Eastern Equine Encephalitis Surveillance and Response, Rhode Island, 2019

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INTRODUCTION

Eastern Equine Encephalitis (EEE) is a rare but serious mosquito-borne viral disease that presents as a meningo-encephalitis in humans, four to ten days after a mosquito bite. Symptoms include sudden onset of fever, headache, vomiting, diarrhea, seizures, behavioral changes, drowsiness, and coma. The mortality rate of EEE is 33%. Among those who survive, many have significant brain damage, which can include intellectual impairment, personality disorders, seizures, paralysis, and cranial nerve dysfunction.[1]

The Eastern Equine Encephalitis virus is an alphavirus that is maintained in a cycle between *Culiseta melanura* mosquites and avian hosts in freshwater hardwood swamps. *Cs. melanura* feeds almost exclusively on birds and transmission to humans and other mammals requires a mosquito that is capable of serving as a 'bridge' between infected birds and uninfected mammals. *Aedes vexans*, *Ae. sollicitans* and *Coquillettidia perturbans* are common bridge vectors in Rhode Island.

Between 2008 and 2018, there was an average of seven cases of EEE nationwide each year. In 2019, however, there were 38 cases, including 15 deaths, in the United States (**Figure 1**),[2] of which 3 cases and a death were in Rhode Island residents. Rhode Island had not seen a human case since 2009, and the last death was in 1998 (**Figure 2**). This dramatic increase required an unprecedented public health response.

Figure 1. Cases and Deaths from EEE in the United States, 2009–2019

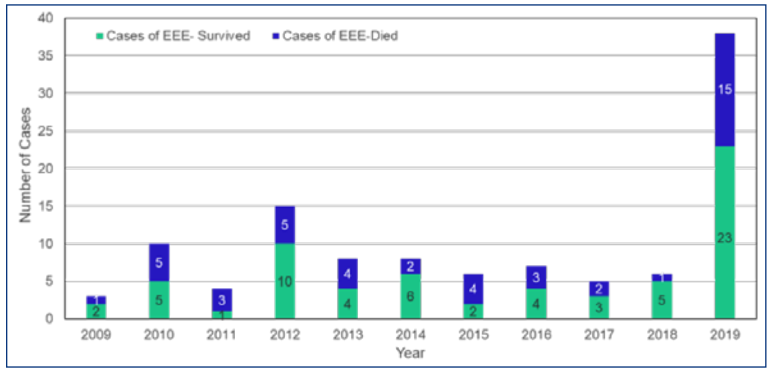
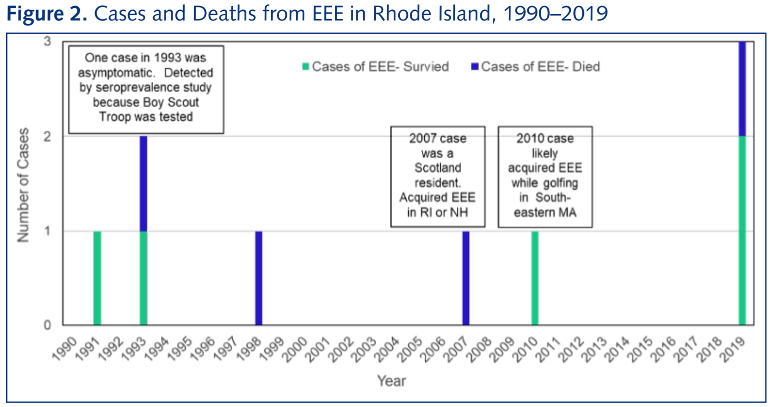


Figure 2. Cases and Deaths from EEE in Rhode Island, 1990–2019



METHODS

Annually in June, the Rhode Island Department of Environmental Management (RI DEM) distributes larvicide to cities and towns to apply to underground storm-water catchment basins to reduce human risk of West Nile Virus (WNV) in urban areas. In addition, RI DEM traps mosquitoes at various locations throughout Rhode Island from early June to October. Mosquito traps are placed strategically throughout the state based on the knowledge of environmental conditions conducive to WNV and EEE amplification in the mosquito population. Once traps are collected, the mosquitoes are sorted by species into "pools." Each pool contains one species of mosquito from one trap site from one trap night. The Rhode Island State Health Laboratory (RISHL) tests each pool for the presence of WNV and EEE through PCR testing.

Human arboviral infections are required to be reported to Rhode Island Department of Health (RIDOH). An epidemiologic investigation is conducted by RIDOH to determine potential exposures. Serum and cerebral spinal fluid (CSF) are collected from suspect cases and submitted to the CDC for testing. As part of the CDC arboviral testing panel, EEE IgM testing is performed using a Microsphere Immunofluorescence Assay. If the EEE IgM is positive, a confirmatory Plaque Reduction Neutralizing Test (PRNT) is performed.

During the arboviral season on a periodic basis, a group of subject matter experts discuss EEE surveillance findings, mosquito trapping results and other environmental factors. To help determine human risk and provide recommendations on statewide response activities, the group utilizes the

Guidelines for Phased Response to Eastern Equine Encephalitis Surveillance Data. This document was created in 2019 to supplement an existing Mosquito Bourne Disease Management Protocol.[6]

Recommendations and surveillance findings are incorporated into a Rhode Island Arbovirus Activity Update that is created by RIDOH periodically during the arboviral season. This report is posted to the RIDOH website and distributed by e-mail to individuals, including town managers, infectious disease physicians and veterinarians. RI DEM also issues periodic press releases to inform the public about mosquito test results and human risk for mosquito-borne disease.

RESULTS

During the 2019 arboviral season, Rhode Island had three human cases of EEE, including one death.

The serum on all three cases was EEE IgM positive/EEE PRNT positive. The CSF for two of the three cases was EEE IgM positive, as one case did not have CSF EEE IgM testing performed. The CSF EEE PRNT testing was positive for all three cases. The epidemiologic investigation determined that all individuals were likely exposed in their town of residence (**Table 1**).

During the 2019 arboviral season, 2,501 mosquito pools were tested. Nine of those pools were positive for EEE (5 *Cs. melanura*, 2 *Culex sp.*, 1 *Aedes japonicus* and 1 *Anopheles punctipennis*). Mosquito trap density, the average number of mosquitoes per trap, was calculated weekly throughout the 2019 season and it was consistently higher than the 5-year average (2014–2018) for the corresponding week (**Figure 3**). Prior to the 2019 season, the highest mosquito density documented in any single week from 2014–2018 was 63 mosquitoes per trap. In 2019, 5 weeks had mosquito densities greater than 63 mosquitoes per trap, including two weeks with over 100 mosquitoes per trap. In addition to the above findings, there were 3 deer, 1 horse and 1 dog identified with EEE in Rhode Island in 2019 (**Table 2**). The deer and dog represent the first time EEE was identified in these animals in Rhode Island.

The average number of mosquitos per trap during the 2019 season peaked in August, and then began to decline (**Figure 3**). The average number of mosquitoes per trap throughout the 2019 season was higher than the 5-year average (2014–2018). During the week of August 4, 2019 there was an average of 101 mosquitos per trap, the second highest of the season. During the same week, the first two positive mosquito pools were detected, and the first human case had onset of symptoms. The week of August 11 only had 35 average mosquitoes per trap. This was likely as a result of weather conditions such as rain, wind, and cooler temperatures. The week of August 18 had the highest average number of mosquitos per trap at 117. That week there was an EEE+ horse and two additional mosquito pools detected. One mosquito pool was a human-biting species, and the other was in a non-human biting species. Detection in the non-human biting species indicates that the virus is amplifying in the environment. One week later, during the week of August 25, two additional human cases had onset of symptoms.

Taking into consideration all Rhode Island human, animal, and mosquito surveillance data, as well as the increased EEE activity in Massachusetts and Connecticut, the group of subject matter experts and policy makers determined that this level of EEE activity warranted larviciding and adulticiding, in an attempt to reduce human health risk.

Larviciding targeted Chapman Swamp in Westerly where two mosquito pools and a horse were positive for EEE; the South Branch of the Pawtuxet River in West Warwick

Table 1. Human Cases of EEE, Rhode Island, 2019

Case No.	Age	Town of Residence	Illness Onset Date	Incubation Range (4–10 Days)	Outcome
1	50–59	West Warwick	8/9/2019	7/30/2019–8/5/2019	Died
2	50–59	Charlestown	8/27/2019	8/17/2019–8/23/2019	Survived
3	<10	Coventry	8/30/2019	8/20/2019–8/26/2019	Survived

Figure 3. Average Number of Mosquitos per Trap and EEE+ Findings by Week, Rhode Island, 2019

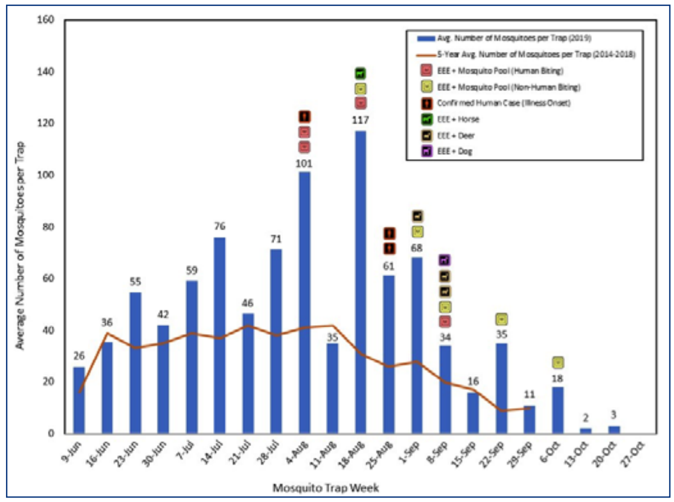


Table 2. Animal Cases of EEE, Rhode Island, 2019

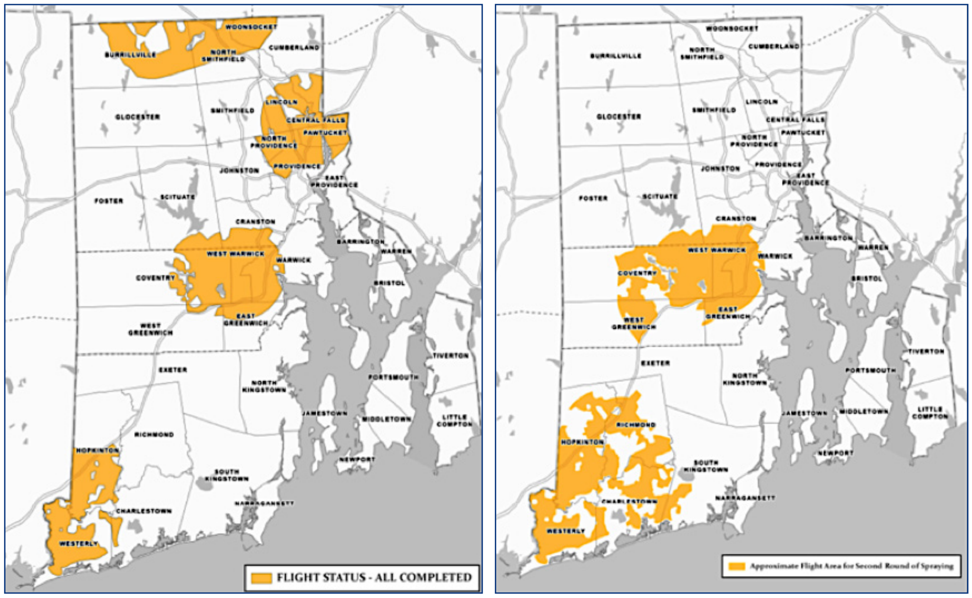
Result Date	Animal	Town
8/24/19	Horse	Westerly
9/6/19	Deer	Coventry
9/11/19	Deer	Richmond
9/14/19	Deer	Exeter
11/6/2019	Puppy	North Situate

where the first case lived; and the Valley Marsh area in Central Falls where EEE was detected from two positive pools.

Two rounds of adulticiding were also conducted. The first round of aerial spraying was conducted September 8–10 and targeted four areas that were high risk. The second round was conducted on September 25 and targeted two areas that were high risk (**Figure 4**).

Figures 4a and 4b. Spray Zones for Aerial Spraying of Adulticide

4a. First Round Spray Area, September 8–10, 2019 **4b.** Second Round Spray Area, September 25, 2019



DISCUSSION

Scientists cannot conclusively explain why there was a dramatic increase in EEE activity in 2019, but they describe several contributing factors. Climate changes result in longer summers, milder winters, and more extreme rain events, all of which result in better survival and breeding grounds for mosquitos. Other factors include reforestation, expansion of mosquito-breeding swamps, and an increase in the number of people who now live near those areas.[3] In addition, increased precipitation during the lifecycle of the mosquito correlates with an increase in human cases of EEE.[4] Scientists also suggest that an increase in EEE activity will likely last for two or three seasons.[3]

Healthcare providers have asked to send specimens to private laboratories instead of the CDC, because the turnaround time is shorter. Commercial laboratories that offer testing for EEE only do IgM testing. Since EEE can have cross-reactivity with other arboviruses, this test does not have high specificity, which results in inaccurate results.

Connecticut healthcare providers sent specimens from their four patients to Quest, and the results were IgM negative for EEE. Due to clinical suspicion and increased EEE activity, the Connecticut Department of Public Health also sent specimens to the CDC. Specimens for all four patients were IgM positive at CDC, and all were confirmed with PRNT.[5] This supports the hypothesis that commercial testing for EEE is not reliable.

References

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Acknowledgments

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