State of Connecticut Eastern Equine Encephalitis (EEE) Response Plan

Department of Energy and Environmental Protection
Connecticut Agricultural Experiment Station
Department of Public Health

Introduction

This 2020 Eastern Equine Encephalitis (EEE) response plan describes EEE ecology and disease, surveillance activities conducted by collaborating agencies, assessment of transmission risk, prevention strategies, and communications during periods of increased disease risk. EEE is a virus spread by mosquitoes and although rare presents a serious risk to human health. Outbreaks of EEE have occurred sporadically among horses and domestic pheasants in Connecticut since 1938. Since 2000, five cases of EEE in humans have been identified in Connecticut, one in 2013 and four in 2019; the 2013 case and three of the 2019 cases were fatal. The plan describes a progression of response to EEE based on assessment of transmission risk.

The state's mosquito monitoring and management effort is a collaboration involving the Department of Energy and Environmental Protection (DEEP), the Department of Public Health (DPH), the Department of Agriculture, and the Connecticut Agricultural Experiment Station (CAES), and the Connecticut Veterinary Medical Diagnostic Laboratory (CVMDL). Together, these agencies conduct mosquito, human, and veterinary surveillance. Surveillance data are used to monitor trends, detect increased transmission risk, and implement a phased response.

The purpose of this plan is to provide guidance for risk assessment, prevention activities, communication, and community action. Recommended actions are limited to those that are warranted by the specific extent of the potential threat to human health. This plan does not address long-term, municipal planning activities.

Agency Roles

- DEEP is responsible for the systematic identification and monitoring of mosquito breeding sites, the provision of technical assistance to municipalities and private property owners regarding mosquito control, and the collection and communication of information and data. Long term mosquito breeding site management will continue through DEEP's wetland restoration program.

- CAES conducts mosquito trapping and virus identification statewide. Trapping will be conducted in areas known or suspected to support mosquito populations, which have historically tested positive for EEE, are capable of supporting such populations, or are proximate to locations where EEE-related human or equine cases have occurred. CAES will communicate positive findings to partner agencies in near-real time, inform the media of findings increasing risk of human infection, and make mosquito trapping and testing data available to the public weekly online.

- The Department of Agriculture (DoAg) conducts surveillance for EEE disease among horses, farm-raised birds, and other domestic animals. DoAg will work with veterinary personnel and animal owners to identify potential cases of EEE disease, facilitate laboratory testing of animals, provide guidance and recommendations about vaccination of horses, and communicate findings.

- DPH conducts human surveillance for EEE disease. DPH, with CAES and DEEP, will review all mosquito, human, and animal surveillance data and consult regarding the epidemiological significance of such results. Based upon its evaluation of the potential human health risks, and in accordance with this response plan, DPH will provide advice about appropriate personal, municipal, and state actions to reduce such risks. DPH will also work with health care providers to identify potential EEE human illnesses, facilitate laboratory testing, and communicate findings.

- CVMDL conducts testing for West Nile virus in horses and facilitates testing of animal specimens for EEE at the National Veterinary Services Laboratory.

- Local Health Departments/Districts are the local health authorities and the primary points of contact within a community for DPH. Surveillance information is communicated to the LDOH who may conduct educational outreach via the media and/or other means, assist DPH in investigating cases, disseminate surveillance and risk assessment information to other community leaders, and undertake other activities, including mosquito control, based on their community's needs.

Disease Ecology

Eastern Equine Encephalitis (EEE) is a virus in the genus *Alphavirus* and is enzootic in Connecticut. The virus is found in species of perching birds (songbirds), mainly in hardwood fresh-water swamp habitats. The virus is transmitted between birds primarily by the mosquito species *Culiseta melanura*, a species that almost exclusively bites birds. It is thought the virus is introduced into the Northeast each year by migratory birds and the typical appearance of EEE from July to August coincides with the hatching of highly susceptible bird populations. Initially, a relatively smaller proportion of birds and mosquitoes carry the virus; throughout the mosquito season, continuous transmission between mosquito vectors and bird reservoir hosts increases the proportion of infected birds and mosquitoes, leading to a greater amount of virus circulating in the environment, usually in early September. This is called the virus amplification cycle.

In the Northeast, EEE transmission foci occur in and around forested swamps of mature white cedars and red maples that are the primary habitat of *Cs. melanura*. The buttressed root systems of these trees create dark holes, or crypts, that are generally filled with water and serve as larval habitat for *Cs. melanura* development and overwintering. The amount of rainfall during the summer and fall affects the survival of the larvae during the winter and, in part, determines the population of adult mosquitoes the following year. Because of the unique features of the enzootic foci, the risk of EEE in humans varies geographically in Connecticut. Historically, areas where EEE has been found are in the southeastern portion of the state (Figure 1).

In most years, EEE exists mainly in a mosquito-bird cycle. In years with high virus amplification, the virus may eventually spill over into secondary, or "bridge", mosquito vectors that feed on both birds and mammals, including humans. In the Northeast, these bridge vector species include *Coquillettidia perturbans*, *Ochlerotatus* (*Aedes*) *canadensis*, *Culex salinarius,* and *Aedes vexans*. Most sites where EEE has been identified in these latter species of mosquitoes are in or near hardwood swamps or areas bordering freshwater swamps. Salt marsh mosquitoes are not generally found near the forested swamp environments where bird reservoirs of EEE are concentrated and the risk of EEE transmission to humans by these species is low.

Mosquitoes are unlikely to be active when temperatures fall below 50 degrees in the evening. Most remaining adult mosquitoes are killed during the first frost.

Human EEE Disease and Diagnosis

Eastern equine encephalitis is a serious disease in humans, with 30-50% mortality and lifelong neurological disability among many survivors. The first symptoms of EEE are fever (often 103º to106ºF), stiff neck, headache, and lack of energy; some patients experience nausea or vomiting. These symptoms begin three to ten days after a bite from an infected mosquito. Additional symptoms may include difficulty speaking and weakness. Inflammation and swelling of the brain, called encephalitis, is the most dangerous and frequent serious complication. The disease may rapidly worsen and some patients may go into a coma within a week. There is no vaccine or treatment for EEE. People who survive this disease will often be permanently disabled due to neurologic damage. Few people recover completely. Human cases of EEE are most likely to occur in late August and September.

Testing for EEE usually consists of a preliminary screening test (an microsphere immunoassay (MIA) for IgM antibody to the virus), followed by confirmatory testing by plaque reduction neutralization testing (PRNT). Because the initial screening test could pick up cross-reactions with other arboviruses, confirmatory testing is needed to verify antibodies specific to EEE. Certain specimens, such as cerebrospinal fluid drawn shortly after symptom onset, may be tested by polymerase chain reaction (PCR). The EEE virus IgM MIA is available at the Connecticut DPH State Public Health Laboratory. Confirmatory PRNT or PCR testing is performed at the Centers for Disease Control and Prevention. The IgM MIA test results are available within 48 hours after sample submission; PRNT confirmation may take 7-10 days. Only specimens that are positive on the confirmatory PRNT test or on PCR are considered to represent true cases and used for risk assessment. Risk assessment is based on the period in which the patient was most likely infected (4 to 10 days prior to illness).

Additional information about EEE disease can be found on the CDC's EEE website.

Assessment of Transmission Risk

Assessment of the risk of transmission of EEE to people in Connecticut depends on multiple factors:

- Introduction of EEE into the state;
- Timing of this introduction;
- Abundance of key mosquito species at critical periods of the transmission season;
- Rate and magnitude of virus amplification;
- Virus isolations during the early part of the season (mid-summer);
- Isolation of EEE from multiple species of mosquitoes;
- Proximity of infected mosquitoes to residential areas, camping areas, or human activity;
- Identification of EEE cases in animals (horse, commercial exotic bird flock, wildlife)
- Identification of human EEE cases.

Identification of EEE in *Cs melanura* is useful as a proxy measure of the amount of EEE virus in the environment. Abundant populations of this species provide greater opportunity for the virus to amplify within the bird population and be picked up by a bridge vector mosquito species. The more virus that has spilled over into bridge vector species, the greater the chance that a person will be exposed to the virus. Jurisdictions without trapping sites should monitor trapping sites in neighboring jurisdictions, and surrounding regions, to assess local risk.

Other factors affecting seasonal risk are groundwater levels and the timing of rainfall and flooding during the mosquito season. Long-term weather patterns during the fall and winter that produce high ground water levels and snow cover may enhance survival of *Cs. melanura* larvae. Warm temperatures increase the rate of both mosquito development and virus replication within mosquitoes.

It is not currently possible to accurately forecast either the abundance of mosquitoes or the risks for encountering an infected vector. Risk assessment relies upon a robust mosquito surveillance system to monitor both mosquito populations and virus amplification as the season progresses. Consistent routine testing over a period of years provides data upon which to revise and refine the state's risk assessment and mosquito management efforts.

Surveillance

Connecticut conducts passive human and veterinary surveillance and active mosquito surveillance. Data from these surveillance systems, plus the extensive expertise of state and local agencies, are used in combination to assess risk of human disease.

Mosquito Surveillance

Statewide mosquito trapping is conducted from the first week of June to the end of October at 108 collection sites in 87 municipalities . This includes the 16 new trapping locations that were added in 2020 to increase trap coverage in high risk areas in eastern Connecticut. Trapping locations to monitor EEE transmission were established in more sparsely populated rural settings that included permanent fresh-water swamps (red maple/white cedar) and bogs, coastal salt marshes, horse stables, and swamp-forest border environs. Trapping sites have been selected based on the detection of EEE in mosquito or animals (horses or farm raised birds) or proper habitat for *Cs. melanura* development. Other mosquito trap sites are concentrated in more urban and suburban parts of the State where West Nile virus is more prevalent. These sites include municipal parks, greenways, golf courses, undeveloped wood lots, sewage treatment plants, dumping stations, and temporary wetlands associated with waterways.

Mosquito trapping occurs four days per week (Monday-Thursday). Traps are set overnight at each site every 10 days on a regular rotation and trapping frequency is increased to twice a week after detection of EEE or West Nile virus at that site. Two trap types are used at all trapping stations. 1) a CO_2-baited CDC Light Trap, designed to trap host-seeking adult female mosquitoes (all species) and 2) a Gravid Mosquito Trap, designed to trap previously blood-fed adult female mosquitoes (principally *Culex* species). Mosquitoes are transported to the laboratory the following morning where they are identified on the date of collection. Mosquitoes are pooled into groups of 50 or fewer according to species, collecting site, trap type, and date, and processed for virus testing the following day.

All of the virus isolation work is conducted in a certified Bio-Safety Level 3 laboratory at the CAES. Aliquots of each mosquito pool are inoculated into Vero cell cultures for detection of EEE and other mosquito-borne arboviruses of public health importance. Cell cultures are incubated at 37ºC in 5% CO_2 for up to 7 days and examined daily for viral growth. Isolated viruses are identified by Real Time (TaqMan) reverse transcriptase polymerase chain reaction (RT-PCR) or standard RT-PCR using virus-specific primers.

Complete processing of mosquitoes (from collection to virus isolation and identification) are completed within 10 days. Test results include, but are not limited to, trap sites, number and species of mosquitoes, collection date and arbovirus testing results. CAES reports results to the Department of Public Health and

the Centers for Disease Control and Prevention via ArboNet, the national electronic reporting system as soon as possible. Test results are posted online weekly.

Veterinary and Wildlife surveillance

EEE causes severe disease in horses and has been associated with illness in exotic game and non-native birds, birds of prey, goats, and white-tailed deer; evidence of infection and possibly illness in dogs and cats has been reported. Non-native bird species such as emus, ostriches, and exotic game birds, such as pheasants, partridge, emus, or ostrich, are highly susceptible to EEE and infections within farmed flocks have occurred in Connecticut

Specimens from horses and other domestic animals that have severe neurological disease suspected of being caused by EEE infection can be tested through the Department of Agriculture and University of Connecticut Veterinary Diagnostic Laboratory; specimens may be sent to the National Veterinary Diagnostic Laboratory. Testing can take up to several weeks to complete depending upon the type of sample submitted and the testing protocol required to obtain a definitive result. A vaccine is available for horses and other animals. Annual vaccination is the primary means of preventing infection in horses.

Blood and/or tissue samples from other animals such as zoo animals and captive or free-ranging wildlife with neurologic symptoms, or flocks with sudden die-offs, may be tested. Testing is coordinated through DEEP and University of Connecticut Veterinary Diagnostic Laboratory; specimens may be sent to the National Veterinary Diagnostic Laboratory. Testing of highly suspect bird specimens for EEE infection is coordinated through DEEP and University of Connecticut Veterinary Diagnostic Laboratory; specimens may be sent to the National Veterinary Diagnostic Laboratory.

Connecticut does not conduct active surveillance of birds for EEE. Most birds that are infected with EEE virus survive the viremia, making individual dead bird EEE monitoring impractical.

Results of animal surveillance are posted weekly.

Human Surveillance

EEE has been a reportable disease in Connecticut since 2000. Since then, human cases have been identified in 2013 (1) and 2019 (4). Four out of these five people identified with EEE disease died from the infection.

Due to the time delay for specimen collection, submission, and testing, it is possible several weeks may pass between the onset of a person's illness and a confirmed diagnosis. Assessment of transmission risk is made based on the likely time of a patient's exposure to the virus, which is up to 10 days before the onset of symptoms.

Results of human surveillance can be found at the DPH EEE website. To protect patient confidentiality, DPH generally releases only age category, gender, current patient status, town of residence and likely exposure location, if known. Results are also reported to the CDC's ArboNET reporting system for national surveillance.

Communication Plan

Identification of virus in mosquitoes from a given town is reported to the LHD by telephone within 24 hours of identification. Laboratory confirmation of a human EEE case is reported within 24 hours to the LHD for the town where the case resides. The Department of Agriculture or DEEP will inform partner agencies of laboratory confirmation of EEE infection in a domestic, wild, or captive/zoo animal within 24 hours; DPH will inform the LHD for the town in which the case resides within 24 hours of notification. Local health directors are encouraged to notify municipal leaders and elected officials of human, veterinary, or mosquito findings. After all appropriate state and local agencies have been notified, positive surveillance findings will be made available to the media and the public.

Results of human surveillance will be posted on the DPH EEE website upon confirmation of illness in a resident of CT. This website, which also includes links to educational materials related to mosquito-borne diseases, is updated throughout the arbovirus season. To protect patient confidentiality, only limited information is released to the public on any individual. DPH generally releases only age category, gender, current patient status, town of residence and likely exposure location, if known. Weekly summaries of mosquito trapping and testing will be posted at https://portal.ct.gov/mosquito. Summaries include a town-level map with locations of positive mosquitoes and human and animal cases indicated.

Participating state agencies will issue public health alerts through the media when surveillance information indicates an increased risk of human disease or if a significant surveillance event occurs (for example, the first arbovirus activity of the season). In general, alerts include current surveillance information and emphasize prevention strategies. Local health departments or districts, or municipalities, may issue public health alerts to share risk and prevention information with community members.

During seasons of elevated EEE transmission risk, multi-agency conference calls will be held weekly or as needed. Affected LHDs and municipal officials as well as adjacent LHDs and municipalities will be invited to participate in these calls. Risk assessment changes will be communicated to the LHD and any immediately adjacent community.

Response and Recommendations for Risk Reduction

The following recommendations are general guidelines only. Specific situations and local risk levels within communities should be considered individually. Assessment of risk of human disease is complex; no single finding can provide a precise measure of individual risk and no single prevention measure can eliminate risk of infection. **Personal protective measures must form the basis of all risk reduction.** The need to use these measures must continue even if other mosquito control activities, including aerial spraying, are conducted. Communication with the public and public awareness of what can be done to reduce individual risk of infection is of utmost importance.

Typically, risk for any individual is expected to be relatively low, and the routine precautions taken by individuals may be sufficient to reduce opportunities for infection.

Routine personal protective measures should include all the following actions:

- Minimize time spent outdoors between dusk and dawn when mosquitoes are most active;
- Using mosquito repellents containing an EPA registered active ingredient, including DEET, Picaridin, IR3535, oil of lemon eucalyptus, para-methane-diol (PMD), or 2-undecanone when it is necessary to be outdoors;
- Wearing shoes, socks, long pants, and a long-sleeved shirt when outdoors for long periods of time, or when mosquitoes are more active. Clothing should be light colored and loose fitting and made of tightly woven materials that keep mosquitoes away from the skin.
- Ensuring door and window screens are tight-fitting and in good repair;

- Use mosquito netting when sleeping outdoors or in an unscreened structure;
- Protect babies from mosquito bites when outdoors;
- In addition to the above measures, during periods of elevated risk, all people spending time outdoors should be cautioned to avoid wooded areas where mosquitoes are prevalent. Mosquitoes in densely wooded or shaded areas will often bite when disturbed during daytime hours.

Depending on level of risk as outlined below, community level precautions may include:

- DEEP may prepare and post signs containing recommended personal protective measures in state owned land and recreation areas.
- LHDs may consider posting signs containing recommended personal protective measures in town owned properties, land trusts, and other areas;
- Considering restricting, rescheduling, or cancelling outdoor group activities between dusk and dawn within focal areas of moderate to high transmission risk (intensive virus activity);
- Considering ground level ULV application of mosquito adulticide.

Although mosquitoes are unlikely to be active when temperatures fall below 50 degrees in the evening, EEE infection risk continues until the first frost, which kills most remaining adult mosquitoes and virtually eliminates risk of transmission. A hard frost is defined as two consecutive hours of temperatures below 28 degrees Fahrenheit or three hours below 32 degrees. This will occur at different times for different communities. However, before the first frost, mosquito activity may decline to a degree that the risk of ongoing transmission is low. Communities should consider this information when making decisions about planned outdoor group activities late in the season.

In situations where there is an identified elevated risk of human disease, state officials may consider the use of focal (truck mounted), or aerial pesticide spraying to reduce the number of potentially infected adult mosquitoes. Aerial spraying is conducted by aircraft. Licensed mosquito control professionals apply EPA approved pesticides in an ultra-low volume (ULV) spray, which dispenses fine aerosol droplets that kill adult mosquitoes on contact. Spraying occurs during evenings into overnight if weather conditions are favorable. Many areas of high concern for transmission in hardwood swamp areas are not fully accessible by truck or backpack mounted ground sprayers. Any decision to use focal (truck mounted) or large-scale aerial application of pesticide will be made only after evaluation of the multiple factors which contribute to risk of transmission of EEE to people and after discussion with officials from the potentially affected communities.

Aerial, truck, or backpack mounted pesticide applications can be used in conjunction with all other available risk mitigation tools. However, these measures do not eliminate all disease risk and it is critical that residents continue to protect themselves from mosquito bites.

Phased Response to EEE Transmission Risk

Definitions:

Sporadic EEE activity- when 1-2 mosquito isolates are detected during non-consecutive weeks within one focal area.

Sustained EEE activity- when mosquito isolates are detected for 2 or more consecutive weeks within one focal area.

Phase 0: No risk (baseline)

Findings:

- No EEE virus isolations from mosquitoes
  AND
- No human, horse, or commercial exotic bird deaths reported.

Probability of human disease: Remote

Actions:

- Trapping at 108 locations throughout the state will be conducted from June through October by CAES (Figure 2);
- Weekly results of mosquito trapping and testing will be made available to the public online at https://portal.ct.gov/mosquito ;
- Agencies will maintain passive human and animal surveillance;
- The EEE Working Group will communicate with Massachusetts and Rhode Island regarding their EEE monitoring programs and obtain updated information on confirmed EEE cases and public health advisories issued in those areas.

Phase I: Public Health Notification

Findings:

- Sporadic EEE virus isolations from *Culiseta melanura* or other bird biting mosquitoes such as *Culex pipiens, Culex restuans, Culiseta morsitans* and *Uranotaenia sapphirina*.
  AND
- No human or horse cases or commercial exotic bird deaths reported.

Probability of human disease: LOW

Actions:

- Continue Phase 0 Baseline Activities;
- DPH will notify LHDs of EEE isolations in their jurisdiction;
- CAES will issue press release about first findings of EEE and include routine personal protective measures;
- CAES will intensify trapping and testing in the region of occurrence.

Phase II: Public Health Notification

Findings:

- Sustained EEE virus isolations from *Culiseta melanura* or other bird biting mosquitoes
  AND
- No human or horse cases or commercial exotic bird deaths reported.

Probability of human disease: LOW

Actions:

- Continue Phase 1 activities;
- Additional communication from state and local agencies will advise residents in affected areas to use personal protective measures.

Phase III: Public Health Alert Level 1

Findings:

- Sustained EEE activity in *Cs. melanura* with weekly mosquito infection, *and* sporadic infection in human biting mosquitoes. Criteria in Phase III (Level 1) can occur along with, or soon after, Phase II.
  And/Or
- Confirmed EEE infection in a horse or commercial bird flock is identified.

Probability of human disease: Moderate

Actions:

- Continue Phase II activities;
- Agencies will issue a heightened public health warning to local officials, health agencies and residents advising personal precautions in the region(s) of concern;
- The public will be advised use all personal protective measures as detailed in section "Response and Recommendations for Risk Reduction";
- DEEP or LHDs may prepare and post signs containing recommended personal precautions in public land and recreation areas;
- Communities may wish to consider precautions listed in section "Response and Recommendations for Risk Reduction";
- Consider ground level application of mosquito adulticide;
- DPH will notify acute care hospitals of heightened EEE risk and clinical specimen submission protocols.

Phase IV: Public Health Alert Level 2

Findings:

- Sustained EEE virus isolations from human biting mosquitoes,
  And/Or
- Confirmed case of EEE involving a human, horse, or commercial exotic bird.

Probability of human disease: High

Actions:

- Continue Phase III activities;
- Agencies will issue heightened public health warnings to local officials, health agencies and residents advising personal precautions in the region(s) of concern;
- Weekly conference calls will be held with local health officials and municipal officials in affected communities;
- In addition to the personal protective measures advised in Phase III (Level 1), the public will be advised to avoid wooded areas where mosquitoes are prevalent at all times;
- Agencies may recommend restricting group outdoor activities during dusk to dawn in areas of intensive virus activity;
- Consider closure of state parks and campgrounds near affected areas
- Consider ground level application of mosquito adulticide;
- Consider aerial application of mosquito adulticide;

Figure 1. Land use map of Connecticut showing the distribution and prevalence of Eastern Equine Encephalitis virus isolations from mosquitoes and human and horse cases from 1996-2019.

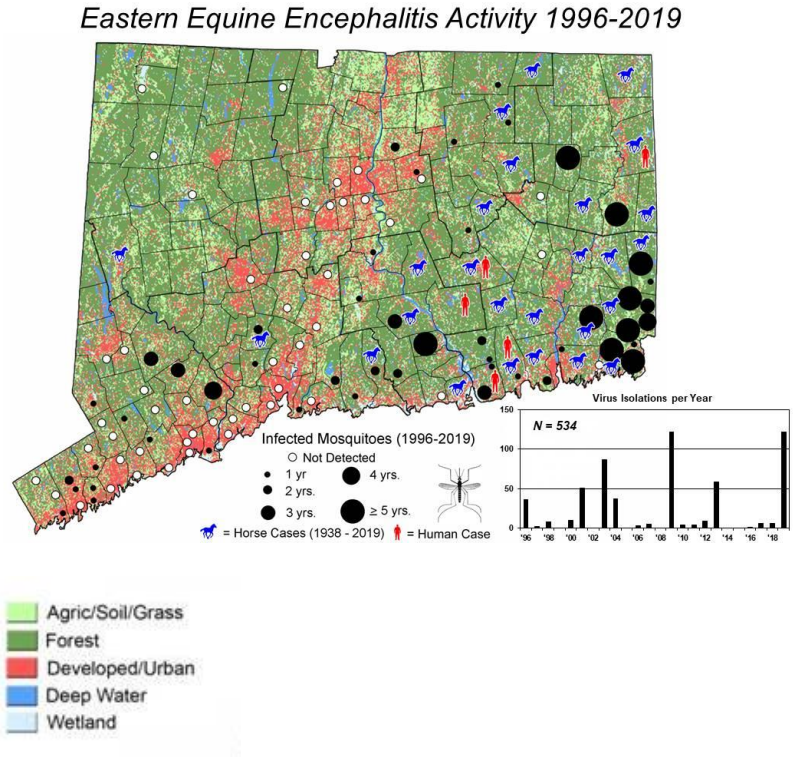

Figure 2. Map of Mosquito Trapping Stations for 2020.