	inside	9/15	bees	9/18	10.5	48.2
					bees	9/25	ND	ND
AR	Plymouth	yes	inside	8/9; 8/22; 9/22	bees	9/25	ND	14.6
HS	Plymouth	yes	inside	8/11; 8/21	bees	8/12	15	49
					bees	8/19	ND	1.5
					bees	8/24	ND	18.3
DP	Worcester	yes	inside	9/15	bees	9/16	ND	2.7
					bees	9/18	ND	4.1
					pollen	9/18	45.2	127.4
SJL	Worcester	yes	inside	9/15	bees	9/18	14.4	47.6
			Total Samples	15	bees	14	4	9
					pollen	1	1	1
				Pesticide Prevalence of Samples (%)			33.33	66.66

Table 3. Virus prevalence in samples of dead adult honey bees.

Sample ID	Sample County	MDAR Monitored Apiary	Apiary Location (i.e. inside or outside spray area)	Aerial Application Date (2019)	Sample Date (2019)	Sacbrood Virus (SBV)	Varroa Destructor Virus 1 (VDV1)	Deformed Wing Virus (DWV)	Black Cell Virus (BQCV)	Israeli Acute Paralysis Virus (IAPV)	Lake Sinai Virus (LSV)	Chronic Bee Paralysis Virus (CBPV)
LL	Bristol	no	inside	8/9; 8/23; 9/24	10/16	+	-	-	-	+	-	-
KC	Bristol	no	outside	N/A	10/25	+	+	-	-	+	-	-
NG	Bristol	no	inside	8/24; 9/20	10/7	+	+	-	-	-	-	-
WA	Bristol	no	inside	8/10; 8/24	8/28	+	+	+	-	-	-	-
BM	Hampden	no	outside	N/A	9/25	+	+	-	-	-	-	+
						+	+	-	-	-	-	+
CP	Middlesex	no	outside	N/A	8/7	+	+	+	-	-	-	-
						+	+	+	-	-	-	-
MR	Middlesex	no	inside	9/10	9/27	+	+	-	-	-	-	+
NM	Middlesex	no	inside	8/26; 9/15	9/24	+	-	-	-	-	-	-
AF	Norfolk	no	inside	9/14	7/15	+	+	-	-	+	+	-
MB	Norfolk	no	outside	N/A	9/23	+	+	+	+	+	-	-
						+	+	+	-	+	+	-
AR	Plymouth	yes	inside	8/9; 8/22; 9/22	8/19	+	+	-	+	+	-	+
					8/30	+	+	-	-	+	-	+
AT	Plymouth	no	inside	8/9; 8/22; 9/21	9/27	+	+	-	-	-	-	+
HS	Plymouth	yes	inside	8/11; 8/21	8/30	+	-	-	+	-	-	+
JW	Plymouth	no	inside	8/21	10/23	+	+	-	-	-	-	+
SF	Plymouth	no	inside	8/9	8/15	+	+	-	-	+	+	+
DH	Worcester	no	inside	9/15	9/7	+	+	-	-	-	-	-
DP	Worcester	yes	inside	9/15	9/16	+	+	-	-	-	-	-
PM	Worcester	yes	inside	8/26; 9/11	9/24	+	+	-	-	-	+	-
				Total Samples	22	22	19	5	3	8	4	9
				Virus Prevalence of Samples (%)		100.00	86.36	22.73	13.64	36.36	18.18	40.91

+ virus detected in sample
- virus not detected in sample

Table 4. Toxicity endpoints and calculated risk quotients for d-Phenothrin and piperonyl butoxide (PBO) in the dead honey bees.

Pesticide	LD_{50} (µg/bee) (contact)	LD_{50} (µg/bee) (oral)	LD_{50} (ppb body weight) (contact)	LD_{50} (ppb body weight) (oral)	Range of Levels Detected in Bees (lowest-highest detected) (ppb)	Range of Risk Quotient (contact)	Range of Risk Quotient (oral)
d-Phenothrin	0.13	0.16	1015	1250	10.5-27	0.01-0.03	0.004-0.02
piperonyl butoxide (PBO)	>25	-	195,312	-	1.5-97.9	<0.0005	-

Table 5. Toxicity endpoints and calculated risk quotients for d-Phenothrin and piperonyl butoxide (PBO) in the pollen sample.

Pesticide	LD_{50} (µg/bee) (contact)	LD_{50} (µg/bee) (oral)	Measured level in pollen (ppb)	Acute Risk Quotient (adult)
d-Phenothrin	0.013	0.016	45.2	0.15
piperonyl butoxide (PBO)	>25	-	127.4	<0.00005

End of apiary report.