

Sentinel Chickens and Their Role in Mosquito-Borne Virus Surveillance in Delaware

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The Delaware Mosquito Control Section (part of the Division of Fish and Wildlife in the Delaware Department of Natural Resources and Environmental Control) provides statewide services to maintain quality-of-life and protect public health by reducing mosquito population densities, and reducing the possibility of mosquito-borne illness to over 900,000 residents and nearly seven million annual visitors.¹ With 90 miles of coastline and over 320,000 acres of wetland habitat, Delaware is home to approximately 57 species of mosquitoes, 19 of which are considered to be pestiferous towards humans and 17 of which are potential disease vectors.² With an abundance of potential breeding habitat, Delaware also has the eighth-highest human population density in the United States.³ Whether it be from a nuisance standpoint (affecting quality of life, tourism, recreation, animal husbandry, property values) or the potential risk to public health, our staff focuses on controlling mosquito populations through an integrated pest management approach. Our integrated pest management includes mosquito population monitoring (both adult and larval), water management/source reduction, judicious insecticide use, and mosquito-borne virus surveillance. The Mosquito Control Section's and the Delaware Division of Public Health's mosquito-borne virus surveillance programs provide pertinent data to the medical and veterinary professionals throughout Delaware, alerting them to the active presence of Eastern Equine Encephalitis (EEE) and West Nile Virus (WNV) circulating in adult mosquito populations. The Mosquito Control Section conducts mosquito-borne virus surveillance and monitoring of EEE and WNV through its statewide sentinel chicken program.

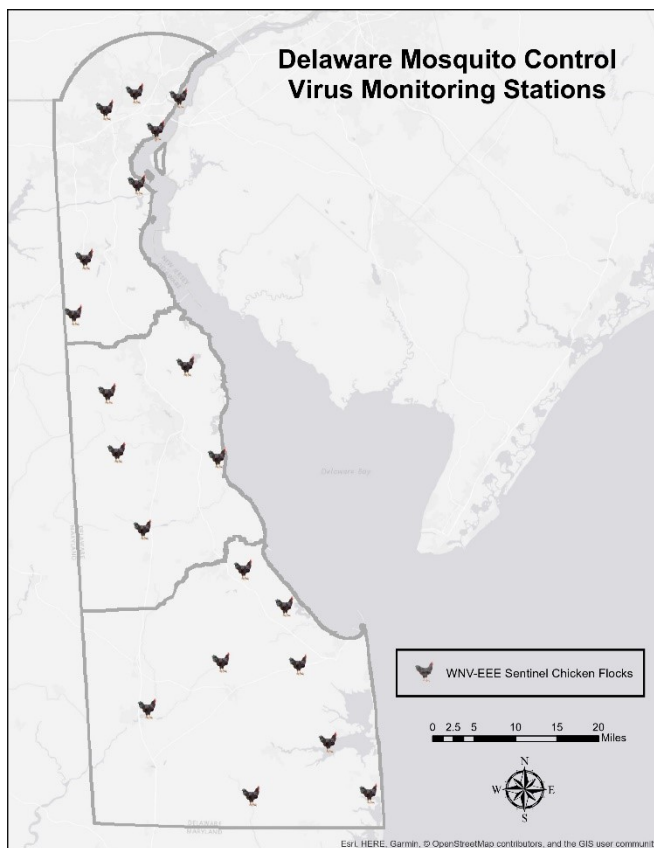
The transmission cycle of both WNV and EEE is maintained between vector mosquito species and susceptible avian hosts. Mosquitoes become infected when feeding on infected birds, and when taking their next blood meal, the now infected mosquito can then transmit virus to humans and horses (dead-end hosts).⁴ The amplification of virus occurs when the infected mosquito feeds again on another susceptible avian host.

One of the more common ways around the country for conducting mosquito-borne virus surveillance is through the use of sentinel chicken flocks. Chicken flocks are placed in secured pens in mosquito prevalent areas where they are exposed to biting adult mosquitoes. Weekly blood samples are taken in the field from the chickens and are then processed by a qualified health lab. When a chicken tests positive for EEE or WNV, this means local active transmission is occurring and medical, veterinary, and mosquito control professionals can respond accordingly. Once a chicken tests positive, it is removed from further testing and replaced with another non-infected chicken (i.e., no virus antibodies present). Chickens serve as valuable sentinel animals since they are not effective amplifying hosts,⁵ and they develop a short and relatively low viremia compared to other bird species when infected by WNV or EEE.⁶

Through a working partnership with the University of Delaware, our sentinel chicken flock is raised in an indoor laboratory setting at the University's College of Agriculture. Following the Centers for Disease Control and Prevention (CDC) guidelines, at 12 weeks old the chickens are banded and pretested to ensure each individual is not infected before deployment into the field.⁷

Four chickens are deployed at each of the 20 monitoring sites around the state (see Figure 1). Beginning in the first week of July and continuing for an eighteen-week period through the end of October, blood samples are taken weekly from a pair of chickens from each monitoring site (and thus an individual chicken is tested bi-weekly). Sampling occurs in the field by a pair of trained staffers drawing blood from the wing vein of the chicken. Collected samples are then processed by the Delaware Division of Public Health's Delaware Public Health Laboratory (DPHL). The DPHL tests the blood samples for WNV and EEE antibodies (seen as seroconversions) using an ELISA assay method.⁸ When a blood sample seroconverts for either WNV or EEE, the DPHL initiates a sequence of emails notifying the Department of Health and Social Services' (DHSS) Division of Public Health Office of Infectious Disease Epidemiology, the Delaware Department of Agriculture (DDA), and the Mosquito Control Section.

Figure 1. Sentinel Chicken Locations in Delaware



Positive detects of sampled chickens are shared amongst key state entities so that local response can be enacted. From the public health lab, alerts are subsequently reported to the Epidemiology Office within DHSS, the DDA's state veterinarians, as well as the Mosquito Control Section. Each plays a pivotal role in the One Health Initiative of Delaware. Upon receiving the positive results of either WNV or EEE in a sentinel chicken, the Epidemiology Office then enters these data into ArboNET, which is the national arboviral surveillance system managed by CDC and state public health departments. In addition, the Epidemiology Office then uses the information internally as an early indicator of what may be happening to the human population within the geographic area represented by a sentinel chicken monitoring location. If trends start to show a particularly elevated or concerning level of activity, the Epidemiology Office will send a

Delaware Health Alert Notification (DHAN) to the local medical and health care community with updated information regarding rising transmission rates within the specified area. Relative to concerns about mosquito-borne diseases and horses, the DDA also enacts a chain of events upon receiving analysis results from DPHL. This includes notifying state and regional stakeholders via a mailing list that consists of clinical equine veterinarians and regulatory animal health personnel at the federal and state levels.

Ultimately, the Mosquito Control Section's involvement is a response to monitor and actively reduce, as warranted, the population density of virally infected adult mosquitoes within the geographic region of a positive sentinel chicken surveillance location. This is accomplished through either ground applications of adulticides via truck mounted ULV (Ultra Low Volume) 'fog' sprayers for more localized treatment, or via an aerial fixed wing application of adulticides for more widespread areas.

The level of response taken by each agency can depend on the timing and frequency at which the detections are occurring. Figure 2 totals the monthly WNV and EEE seroconverted chickens over the past ten years. While EEE positives remain relatively low and follow no notable trend, WNV positive detections typically begin in July and increase through August before peaking in the month of September. Cooler fall temperatures in October and November bring an end to the mosquito and virus season; however, the virus is able to remain in the environment through overwintering vector mosquito species and in avian hosts populations.⁹ Figure 3 displays the yearly totals of WNV and EEE seroconverted chickens from 2000-2020. Delaware sees an average of 19.5 WNV seroconverted chickens per season, with the highest totals occurring in 2017 and 2018. Using historic data trends helps the Mosquito Control Section prepare for the current arboviral season response. By analyzing monthly data trends, Mosquito Control can gain insight into resource allocation needed for mosquito-borne virus transmission suppression.

Figure 2. Total number of seroconverted chickens by month over the last ten years in Delaware.

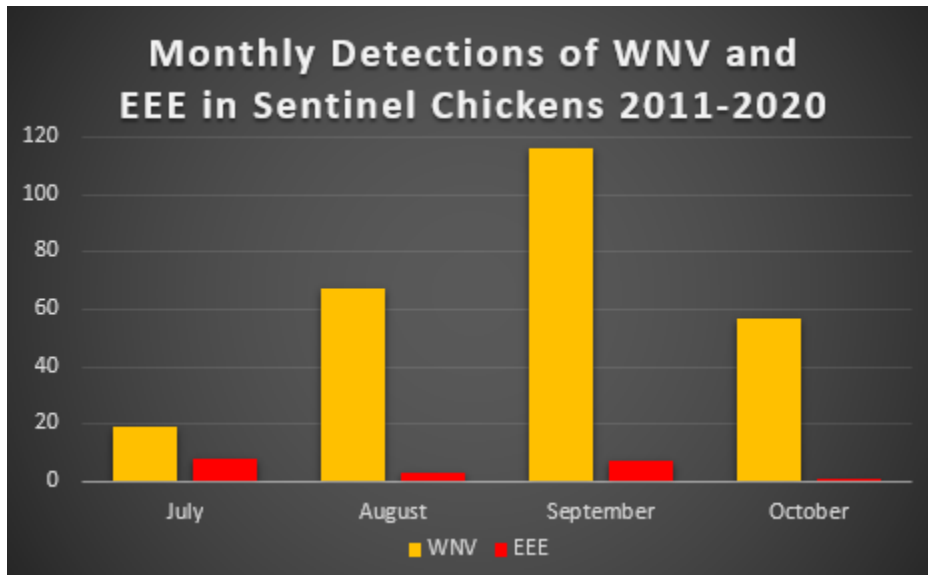
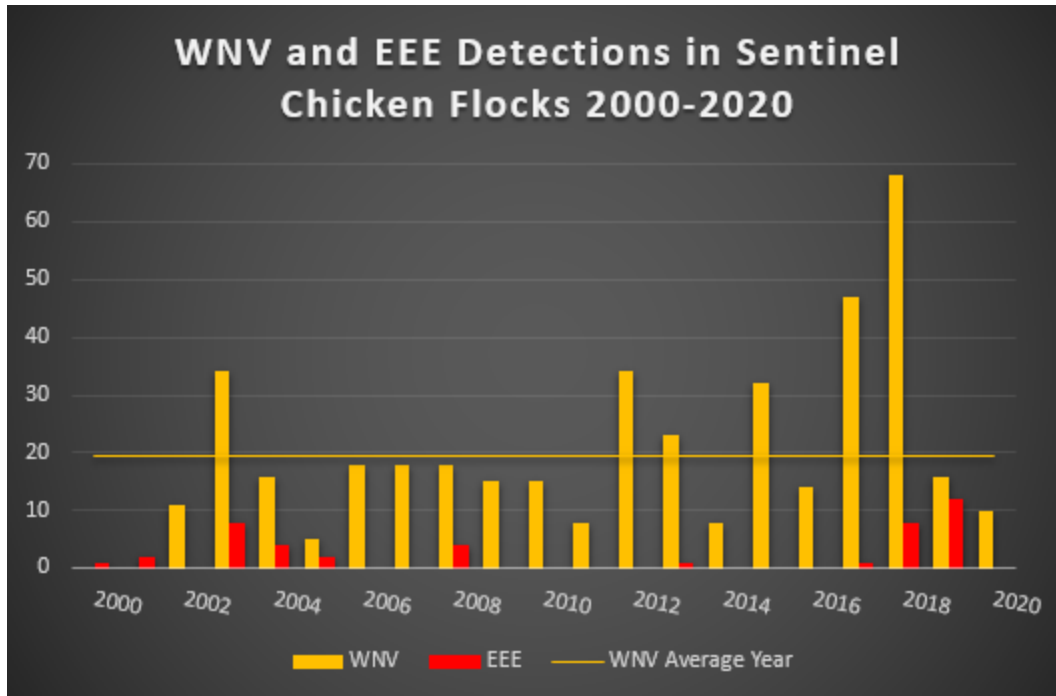


Figure 3. WNV and EEE seroconversions of sentinel chickens from 2000-2020; WNV seroconversions average 19.5 per year.



The mosquito-borne virus surveillance data obtained through the Mosquito Control Section's sentinel chicken program serves as a vital tool in Delaware's One Health initiative. This program increases the ability to predict when and where mosquito-borne virus transmission to humans is likely to occur in Delaware, while also encompassing the ideology of the One Health goal of protecting human, animal, and environmental health through collaboration, coordination, and communication.¹⁰ Through scientific collaboration, state agencies including the Delaware Department of Health and Social Services and the Delaware Department of Agriculture, along with the Delaware Department of Natural Resources and Environmental Control, are able to inform medical and veterinary professionals and the public of active mosquito-borne viral transmission occurring within the state. The Mosquito Control Section is able to provide an appropriate, timely insecticidal response to help avoid or suppress mosquito-borne disease outbreaks, and through press releases is able to promptly notify Delaware residents and visitors alike to take the necessary precautions to protect themselves from mosquito bites while still enjoying Delaware's great outdoors.

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