

North Carolina Vector borne Disease Management

***Developing capacity in the Communicable Disease Branch,
Environmental Health Section and State Laboratory of Public
Health***

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Background

In 1957, the North Carolina General Assembly established the Salt Marsh Mosquito Study Commission to evaluate ways of lessening the mosquito problem in coastal North Carolina (NC). Upon recommendations of this commission, the Mosquito and Vector Control program was established in General Statute 130A-346 through 349. This program evolved over the years to address concerns related to tick and mosquito borne conditions and remained funded until 2011 when it was abolished and repealed by Session Law 2011-145, s. 13.3(j).

Burden of vector borne disease in North Carolina

Vector borne diseases represent approximately 15% of all reported general communicable diseases (VPDs and STIs excluded) in North Carolina. The vast majority of reported vector borne conditions are spotted fever group rickettsia (SFR) infections acquired in North Carolina. The state often has one of the highest annual incidence rates of SFR in the country. While endemic mosquito borne infections are not as common, North Carolina also often has the highest incidence rate of reported cases of LaCrosse Encephalitis in the country. While local transmission has not been documented, travel associated cases of malaria, dengue, chikungunya and zika are routinely identified and autochthonous transmission is possible, though perhaps not probable.

Vector borne disease ecology

The complex life and transmission cycles of many vector borne conditions requires a thorough understanding of the ecology of the organism to characterize environmental risk factors, identify methods to interrupt disease transmission, and educate the public and providers. As examples there are key factors regarding several diseases that are unknown in NC:

- While SFR cases are common in North Carolina, the tick vector (*Dermacentor variabilis*) classically associated with transmission is rarely found in North Carolina, Tennessee or Virginia. This raises questions of whether other vectors are involved, or other pathogens are causing a similar illness. Based on investigations in other states, both are likely, but further ecologic study is needed.
- North Carolina has historically reported a low incidence of Lyme disease cases, yet the condition has been steadily progressing through Virginia from the capital area to the Southwest, and modeling studies indicate the condition is likely to emerge in Northwestern North Carolina. Due to concern and potential late manifestations of untreated Lyme disease, it will be essential to characterize the risk of infection geographically to better educate citizens and clinicians.
- While approximately 65 species of mosquitoes are known to be present in North Carolina, a systematic survey to address species presence and abundance has not been conducted in over 20 years. With those data it is difficult to know whether or not the Yellow Fever mosquito (*Aedes aegypti*, a recognized vector of dengue, chikungunya, and zika) is present in the state. Such a survey would help estimate risk of local transmission of these infections.

Vector borne disease program elements

Several functions are necessary to fully characterize, respond to, and educate the public about vector borne diseases. To carry out these functions a collaborative approach involving the Division of Public Health, Local Health Departments (communicable disease and environmental health), local mosquito control programs and districts, and academic partners will be required.

The program elements include:

1. Surveillance for human cases of disease
2. Entomologic surveillance to include determination of vector species presence, absence, and relative abundance. Also included would be study of collected vectors for presence of pathogen
3. Laboratory capacity to facilitate both human and entomologic surveillance
4. Education and outreach tailored to local health departments, health care providers, and the general public
5. Guidance and instruction for local vector management programs advocating adoption of Integrated Vector (Mosquito) Management

Creating an effective vector borne disease program in North Carolina

The goal of the Division of Public Health is to increase capacity and achieve a functional and comprehensive vector borne disease program in order to assess and mitigate the risk of disease in people. There is historic capacity (staff) within the Communicable Disease branch and the State Laboratory of Public Health to conduct human surveillance and laboratory testing for vector borne conditions. These staff have promulgated education, laboratory and clinical guidance, and managed the state vector borne disease working group. Despite these efforts, there is a clear void in terms of understanding the ecology of these conditions, and that has slowed prevention and control efforts. With the introduction of entomologic, laboratory, and aid to county capacity, these gaps will be addressed and other areas will be enhanced.

Understanding the ecology of these pathogens to reduce human disease risk meshes with the mission of the Communicable Disease Branch which is to conduct surveillance activities and outbreak response for communicable disease, including HIV and other STDs, and other diseases reportable under NC law, and to protect the health of the citizens of North Carolina through prevention and control of those diseases. As such the entomology capacity will be placed in the Communicable Disease Branch.

To develop new testing protocols and increase testing capacity for vector borne diseases the laboratorian will be placed with the State Laboratory of Public Health.

Will the new vector borne disease program replicate the activities of the former Public Health Pest Management (PHPM) program?

The objectives of the PHPM program were, in part, set by statute (130A-346 through 349) and required the program to address issues presented by vectors, arthropods and rodents of public health significance and to direct how to spend mosquito control funds with an emphasis on

abatement. Some functions of the former PHPM program will be similar, but the new program will be focused on understanding the ecology of tick and mosquito borne conditions to mitigate their impact on people. The new program will not have specific laws directing its function but will be based on the principles and practice of communicable disease control.

What, specifically, will be the responsibilities of the medical entomologists in the Communicable Disease Branch?

1. *Aedes spp* (primarily *aegypti* and *albopictus*) surveillance and control: Based on historical reports and literature review, identify areas of North Carolina where *A. aegypti* are likely to be identified. Provide oversight, technical guidance, and consultation to conduct surveillance, education, and control measures (in accordance with Centers for Disease Control and Prevention guidelines) in collaboration with local, academic, and federal partners. Create distribution and abundance maps to identify areas of potential risk for Dengue, Chikungunya or Zika virus infection in North Carolina.
2. Vector surveillance: Create and maintain a roster of local (city/county/mosquito control district/etc.) vector surveillance activities. Develop and enhance local capacity for vector surveillance in a manner consistent with published guidelines to include training on appropriate field collection techniques, speciation, and documentation of results. Direct all federally supported entomologic surveillance activities related to arboviral diseases, Lyme disease, or spotted fever group rickettsial infections.
3. Vector control: In collaboration with the NCDA&CS pesticides division, North Carolina Mosquito and Vector Control Association, academic partners, and other appropriate agencies, provide guidance on scientifically established and validated methods of vector control (Integrated Mosquito Management or Integrated Vector Management).
4. Pathogen Surveillance, Identification and characterization: Work with the State Laboratory of Public Health to conduct advanced molecular diagnostics on vector populations (primarily mosquitoes and ticks) for pathogens of public health significance when indicated. As necessary for disease surveillance programs, conduct mosquito pool testing and serologic screening of wild caught birds or sentinel flocks.
5. Vector borne disease case surveillance and investigation: In collaboration with the vector borne disease nurse consultant and state public health veterinarian, assist with case surveillance, investigation and reporting. Integrate human, veterinary, avian and mosquito pool surveillance. All bird, human, horse, and mosquito arbovirus cases are mapped using Geographic Information System (GIS) software so that clusters of the disease can be identified. Conduct field investigations as appropriate when clusters or diseases of significance are identified in human or veterinary patients.
6. Professional consultation, communication, and education: provide expert consultation on arthropods of medical and public health importance to staff and clients, including physicians and other health care providers, veterinarians, environmental health specialists, lab workers, epidemiologists and other health and public health professionals. Develop comprehensive multimodal education campaign focused on tick and mosquito borne disease reduction (i.e. “fight the bite” and “tip and toss”).

What, specifically, will Aid to County funding be used for?

1. This funding may be used in development and implementation of Integrated Vector (Mosquito) Management.
2. In accordance with the principles of IVM/IMM the funding may be spent on education and surveillance activities under the general guidance of the DPH entomologists.
3. The funding may be spent on abatement and control activities only if surveillance (entomologic or human) suggests a need.
4. This funding will be distributed annually by the Environmental Health Section through an agreement addendum with participating local health departments.

What, specifically, will be the responsibilities of the laboratorian in the State Laboratory of Public Health?

The primary purpose of this position is to provide professional and technical direction for laboratory method development and implementation, quality assurance, staff training, problem resolution, and maintenance of molecular and serological testing associated with vector-borne disease surveillance. This position is responsible for the development and performance of advanced laboratory testing technologies, such as plaque-reduction neutralization tests (PRNT) and other serological assays to characterize human immune response to infectious agents. In addition, this position will 1) develop and/or implement molecular assays, such as multiplex PCR and next generation sequencing to rapidly detect and characterize emerging pathogens, 2) cultivate and isolate viral agents, and 3) generate molecular tools to identify, group, type and sub-type these agents. The tests employed can be used to diagnose and treat patients and/or conduct surveillance to allow for data-driven decision-making to strategically implement vector and disease control measures.

This position will independently perform highly complex and unusual analytical procedures to separate and purify organic and inorganic molecules, sequence DNA strands, and characterize isolated DNA or RNA strands. Analyses will be requested to meet special epidemiological, clinical and environmental challenges and /or reduce the cost of conventional analytical techniques. This position is responsible for conducting routine biosafety risk assessments and developing risk mitigating strategies to safely handle novel viral threats using biosafety level 2 and 3 work practices and facilities. This position will serve as the State Laboratory of Public Health's expert and consultant for vector-borne disease surveillance and other high consequence viral threats such as avian influenza and orthopox viruses.

This position will report to the Virology/Serology Unit Manager, and is responsible for overseeing method development and technology transfer within the Virology/Serology Unit. These molecular and serological diagnostic and surveillance assays are typically laboratory developed tests that require advanced training in virology and serology.

What role will the Vector borne disease management program have in the North Carolina zika response?

The program, as a constituent element of the Communicable Disease Branch, and in close collaboration with the Environmental Health Section, State Laboratory of Public Health, NC Department of Agriculture & Consumer Services, and academic partners, will provide assistance and direction to local health departments and mosquito control programs. These agencies will work collectively to provide the following elements:

1. Clinical and laboratory guidance regarding testing, diagnosis, and reporting of zika cases
2. Guidance regarding screening, identification, and reporting of potential adverse pregnancy outcomes associated with zika virus infection
3. Assisting in management of the zika pregnancy registry
4. Comprehensive education focusing on risk reduction for zika virus infection
5. Implementing larval and ovitrap surveillance in selected North Carolina counties (which will expand as the program develops) to determine presence/absence/abundance of container breeding Aedes mosquitoes in North Carolina
6. Guidance to local vector control programs to implement Integrated Mosquito Management, which will have benefits beyond zika

What constitutes Integrated Mosquito Management (IMM)?

As defined by the American Mosquito Control Association IMM is a “comprehensive mosquito prevention/control strategy that utilizes all available mosquito control methods singly or in combination to exploit the known vulnerabilities of mosquitoes in order to reduce their numbers to tolerable levels while maintaining a quality environment.”

The following steps characterize IMM:

1. Education and community outreach
2. Entomologic surveillance and mapping
3. Set action thresholds
4. Source (habitat) reduction
5. Application of Biological controls
6. Application of Public health mosquitocides (IAW with CWA & NPDES permitting)
 - a. Larval
 - b. Adult
7. Monitor for efficacy and resistance
8. Record Keeping

Conclusion

The vector borne disease program gives the Division of Public Health the opportunity to build needed capacity that will address the changes in the vector population in North Carolina. Emerging infections, such as Zika, require renewed attention and focus on vector control and integrated mosquito management. This program will require a collaborative approach and will rely on public health partners in order to ensure success and sustainability.