The Suburban Mosquito Community: A Unique Vector Control Challenge

By Meredith Spence Beaulieu, NCSU

Humans are drastically changing the landscape globally, and North Carolina is no exception. A quick scan of historical aerial images, such as those archived in Google Earth, shows a creeping expansion of roads peppered with houses invading previously natural lands. This is the hallmark of suburbanization, the fastest growing land-use category in the United States. Suburban sprawl is likely affecting many of the organisms around us, and its effects are known for birds, butterflies, and other charismatic fauna. But what impact does it have on mosquito communities? This is the question that I sought to answer in my recent paper, “Simplification of vector communities during suburban succession” (Spence Beaulieu et al. 2019, *PLoS One* DOI: 10.1371/journal.pone.0215485).

Over the course of two years, I sampled mosquitoes in suburban neighborhoods of different ages throughout Wake County, as well as in undeveloped wooded and field areas as control sites. Continued page 6...
President’s Message 2019

Michael Doyle, MS

The hurricanes of 2018 renewed interest in mosquito control in North Carolina, and it is important for us to focus this interest into effective methods of mosquito suppression at the local level. Regardless if the goal of mosquito reduction is to stop disease transmission, recover after storms, or other reasons, two things are critical – the ability to respond very quickly, and knowledge of local species.

The ability to respond quickly requires having a contingency contract with a qualified and experienced mosquito control contractor. For large mosquito programs, the contractor acts as a back-up and aerial wing; for small programs, as the primary control force. To be effective, the local program has to create a USFWS-reviewed “maximum spray area” map that covers the majority of populated areas within the city or county borders, and establish communication channels with local Emergency Operations, beekeepers, organic farmers, and the public in general.

Knowledge of local species includes internal knowledge -- baseline population data acquired by local staff through trapping (preferred) or performing landing counts. External knowledge can be gained through publications like the Biting Times, NCMVCA events, or internet-based training such as AMCA’s E-Modules (https://www.mosquito.org/page/training). For effective control, it is important to “know thine enemy” -- the target species’ typically flight range, what hours of the day or night they are vulnerable to ULV spraying, where they harbor, where their larvae develop, and what adulticide and larvicide products are effective. Historic information was collected by former Public Health Pest Management staff, and we are making an effort to find and share some of this hard-earned information. New information is being discovered through CDC-funded University projects (i.e., Western Carolina, North Carolina State, and East Carolina Universities), and by local staff through the State DHHS-funded “Counties of Regional Expertise” program. We will work hard this summer to keep you updated on the findings.

Michael Doyle, President of NCMVCA
Guess that Skeeter: *Culex pipiens/quinquefasciatus*

By Michael H Reiskind, NCSU

This is one of the notorious human associated species, the southern or northern house mosquito. There are two species in North Carolina that are indistinguishable as adult females, and have a similar (although not identical) ecology, *Culex quinquefasciatus* (the southern house mosquito), and *Culex pipiens* (the northern house mosquito). They also form hybrids, which we have at the latitude of Raleigh. They are important vectors of native and exotic encephalitis causing viruses, like West Nile virus and St. Louis encephalitis virus, as well as good vectors of human filarial worms and dog heartworm. They are associated with larval habitats heavy in organic matter, like latrines, swine lagoons, and stagnant urban streams during times of drought. Best control approaches include larval and adult surveillance, mosquito dunks for larval control in sewers and ULV spraying during dusk.

Image: Craker, CLE, ValentBiosciences/ONU

The Biting Times, December 2018

**Editor-in-chief**: Dr. Michael Reiskind

**Contributors**: Matthew DuPont, Meredith Spence Beaulieu, Michael Doyle, Michael Reiskind

**Photos/Images**: Matt Bertone, Sean McCann, CDC, ValentBiosciences, Meredith Spence Beaulieu
Brunswick County ULV Calibration Workshop

By Matthew DuPont, Brunswick County Mosquito Control

On April 24th, 2019 at the Brunswick County Complex, 63 people from 9 counties and 16 municipalities gathered to participate in the 16th Annual Brunswick County Ulv Workshop. This 2-day event, sponsored by Clarke Mosquito Control, brought together Health Directors, Environmental Health Specialists, Geographical Informational Systems Supervisors, staff from ECU and frontline mosquito control operators to discuss and evaluate the criteria for mosquito related disaster response after Hurricane Florence.

Thirty-one trucks attended the second day of the workshop to get their sprayers calibrated for the season. Our host, Clarke Mosquito, provided 2 representatives to calibrate the Ulv machines. Calibrations started at 9:00 am and ran until 12:30 pm.

Melinda Fields, Graduate student at ECU, describing the impact of Hurricane Florence on mosquito populations. Photo: Jeff Brown.

The workshops theme emphasized the importance of documentation and the urgency of maintaining proper documentation before, during and after the disaster response activities to meet FEMA requirements for reimbursement.

The workshop focused on 4 elements:

- Baseline surveillance
- An aerial response
- Post-storm documentation for recovery efforts

Continued next page...
The baseline surveillance section covered the historical data surveillance and data collection needed prior to a hurricane. We also addressed the documentation and required letters would be needed from local Health Directors for emergency disaster relief. Brunswick County highlighted practices that most programs perform such as landing counts, maintaining pesticide records for 3 years and citizen service requests. All of which can be found in the Appendix G in the Public Assistance and Program Policy Guide on the FEMA website, or the (PAPPG.)

The second portion of the program discussed the process for performing an effective ground-based emergency response. FEMA has certain requirements to request disaster relief aid. The participants were informed how to effectively perform a ground-based emergency response per FEMA standards. Brunswick County walked the classroom through their ground-based efforts from the time ground based spraying began, leading up to treating the area via aerial application. During the ground-based response, surveillance activities will assist in gaining information needed for disaster relief and aerial information. Again, information can be found on the PAPPG on FEMA website. Dr. Stephanie Richards highlighted the importance of the work ECU is doing with insecticide resistance, and graduate student Melinda Fields discussed her thesis project and how it will impact local mosquito control programs in the future with respect to emergency mosquito control.

Performing an aerial response was covered next. The highlight of the afternoon, where to go to obtain disaster relief via air was shown, and the necessary documentation was discussed. Brunswick County Mosquito Control Supervisor Jeff Brown discussed the process of obtaining a contract for aerial application and related his experience to the Appendix G: Mosquito Abatement processes. He provided insight into future aerial applications in the County. The PAPPG, once again, contains all the necessary information and is essentially the road map for a disaster response.

Finally, post storm documentation for recovery efforts was discussed at length. This section tied all the previous talks and presentations together. The 63 participants left the workshop with a good preliminary understanding of what is necessary before and after a hurricane to ensure timely reimbursements for mosquito control from FEMA.
I performed routine monitoring of mosquito communities using a CDC light trap baited with dry ice, and calculated three measures of mosquito diversity at each site to investigate trends over time as neighborhoods got older. This study revealed that all three mosquito diversity measures decreased as neighborhoods aged, resulting in the oldest suburban areas having a mosquito community that was significantly less diverse than communities in undeveloped field and wooded areas. In addition to being less diverse, suburban mosquito communities were also composed of different mosquito species. The species assemblages at the various neighborhood sites were strongly affiliated with the presence of pavement and buildings, suggesting that suburbia and its unique environmental attributes are shaping a distinct suburban mosquito community.

Perhaps unsurprisingly to mosquito control professionals working in North Carolina, this suburban mosquito community is dominated by the Asian tiger mosquito, *Aedes albopictus*. My research found that *Ae. albopictus* alone explained between 28% and 46% of the difference among suburban, woodland, and field mosquito communities. In addition to being a primary mosquito species in suburban neighborhoods, its abundance increased with neighborhood age, leading to established suburban areas having the highest numbers of *Ae. albopictus*. This distinctive striped mosquito uses man-made containers as its breeding environment—tires, flower pots, bird baths, pet bowls, and other water-holding yard debris are all common larval habitats for *Ae. albopictus*, and all of these items are common in suburban areas across income levels. Unfortunately for us, this mosquito species that we are unintentionally selecting for around our homes is a species that is known to...
From previous page.

...vector many concerning human viruses, including Zika virus, West Nile virus, and La Crosse virus, as well as parasites that affect our pets, such as the dog heartworm.

It is not likely that we will be able to undo the mosquito community changes caused by suburban development. Where housing developments exist, we will continue excluding mosquito species that require larger natural habitats, such as ponds and marshes or floodwater pools in open fields. My research supports this idea; even the oldest neighborhoods—that presumably look more like wild areas due to higher levels of vegetation, older trees, and greater canopy cover—never regained their mosquito diversity and were in fact the least diverse among all of the suburban areas. So what can be done? Although we can’t reverse these biological processes, we can use this information to educate our communities about the importance of integrated mosquito management. We can encourage residents to practice “tip and toss” within their yards and highlight the necessity for well equipped mosquito control districts. We can also contact our legislators to advocate for funding of research on mosquitoes, vector-borne diseases, and vector control. Through greater understanding and better management of the suburban mosquito community, these actions could have significant impacts on public health in residential areas of North Carolina.

Seven Counties, Eight Adulticides: 2017 NC Aedes albopictus Insecticide Resistance Results

By Michael Doyle, MS, NCMVCA President

In order to be better prepared for future disease outbreaks, the State Health Department is using CDC’s ELC grant funding to collaborate with Dr. Stephanie Richards at East Carolina University, Dr. Brian Byrd at Western Carolina University, and Dr. Michael Reiskind at NC State University. The goal is to begin consistent insecticide resistance testing across North Carolina.

The first mosquito of interest is Aedes albopictus because of its ubiquitous nature in the state, close proximity to humans, and potential to transmit a number of arboviruses. Next in line is Aedes triseriatus (LaCrosse Encephalitis vector), and then Culex quinquefasciatus/pipiens (WNV vector).

Continued next page...
On the next page is a graphic describing the results of *Aedes albopictus* mosquitoes collected in 2017 in several counties. Special thanks to Chris Ernst of Buncombe, Jeff Brown of Brunswick, James Bjorneboe of Mecklenburg, Neil Cagle of Transylvania, and Anastasia Figurskey of Wake/NCSU for collection and submission of eggs for this project.

Note that formulated products were tested alongside their active ingredients. This produced similar results for most insecticides, with the exception of tau-fluvalinate and malathion. In the first case, *Aedes albopictus* was largely susceptible to active ingredient tau-fluvalinate, yet were largely resistant to the formulated product Mavrik except in Wake and Pitt Counties. Conversely, *Aedes albopictus* was somewhat resistant to the active ingredient malathion, yet highly susceptible to the formulated product Fyfanon. This brings up questions about sources of active ingredients, and how diagnostic doses are compared. Please see the published paper for details at 10.1093/jme/tjy216.

The primary lesson learned is that resistance can be very different from county to county, or even city to city. This depending on several factors, not the least of which is agricultural and turf industry usage of our limited number of active ingredients.

While these results can help guide your choice of adulticides, it is important to test mosquitoes in your area. Contact the NCMVCA, Dr. Stephanie Richards (richardss@ecu.edu), or me, Michael Doyle (Michael.doyle@dhhs.nc.gov) for assistance.

*Aedes albopictus*, the first target for resistance testing in North Carolina. This summer, further testing on other species will commence.
### Table: \textit{Aedes aegypti Insecticide Resistance Tests (CDC Bottle Bioassay Method), NC, 2017}

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<thead>
<tr>
<th>Source</th>
<th>Type of Insecticide</th>
<th>Percentage Mortality</th>
<th>Mortality Rate</th>
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<tbody>
<tr>
<td>Transaminase</td>
<td>Permethrin</td>
<td>100%</td>
<td>96%</td>
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<td></td>
<td>Pyrethrin</td>
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<td></td>
<td>Ellagic Acid</td>
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<td></td>
<td>Malathion</td>
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<tr>
<td></td>
<td>Chlorpyrifos</td>
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<td>Naled</td>
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Note: Percentage values are based on the results of the CDC Bottle Bioassay Method tests conducted in North Carolina in 2017.
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2019 Executive Committee and Committee Chairs

<table>
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<th>Officers</th>
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<th>Chairs of Standing Committees (TBD for 2019)</th>
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2019 Committee Members

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<td>Auditor (from membership)</td>
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Do you want to be more involved with the NCMVCA as a member on a committee? Speak to any of the above individuals, or contact the new officers to see how you can help your organization continue to grow and promote vector control in North Carolina. We have many openings on our committees!
Order Form

The Mosquitoes of the Mid-Atlantic Region: An Identification Guide

Bruce Harrison, Brian Byrd, Charles Sither, and Parker Whitt

This 201 page spiral-bound 8.5 X 11 inch guide includes dichotomous keys to the adult females and fourth instar larvae for 8 states (DE, GA, NC, MD, PA, SC, VA, and WV) with more than 585 novel Adobe Illustrator figures. Printed on 100 lb gloss paper, this guide includes sections such as: 1) Taxonomic Interpretations, 2) State Records, 3) Basic Morphology, 4) The Acquisition of Characters to Separate Larval Instars, 5) Extensive Notes, 6) Couplet Sequences, 7) Illustration Index, 8) How to Use a Dichotomous Key, 9) Glossary, and others. The keys were thoughtfully reviewed by experts from the Smithsonian Institute, North American Mosquito Control Districts, and Academia.

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Name: ________________________________________________________________

Email Address: _______________________________________________________

Phone Number: _______________________________________________________

Employer: ___________________________________________________________

Mailing Address (where key will be mailed): ________________________________________________________________

Method of Payment: Check (payable to NCMVCA)  Invoice required (emailed to address given)  Credit card (see below)

Card number: ___________________________  Expiration date: ___________________________

Code on back of card: ___________________________  Billing zip code: ___________________________

Email or Mail Completed Form and Payment To:

NCMVCA c/o Stephanie Richards
3403 Carol Belk Building, 300 Curry Court
Greenville, NC 27858
richardss@ecu.edu

NCMVCA: North Carolina Mosquito and Vector Control Association | www.ncmvca.org
Op/Ed: Pest Control and Vector Control: Contentious or Complementary?

By Michael Reiskind, MPH, PhD, NC State University

With the emergence of exotic arboviral disease in the United States over the past twenty years (West Nile virus, 1999, chikungunya 2014, Zika 2016), we have seen an increased interest in public health spheres for vector control. This angle of mosquito control—as vectors, not pests—has met a chaotic landscape of mosquito control districts whose focus was controlling pests. One only has to look at the recent history of our association and North Carolina to see this: established pest control oriented programs where mosquitoes are abundant along the coast, public health interest in vectors where there is disease, and only recent reemergence of state support for either.

Although rarely directly contentious, pest control and vector control do have different approaches and different goals, which can be in conflict. For example, pest complaints because of a non-vector may fall on deaf ears to a public health entomologist, while a few bites from *Ae. aegypti* might not register with a pest-oriented mosquito control district, but would be a veritable scream to a public health official.

In ecosystems we see diversity as an element of resilience, with diverse systems more resistant to dramatic and destructive changes, while simpler systems are more subject to booms and busts. In some ways, the mosquito control landscape has provided this same kind of resilience. In the absence of public attention (and dollars) for surveillance of disease vectors, the expertise, equipment, and people power is preserved in mosquito control districts focused on pests. However, as has been noted in many recent governmental and non-governmental agency reports, there is a need for organized approaches. The best system might be similar to the one we have grown organically in the last five years in North Carolina. This includes positive interactions with established MCD/Vector Control Entities (e.g. New Hanover, Brunswick, Mecklenberg), a robust and dispersed group of academics with both entomology and public health backgrounds (yes, I am bragging), and a moderate investment at the state level which lubricates all of these synergistic interactions through coordination and contract funding.

We have avoided much contention in our small (from the mosquito control perspective) state. Let us continue to work together, with the NCMVCA leading the way, to resilient and complementary approaches to control both pests and vectors.