

## IT'S BEST TO BE PREPARED: LESSONS LEARNED FROM THE PAST PREPARED GEORGIA FOR HURRICANE MICHAEL

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**ABSTRACT.** Onsite assessments for mosquito larval habitat sites are critical after a hurricane makes landfall. Due to lack of forward assessment activities and the uncertain path of Hurricane Irma, it was difficult to determine what areas would be most affected, making it challenging to determine the availability of Department of Public Health Environmental Health Strike Team members from unaffected areas. However, lessons learned from assessing the public health response to Hurricane Irma (2017) helped improve the response to Hurricane Michael (2018).

**KEY WORDS** Environmental health, hurricane strike team, vector surveillance

### INTRODUCTION

Georgia (USA) is vulnerable to hurricanes, tornadoes, flooding, and other natural or man-made disasters. These disasters have caused disruption of essential human services and severe property damage to public roads, utilities, buildings, parks, and other facilities. Mosquito populations following water-related disasters can increase to levels where they become a public health risk, making the restoration of vital services to the citizens of the affected area both dangerous and difficult. Additionally, several mosquito-borne viruses circulate in Georgia each year and are capable of causing disease in humans and other animals. The most common mosquito-borne viruses in Georgia include West Nile virus (WNV), eastern equine encephalitis virus (EEE), and La Crosse encephalitis virus (LAC). Saint Louis encephalitis has also been detected in Georgia, most recently in 2018. The risk of infection with one of these mosquito-borne viruses could increase after a natural or man-made disaster. In addition, Georgia's risk of exposure to emerging mosquito-borne pathogens may increase due in part to international travel, immigration to Georgia, and out-of-state residents relocating to Georgia (unpublished data on Zika virus [ZIKV], Georgia Department of Public Health).

Areas of Georgia most likely to be directly impacted by hurricanes are the coast and coastal plain regions. However, in 2017 Hurricane Irma came through Atlanta, and Hurricane Nate veered west of the city, although it had been downgraded to a tropical depression before reaching Georgia. "Near misses" may also cause heavy rains, flooding, and increases in mosquito numbers. Hurricanes leave damage behind, including changes to the landscape that create new mosquito larval habitat, causing issues for years following the actual hurricane. This damage includes uprooted trees creating pockets and holes that hold water, silting in of storm water retention ponds leading to reduced drainage and an

increase in larval habitat, and accumulation of debris holding water.

Surveillance and control of mosquito disease vectors and nuisance pests is considered an essential part of disaster recovery efforts. However, there is a need for careful evaluation of the effect of specific disaster response activities on the community as a whole. In a state the size of Georgia, with 159 counties and without a centralized mosquito control agency, this can be difficult, but it is a necessary step for ensuring effective response activities. Proper planning for disaster responses ensures communities are prepared to respond and document activities for possible federal reimbursement should the area be declared a federal disaster by the president of the United States and acted upon by the Federal Emergency Management Agency (FEMA). The Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. §§5121-5207 (the Stafford Act) §401 states in part that "All requests for a declaration by the President that a major disaster exists shall be made by the Governor of the affected State."

With sufficient pre- and postsurveillance data, FEMA may reimburse mosquito control efforts after a natural disaster. However, many of Georgia's counties do not have the resources to collect the data or to pay for mosquito control in anticipation of reimbursement. This became readily apparent in 1994, when tropical storm Alberto stalled over south Georgia, causing the worst natural disaster in Georgia's then 207-year history. Affected communities had urgently sought federal support for mosquito control activities. As there were no baseline data or a Public Health Entomologist at that time, the state of Georgia requested assistance from the United States Public Health Service (USPHS), which provided vector control experts to evaluate the mosquito population. Although mosquito populations had increased, no significant increases in mosquito borne disease were detected, so a decision was made to not provide widespread spraying. However, as mosquito

problems increased, limited spraying for nuisance mosquitoes was eventually carried out by the state in several communities (Clinton et al. 1995).

The USPHS decision to resist widespread spraying reflected concern for larger environmental issues, such as the effect of spraying on the large number of honeybee businesses and fish farms in the flooded area. This experience demonstrated the need for careful evaluation of the effect of specific disaster response activities on the community as a whole and the development of a means to respond. Lessons learned from Tropical Storm Alberto and Hurricane Irma and planning for the threat of ZIKV allowed the Georgia Department of Public Health (DPH) to expand its Vector Surveillance and Response unit. This expansion allowed the DPH to conduct statewide mosquito surveillance for all 159 counties and gave it the ability to assist affected communities with emergency mosquito control using resources from the emergency mosquito surveillance trailers, as well as assistance from the Environmental Health Strike Teams and the Regional Vector Surveillance Coordinators.

### PROGRAM EVALUATION

The Georgia Mosquito Control Association and University of Georgia Extension Services completed a limited statewide assessment of mosquito control activities in 2007 and 2009 (unpublished data). With the threat of ZIKV in 2017, the DPH commissioned a new comprehensive statewide assessment of mosquito control services that was undertaken at the Jiann-Ping Hsu College of Public Health at Georgia Southern University (Georgia Mosquito Control Association 2017). This assessment assisted the DPH with response planning for vector-borne disease outbreaks and for hurricane response. It was found that 126 counties and cities in Georgia reported having some kind of mosquito control program (30 county and 96 city programs). Of these programs, 89 offered no form of adult mosquito surveillance, limiting that community's ability to adequately respond to potential vector-borne disease outbreaks. Only 18 programs were deemed to be integrated mosquito management programs. This information assisted the DPH with planning future response activities and predeploying assets to areas of need before a natural or manmade disaster.

In 2005 Florida was hit by multiple hurricanes. At that time, it became obvious that Georgia had no plans to deal with increases in nuisance and vector mosquito populations that occur in the wake of natural disasters such as hurricanes. In 2007 a single emergency mosquito surveillance trailer was obtained by the DPH for response activities. The trailer contained a generator, both gravid and the Centers for Disease Control and Prevention (CDC) light traps, coolers for dry ice, batteries, microscopes, backpack sprayers, laboratory space, and other items used to provide surveillance and identification of

mosquitoes, and potentially small-area control in areas where there may be no electricity or place to work. This trailer proved very useful after the Okefenokee Swamp Fire in 2007 and subsequent Tropical Storm Barry, which assisted in putting out the fire but left widespread flooding.

### HURRICANE RESPONSE

The primary mission of the DPH Environmental Health section (EH) after a hurricane makes landfall is supporting socioeconomic recovery for the affected areas. This includes getting restaurants inspected and reopened, vector surveillance and control, and continuing inspection of shelters. The operational experience from the Hurricane Irma EH response provided a good reference for improving the EH operational response activities before and after Hurricane Michael.

Public Health falls under Emergency Support Function Annex 8 (ESF8) and is charged with coordinating the state's health and medical processes during preparedness, planning, activation and deactivation (Georgia Emergency Management and Homeland Security Agency 2019). One of the ways in which State EH prepared to deal with emergency situations was to form Environmental Health Strike Teams (EH Strike Teams). These teams are made up of Environmental Health Specialists (EHSs) trained in emergency response, credentialed, and prepared to rapidly deploy and respond to emergency situations. There are 2 teams located in each of the 5 Emergency Preparedness Response regions in Georgia (Fig. 1). Each team has 6 members, including a team leader. Additional staff, usually subject matter experts, can be deployed with the teams, and in the case of mosquito surveillance and control following a hurricane, that could include a DPH entomologist or a regional Vector Surveillance Coordinator (VSC).

The VSC program was developed in 2016 in response to the threat of ZIKV in Georgia. Five VSCs were located in 10 Public Health Districts at highest risk for vector-borne disease transmission, with each VSC covering 2 Health Districts with varying numbers of counties (Fig. 2). The DPH also purchased 10 additional surveillance trailers in 2016. These trailers were stocked and placed strategically across the state (Fig. 3). The primary reason for these trailers is to aid in determining the scope of the public health-related mosquito problem, both vector and nuisance species, after a disaster and provide the tools for basic small-scale emergency mosquito control using larvicides and barrier spray applied by backpack sprayer. As planned, the trailers became a critical asset used by EH Strike Team members responding to Hurricane Michael.

A protocol for response to mosquito-borne diseases was developed for the VSCs in response to the ZIKV epidemic and later modified to include response to all mosquito-borne diseases in Georgia as well as hurricane responses. The DPH VSCs and

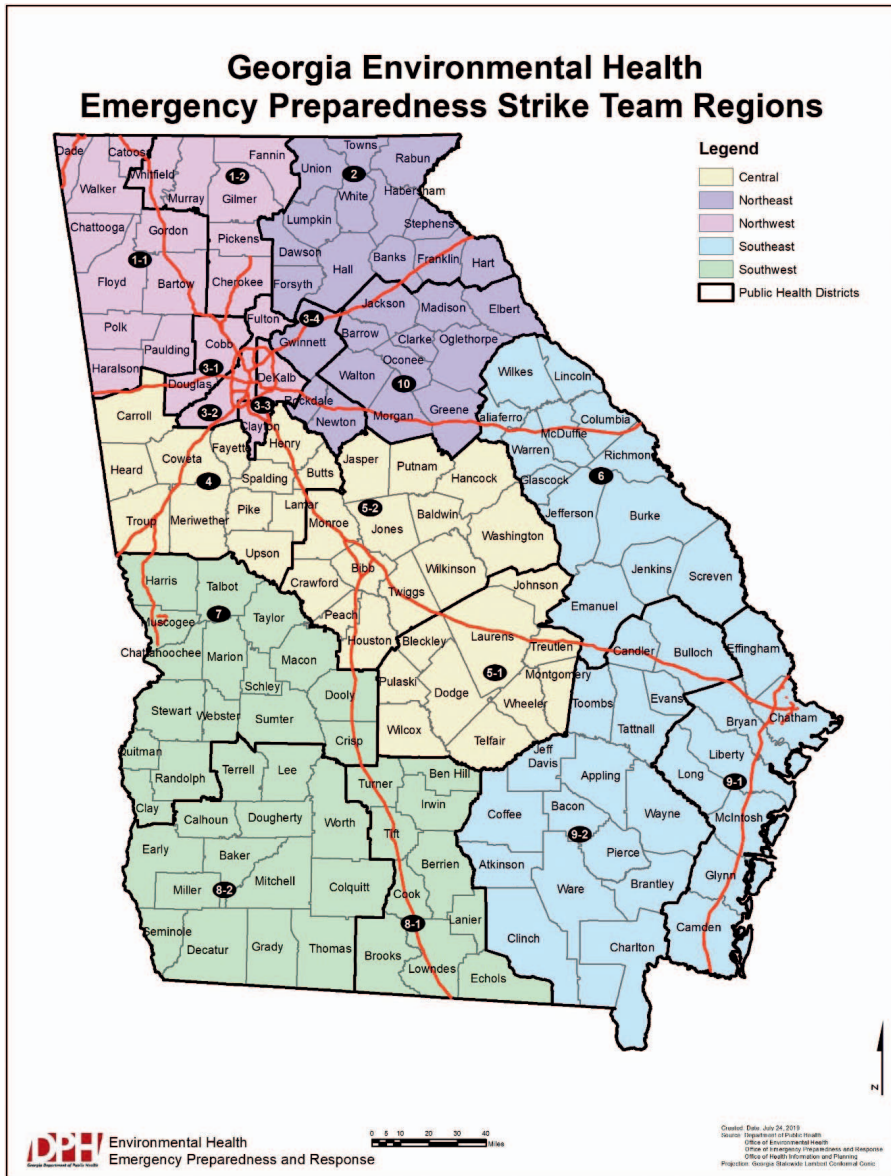


Fig. 1. Emergency response regions in Georgia.

EHSs around the state of Georgia are trained to respond during natural disasters regarding mosquito surveillance and control. The DPH state entomologists organized and revised state emergency response plans for mosquito control to include VSC and EH response activities. The VSCs have primary responsibility to conduct and improve mosquito surveillance for arboviral diseases such as WNV, EEE, LAC, and ZIKV. Duties include establishing surveillance locations throughout the Public Health Districts, setting up traps and collecting mosquitoes, mosquito identification, complaint response, community assessments, and community education pro-

grams. When necessary, the VSCs coordinate mosquito control activities with existing city- and county-contracted mosquito control agencies and assist with localized control efforts. In addition, the VSCs support EH and the EH Strike Teams by assisting with surveillance for other public health issues of concern, including agents of bioterrorism, tickborne diseases, rabies, and bedbugs. They can participate in outbreak detection and response activities and assist in hurricane and flooding response where mosquitoes become a problem.

If a major disaster declaration is declared, it is important to work with the local emergency response

# Georgia Environmental Health Vector Surveillance Regions



**DPH** Environmental Health  
 Georgia Department of Public Health Emergency Preparedness and Response

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 Source: Georgia Department of Public Health  
 Office of Environmental Health  
 Office of Emergency Preparedness and Response  
 Office of Health Information and Planning  
 Projection: Georgia Statewide Lambert Conformal Conic

Fig. 2. Vector surveillance coordinator regions in Georgia.

agency (EMA) to include a request for reimbursement of mosquito control activities in the request to FEMA. Vector control falls under the removal of health and safety hazards. Documentation needed for vector control includes the following: Surveillance Data—current data and past 3 years covering the same period; Operational Data—including all information that supports the Project Worksheet, such as equipment, personnel and pesticide; and Post Surveillance Data—desired but not necessary. It also includes complaint information and larvicide handed out to citizens.

Everything done as far as surveillance and control must be part of the process. The process involves coordination through the County Emergency Opera-

tions Center, notifying the Joint Field Office, having County EMA contact the Georgia Emergency Response Agency State Operations Center, and working with the District EH Director to draft a “Need Assistance; Need Resources” request. Everything potentially needed must be listed so that expenses and insurance are covered.

During the Hurricane Michael response, safety was the number one concern. Depending on the scope of the problem, it was not possible to safely access many areas. Once it was safe to enter the area of concern, it was important to set out CDC light traps near population centers. Supplies in the emergency mosquito trailers were used to aid with both surveillance and control. Mosquitoes were

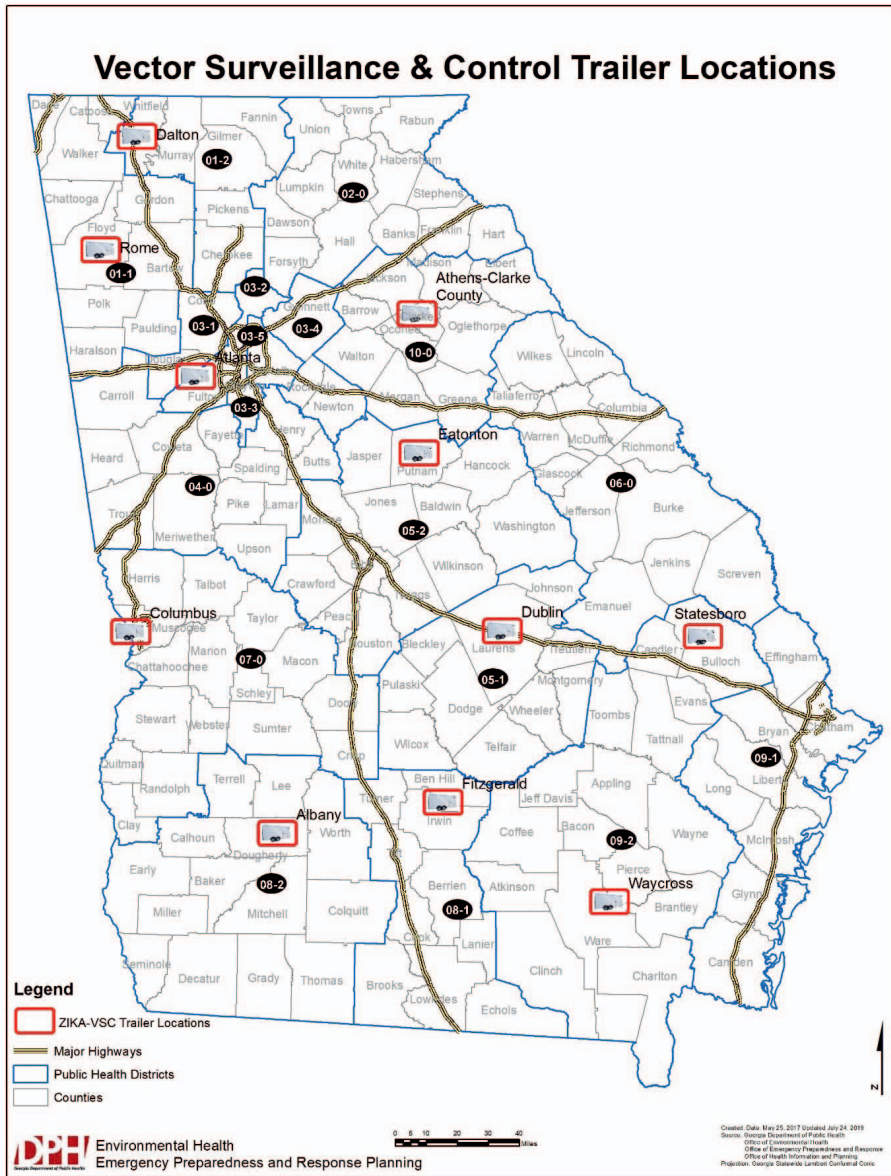


Fig. 3. Vector surveillance and control trailer locations in Georgia.

counted and identified quickly. DPH staff worked with local mosquito control to provide mosquito control for the area. If the scope is very large, DPH has a contingency contract for mosquito control that can be invoked, or the local government can choose to hire an emergency mosquito control agency. The role of the VSCs and Public Health Entomologists is to safely provide data and, potentially, assist with control efforts.

Most counties in Georgia do not have the equipment to provide mosquito control or the funds to contract for control after a hurricane or tropical storm. Building off the successful use of the

mosquito response trailer purchased in 2007, the DPH expanded its response capacity in 2017 by purchasing 10 additional response trailers using Emergency Preparedness funding and pre-deployed each trailer regionally around the state. This allowed for quick access to the supplies and equipment that aided in rapid response to Hurricane Michael. Equipment included in all the mosquito trailers are surveillance traps (CDC light and gravid), microscopes and other material needed to identify mosquitoes, larval dippers, a backpack sprayer, and a Styrofoam-lined chest for dry ice. The 10 additional trailers also contain boxes of repellent towelettes,

personal protection equipment, containers for mixing and holding hay infusion, folding tables and chairs, a portable canopy, BGS® traps (Biogents USA, Moorefield, WI), and the pesticides Altosid® and Mavrik® (Central Life Sciences/Zoëcon, Schaumburg, IL). These were items deemed necessary or useful after the deployment of the original trailer to help with the Tropical Storm Barry recovery. Trailer use protocols are posted on the Georgia Mosquito Control Association page (Georgia Mosquito Control Association 2019) and in the Emergency Preparedness guidelines (Georgia Emergency Management and Homeland Security Agency 2018). These Vector Surveillance and Control Trailers were strategically staged within public health districts throughout the state in preparation for natural disasters. They are physically located at a local or District Health Department. Regional VSCs are responsible for inventory management and have keys to the trailers.

Due to the uncertain path of Hurricane Irma, it was difficult to determine what areas would be unaffected or less affected. Supplies were not always available where they were needed because of this uncertainty. Predicting which EH Strike Team members would be unaffected for deployment was challenging until after the hurricane's impact. Once the hurricane moved away from Georgia, it was then possible to move supplies and identify available EH Strike Team personnel for recovery. However, hurricane damage made it more difficult to move people and supplies. After Hurricane Irma, when counties realized that contracted mosquito control was cost prohibitive, the mosquito trailers were used by the VSCs and EHS to provide barrier spray and larvicide as well as surveillance.

Lessons learned from Hurricane Irma improved the EH response for Hurricane Michael, because all EH strike team members from potentially unaffected areas were notified to prepare for deployment early. One of the EH Strike Team leaders from the Hurricane Irma response also forward deployed to Albany after Hurricane Michael to help expedite EH-related community recovery. The EH Strike Teams were deployed to support the Albany and Columbus Public Health Districts in a timely manner along with EH support provided from adjacent districts. The EH Strike Team response and adjacent district support was critical to expediting the community's return to normalcy as power was restored to affected areas. Replacement EH Strike Teams and an EHS team from the Coastal Public Health District were on standby to complete the mission if needed.

Even though vector surveillance and control trailer supplies had been replenished after Hurricane Irma, surge vector control supplies (larvicide, DEET wipes and spray) were shipped to the affected area from the Athens and Macon Public Health Districts and the DPH EH office to support the response. These surge supplies were readily available for EHS use after Hurricane Michael to protect the public and expedite recovery activities. Additional supplies were staged

in a vector surveillance trailer located within the affected Southwest Georgia Public Health District. This was one of the same trailers staged prior to Irma. The EH Strike Teams and VSCs used the VSC protocol that proved useful during Irma to provide larvicide and barrier spray to help reduce mosquito populations in affected areas. Once it was safe to enter the area of concern, CDC light traps were set out near population centers. Supplies in the emergency mosquito trailers were used to aid with both surveillance and control. Mosquitoes were counted and identified quickly. Where there was local mosquito control, the VSCs worked with them when providing mosquito control for the area. Areas of concern near the district public health office were treated with larvicide, and mass feeding site responders, who provided meals for people staying in shelters as well as for those helping with disaster response and recovery, were provided with DEET wipes for use while working outdoors. The Disaster Recovery Center in Albany was a primary location for sharing mosquito personal protection information flyers and DEET wipe packets to affected families within the health district.

The EH Strike Teams must deal with EH activities of more immediate concern than mosquito surveillance and control, which is why the regional VSCs were also involved in the hurricane response. Of greatest importance is the inspection and reopening of impacted food service facilities. After Hurricane Irma, food safety messages were sent out in the most impacted areas. A lesson learned from Hurricane Irma is many facilities will not have communication devices, which impacts a facility from receiving a public health message. This lesson was carried forward, and before Hurricane Michael landed, food safety messages were sent out before landfall as well as afterward. This assisted with notifying facilities to prepare before the hurricane causing damage. More than 1,200 food service reopening inspections were completed within the affected area after Hurricane Michael by EH strike teams. After completing the EH missions, all EH Strike Teams were demobilized by October 17, 2018.

Previous experiences with hurricanes and tropical storm response led to an increased focus on responding to mosquito issues after the storms. The operational experience documented in an in-house after-action report from the Hurricane Irma EH response provided a good reference for improving the EH operational response activities before and after Hurricane Michael. The after-action report information was part of the improvement process that enhanced DPH's vector surveillance and control training program and support of partner agencies. The improvement process enhances future response efforts with cost-efficient planning methods.

In conclusion, before hiring the VSCs, training the EH Strike Teams in mosquito surveillance and control, and purchasing the emergency surveillance trailers now deployed throughout the state, it was

challenging to collect mosquito surveillance data following a hurricane or flood event. The majority of counties in Georgia that are likely to be impacted by hurricanes are unable to pay for mosquito control in hopes of receiving reimbursement, and so very little was done to control the increased mosquito populations. According to W. H. Foegen, a former CDC epidemiologist and a strong proponent of disease eradication and control, collection and analyses should not be allowed to consume resources if action does not follow (Foegen et al. 1976). With the addition of the emergency response trailers, vector surveillance training for the EH Strike Teams, the addition of trained VSCs, and lessons learned from previous hurricane responses, the Georgia DPH is now able to provide surveillance and control of mosquito disease vectors and nuisance pests within critical response areas to help facilitate disaster recovery efforts.

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