A Practical Guide to Building Local Mosquito Control Capacity

July 2021

NACCHO
National Association of County & City Health Officials
The National Connection for Local Public Health

Introduction

The Zika outbreak from 2015 to 2017 in the United States shined an urgent spotlight on the needs of mosquito and vector control programs from federal, state, and local organizations. The National Association of County and City Health Officials (NACCHO) partnered with the Centers for Disease Control and Prevention (CDC) to identify and gain a better understanding of the capabilities, or lack thereof, of these programs to address future outbreaks.

In 2017, NACCHO conducted a survey of all vector control organizations to assess mosquito surveillance and control capacity. They found that most programs lacked the tools needed to deliver the five core competencies of vector control as recognized by the CDC.

1. Routine mosquito surveillance, standardized trapping, and species identification;
2. Larviciding and adulticiding capabilities;
3. Routine vector control (e.g., chemical, biological, source reduction, or environmental management);
4. Species-specific abatement activities; and
5. Pesticide resistance testing.[1]

After analyzing the data, they were able to identify specific gaps, challenges, and needs for mosquito surveillance and control programs. NACCHO then worked to create the Vector Control Workgroup, develop a Vector Control Toolkit, and provide training and guidance to interested programs through Vector Control Summits. In addition to meeting these objectives of the assessment, NACCHO also wished to provide these programs with a focused, practical guide to build new programs and provide guidance to existing programs to enhance their capabilities in the core competencies.

The purpose of this resource is to provide guidance to local mosquito control programs, whether they are establishing a mosquito surveillance and control program for the first time or considering building on their current capacity. This resource will provide information on establishing baseline activities and further enhancing the building blocks of a comprehensive mosquito control program: surveillance; control and abatement; resistance testing; communication and outreach; partnerships; and workforce development. The guide is provided as a means to educate, support, and encourage programs to be better prepared for future outbreaks of vector-borne disease. It is also a tool that programs can use to foster and strengthen relationships with key stakeholders and the public to inform them of the risks of vector-borne disease, and help them better protect themselves.

Abbreviations

- **IMM:** Integrated Mosquito Management
- **FTE:** Full Time Employee
- **CDC:** The Centers for Disease Control and Prevention
- **NACCHO:** The National Association of County and City Health Officials
- **NEHA:** National Environmental Health Association
- **GIS:** Geographic Information System
- **HIPAA:** The Health Insurance Portability and Accountability Act

SURVEILLANCE

Mosquito surveillance is the foundation for any vector control program and consists of routine monitoring of both larval and adult mosquito populations over the course of an entire mosquito season. It allows a vector control program to monitor changes in mosquito populations, identify which mosquito species are present, detect mosquito-borne pathogens, and ultimately determine what control measures need to be conducted.

BASELINE ACTIVITIES

Know vector species in your area and their basic biology.

- **Vector species and associated pathogens:** Vectors of the United States Map and Informational Hub from the National Environmental Health Association (NEHA): www.neha.org/vector-map.
- **Mosquito Identification Keys:** The Walter Reed Biosystematics Unit (WRBU) offers a variety of mosquito identification keys: www.wrbu.si.edu/vectorspecies/keys.
- **Mosquito Life Cycle (*Aedes aegypti*):** Refer to this document from CDC: https://www.cdc.gov/mosquitoes/about/life-cycles/aedes.htm.
- **Mosquito Life Cycle (Culex):** Refer to this document from CDC: www.cdc.gov/mosquitoes/about/life-cycles/culex.html.

Have the appropriate types and number of traps.

The number and types of traps depends upon vector species present in the area. They can also vary depending on how you are using them - for example, broad surveillance over a large area like a county vs. targeted surveillance for case investigation or monitoring control efficacy.

- **Vector species determine the trap types:** This information can usually be found through several avenues (e.g., local universities, Departments of Agriculture, state entomologists, scientific journals/literature reviews).
- **Trap selection:** Collaborate with peers in your area, if available. Industry representatives can be very helpful, and may have subject matter experts on staff.
- **Number of traps:** Sorting, testing, and reporting on collected mosquitoes can be time-intensive and expensive. The number of full time employees (FTEs) in your vector program may limit the number of traps that can be reasonably used and managed.

Determine where to place traps for surveillance.

Factors to Consider

- **Trap Type:** Some traps need to be suspended several feet off the ground, far from artificial light, or away from buildings. Different trap types also have different recommended placement distances between traps in a given area. For those reasons, it is important to always read the trap specific manual before choosing a location.
- **Ease of access:** Trap sites need to be easy to access for repairs and regular maintenance since some traps require maintenance several times a week.
- **Theft or vandalism:** To prevent tampering by the public, try to place them out of public view. Also, if it is your program's choice to not disclose the locations to the media, it would be in your best interest to hide traps.
- **Environmental conditions:** Most mosquitoes avoid direct sunlight and wind while heavy rains could affect the trap functionality. For those reasons, try to place traps in areas with some type of overhead cover. Avoid locations with lawn watering systems (e.g., residential homes, golf courses).
- **High risk areas:** High risk areas would include locations where there is a potential or existing mosquito problem, an urban area, or has a history of mosquito-borne diseases. Placing traps in these areas would provide valuable information in areas that could require habitat remediation or environmental treatment.
- **Trial and Error:** The first season of trapping could involve the movement of trap locations before the best sites are located. Do not be discouraged if the first location selections are not effective.

SURVEILLANCE

BASELINE ACTIVITIES

Examples of possible locations

Fire Stations

- Not always exposed to the public so there is a low risk of tampering.
- Easy to access.
- Located in population centers.

Public Parks

- Prone to tampering.
- Publicly available areas so they are easy to access.
- Can be important recreational areas to monitor due to increased activity in warmer months.

Employee/Residential Homes

- Not prone to damage or tampering by the public.
- Property must be easy to access or the employee, if properly trained, can perform maintenance and collection.
- Can be in residential areas and population centers.

Routine versus temporary trap locations

- **Routine:** To collect comparable data each season, it is important to keep trap locations the same. By doing this, you can track fluctuations in mosquito populations and positive pools over time. Also, if a habitat remediation effort or adulticide spraying is required in an area near a trap, you will be familiar with normal mosquito counts for a trap site.
- **Temporary:** In certain situations, it may be necessary to add more traps during the season. These traps would not serve routine surveillance tasks, but instead would be used when an area in your jurisdiction needs additional monitoring. For example, after a human case of a mosquito-borne disease, such as Zika, it may be necessary to place temporary traps around the case's property to determine whether the vector species is present in that area.

Trap covers

- Protects the trap from direct sunlight, heavy rains, and winds.
- Results in cleaner catches with mosquitoes that are easier to sort and identify.
- When building a cover, make sure not to restrict the flow of mosquitoes to the trap, and construct it so that it is open on all sides.
- Do not use a paint or sealer that would repel mosquitoes from the trap.

Equitable placement of traps

- Determine what percent of the human population is being covered by traps.
- Traps should be deployed weekly or biweekly.

SURVEILLANCE

ENHANCED ACTIVITIES

Perform routine trap maintenance and repairs.

» Check the manufacturer's website or trap manual for maintenance suggestions and guidance.

» Traps should be routinely maintained, cleaned, and repaired to prevent trap failure during deployment.

» Trap cleaning should be performed periodically during the season and at the end of the season.

» Trap maintenance and repair can be performed during the season if needed, or preferably during the off-season.

» Trap repair can typically be performed using purchased replacement parts or by reusing parts from traps that are no longer in service.

- Some parts and equipment used for repairs can usually be purchased at a local hardware store or from online retailers. Hardware store employees may be able to answer some of your basic questions about equipment, supplies, and repairs/maintenance. Take the trap with you so they can see what you are trying to repair.

» Trap repair can be performed by your staff, possibly by the company that sells the traps (e.g., BioQuip, John Hock), or a local company with that expertise.

» Traps should be identified (e.g., numbered) to allow for tracking maintenance or operational issues.

» To reduce the likelihood of disruption of surveillance during the season, some extra traps should be available to use if traps fail.

» For in-house repairs, techniques (e.g., soldering) and the correct tools are necessary.

- YouTube is a helpful resource to learn about necessary techniques (e.g., soldering, wiring). However, videos specific to trap repair are required.

» Contractual trap maintenance may be possible with local companies who have this type of expertise.

» If using rechargeable batteries, they should be identified (e.g., numbered) to allow for tracking purchase date, deployment date, maintenance or operational issues; they should be tested regularly; and they should be maintained during the off-season. Consult the manufacturer, a battery distributor, or manuals for year-round charging suggestions and guidance to maintaining "healthy" batteries.

SURVEILLANCE

ADVANCED ACTIVITIES

Utilize Geographic Information System (GIS) software.

» After considering all the factors involved in trap placement, you can utilize GIS software to find potential sites. With GIS software, you can map high population areas, past human cases, known mosquito problem areas, public parks, and other items that guide your decision.

Test vectors for disease.

» Determine vector species and associated pathogens for your geographic area.

- Determine the appropriate collection technique (light traps, resting boxes).

» Utilize local health department staff, students, or other stakeholders for collection/identification.

» Develop in-house testing capabilities or contract with academic, commercial, or state labs (if available).

- If using in-house testing capabilities, determine protocols and confirmations for pathogen analyses.

» Detect Pathogens: determine prevalence, track changes in prevalence over time, document geographic distribution, and track changes in geographic distribution over time.

» Estimate the public health risk of vector-borne pathogen exposure.

» Share results with stakeholders to guide education and intervention strategies (local health department, DEC, medical, vets, parks department, general public).

CONTROL/ABATEMENT

Mosquito control and abatement methods can include the elimination of mosquito larval habitats, application of larvicides to kill mosquito larvae, or application of adulticides from backpack, truck, or aircraft sprayers to kill adult mosquitoes. The specific control measures to be used should be based on your program's surveillance data.

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ENHANCED ACTIVITIES

Mapping

» Use the appropriate map scale to resolve mosquito larval habitats, adult populations, and other control efforts.

» Use aerial photography and GIS modeling.

» Utilize the GIS map to show the geographical visualization of high larval and adult mosquito abundance/distribution.

» Mark known troublesome mosquito larval habitats.

» Link all of the data to spatial information for use in GIS.

CONTROL/ABATEMENT

ENHANCED ACTIVITIES (contd.)

Larval source reduction and sanitation

» Removing or reducing mosquito larval habitats is the most effective method of mosquito control.

» Removal of water-holding containers should be a continual process. This will successfully eliminate man-made mosquito-breeding sources.

» Consider both natural and artificial containers as sources for mosquito breeding.

Chemical control of larvae

» Use larvicides when necessary. Refer to www.cdc.gov/mosquitoes/pdfs/larvicides-508.pdf.

» Should also be considered as part of comprehensive program to control container-inhabiting mosquitoes.

Adulticiding

» Use of adulticides when necessary.

» Use Ultra Low Volume (ULV) space sprays.

» Use barrier and residual sprays.

Biological control of mosquito larvae

» Use of aquatic predators such as *Gambusia* mosquito fish, *Toxorhynchites* predatory mosquitoes, copepods, and others such as sunfish, minnows, etc.

Education

» Implementation of environmentally-sound source reduction techniques.

» Continuing education of mosquito technicians.

» Educate the public on mosquito-transmitted pathogens and control methods.

RESISTANCE TESTING

The use of insecticides to kill mosquitoes that spread mosquito-borne diseases is one part of an integrated mosquito management (IMM) program. Over time and with repeated use, insecticide resistance can occur in mosquito populations, reducing the ability of an insecticide to kill mosquitoes. To delay or prevent the development of insecticide resistance in vector populations, programs should include an insecticide resistance management component. Monitoring for resistance in the vector population is essential and useful in determining potential causes for control failures.

BASELINE ACTIVITIES

Find or identify an agency or other mosquito control district to provide resistance testing for your district.

» Colleges and universities such as the Florida Medical Entomology Laboratory with the University of Florida or the U.S. Department of Agriculture have researchers performing bottle bioassays and/or genetic testing for resistance in mosquito adults or egg rafts that you collect.

ENHANCED ACTIVITIES

» Attend or participate in online training for bottle bioassays to familiarize yourself with the process and to learn how to interpret results. Refer to CDC's Bottle Bioassay webpage.
  - Programs in the continental United States and its territories can order free Insecticide Resistance Kits by sending an email to USBottleAssayKit@cdc.gov and requesting an order form. Kits include bottles, insecticide, and manual.

» Obtain necessary equipment to perform the bioassays to include active ingredients from the manufacturer.

» Perform bottle bioassays using the active ingredients that are contained in the formulated products being used by your district annually or biannually.

» Field test adulticides in conjunction with bottle bioassays.

ADVANCED ACTIVITIES

» Consult with other districts or check the literature to learn to perform larvicide resistance testing.
  - The Pacific Southwest Center of Excellence in Vector-Borne Diseases (PacVec CoE) has training videos on this: https://pacvec.us/larval-mosquito-resistance-testing-video/.

» Conduct larvicide resistance testing to ensure that your larvicides are still controlling larvae in various environments.

COMMUNICATION/OUTREACH

Education and community outreach are an important part of an integrated vector management approach to mosquito control. Educating the public to be aware of potential mosquito habitats in their area and showing them how to reduce or eliminate such resources can help reduce mosquitoes. Additionally, communicating with the public on how to avoid, prevent, and protect from mosquito bites can help prevent the spread of mosquito-borne diseases.

BASELINE ACTIVITIES

Have communication strategies in place for awareness, outreach, and education including having:

- » CDC/SHD/LHD contact information readily available.
- » Information on your (LHD, Public Works, Mosquito Control District) website.
- » Information ready to disseminate via social media (e.g., posts, tweets, Facebook Live).
- » Information ready to disseminate via traditional media (e.g., local TV news shows, interviews).
- » Press releases ready to push through website and/or media.
- » Annual reporting in place (e.g., number of samples collected, number of positive pools, number of species identified).
- » Messaging ready for your agency leadership, as well as for leaders in your jurisdiction (e.g., the mayor, town council, county supervisors).

ENHANCED ACTIVITIES

Interact with the public using regular, direct outreach using:

- » Literature and/or graphic art distribution (e.g., brochures, fact sheets, cards, trailhead signage). Make these available at your agency, libraries, and with other stakeholders and community partners.
- » Information booths/tables at Farmers' markets, health fairs, and other community events.
- » Public service announcements online or at movie theaters.
- » Public transportation advertising on buses, trains, cabs, and benches at stops using billboards.
- » Community presentations (e.g., civic groups, homeowners associations, scouts).
- » School presentations/activities.
- » Contacts at your local or state extension office, or any other local agency that regularly has contact with the public for additional events.

ADVANCED ACTIVITIES

Create and maintain a position in your district for an Outreach Coordinator (or) similar titles.

- » The position would be responsible for the base capacity building and Enhanced activities, regularly scheduling and attending events, teaching inside classrooms, managing social media and participating in training opportunities to expand their skills.

PARTNERSHIPS

Establishing partnerships can help integrate your vector control program into the broader public health infrastructure at the local, state, and federal levels. Epidemiology departments can help you determine the types of vector-borne pathogens prevalent in your area and this information can help you tailor your vector control activities to safeguard public health.

BASELINE ACTIVITIES

Establish a relationship and arboviral case communication procedures with your local epidemiology division.

To establish a relationship:

- » Contact your local epidemiology division.
- » Learn how arboviral case investigations are conducted.
- » Determine what information collected would be useful to a vector control program and what information they can share (it may be helpful to have a blank copy of the EPI investigation form).
  - Pathogen
  - Suspected or confirmed case
  - Case home address and other frequented areas
  - Symptom onset date
  - Travel history, etc.
- » Provide HIPAA training for vector control staff.

Establish case communication procedures.

- » Determine the need for communication agreement documentation (e.g., MOU), and regular review and updating procedures.
- » Create a communication procedure and standardized communication form (e.g., arboviral case notification form).

PARTNERSHIPS

Additional partnerships could include state, regional, and national mosquito control associations and higher education facilities.

ENHANCED ACTIVITIES

Work with the epidemiology division to create a collaborative arboviral disease response plan.

- » Establish roles and responsibilities of all parties, including public messaging and communications.

WORKFORCE DEVELOPMENT

A robust vector control department will need staff who are trained to perform core functions of the program. Workforce development, including training and recruitment activities, can help keep your program sustainable in the long term.

BASELINE ACTIVITIES

Have staff with expertise for this program.

- » Identify positions that have the appropriate job specifications for the work that needs to be done.
- » Interns working with local colleges.

ENHANCED ACTIVITIES

Have a training budget for staff.

- » Training budget is determined primarily by two factors: Desired capability and the use of existing staff versus hiring a subject matter expert.
- » Capabilities by functionality
  - **Human surveillance** – Cost will be minimal or free if coordinated with local or state epidemiologists.
  - **Vector surveillance (including trapping and testing)** – Vector surveillance training opportunities: Various training options are available, and in many cases, they can be low cost or free if coordinated with an existing program, if you reach out to professional organizations (e.g., American Mosquito Control Association), or an industry representative.
  - **Habitat remediation** – Training is available online, through literature review, or the above-mentioned groups.
  - **Larvicide application** – *Same as above*.
  - **Resistance testing** – Training is available online through CDC, but it is recommended to send a person to attend a live demonstration or workshop.
  - **Adulticiding (chemical application)** – Variable; State Department of Agriculture or other oversight group usually provides a low cost training to become a licensed applicator along with required Continuing Education Units (CEUs).
    - ◊ **Contractor** – The costs for hiring a company to perform this activity depends upon many factors and can be very expensive.
  - **Training Resources:**
    - ◊ **Funding** - It may be possible to use CDC's Public Health Emergency Preparedness or EPI/lab capacity grants.
    - ◊ **Availability** - There are a number of organizations that offer training opportunities and certifications (e.g., American Mosquito Control Association, Entomological Society of America).

NACCHO has compiled a list of resources from our partners and members to assist mosquito control programs build their capacity. This information is highlighted in "Resources" below.

More resources on mosquito surveillance and control can be found by searching the Vector Control Toolkit in the NACCHO Toolbox. The NACCHO Toolbox is a free, online collection of public health tools that have been created and shared by members of the public health community. To view the Vector Control Toolkit, visit the NACCHO Toolbox and select "Vector Control Toolkit" from the Toolkit's dropdown menu.

Resources

1. CONUS Manual for Evaluating Insecticide Resistance in Mosquitoes Using the CDC Bottle Bioassay Kit [PDF – 19 pages] - https://www.cdc.gov/mosquitoes/pdfs/CONUS-508.pdf
2. Vectors of the United States Map and Informational Hub - National Environmental Health Association (NEHA) https://www.neha.org/vector-map
3. Vector Control Tools & Resources (VeCToR) Toolkit: 10 Essential Environmental Public Health Services – https://www.neha.org/eh-topics/vectors-and-pest-control-0/essential-services
4. Vector Control for Environmental Health Professionals – www.cdc.gov/nceh/ehs/elearn/vcehp.html
5. Continuation of Mosquito Surveillance and Control During Public Health Emergencies and Natural Disasters – www.cdc.gov/mmwr/volumes/69/wr/mm6928a6.htm
6. Mosquito Control for Professionals – www.cdc.gov/mosquitoes/mosquito-control/professionals/index.html

Citations

1. Rodgers, Kim. "NACCHO Report: Shifting Our Approach to Mosquito Control Capabilities in the U.S." NACCHO, 16 Oct. 2017, www.naccho.org/blog/articles/naccho-report-shifting-our-approach-to-mosquito-control-capabilities-in-the-u-s.

Acknowledgements

This guide was supported by the efforts of NACCHO's Vector Control Workgroup and sponsored by the Centers for Disease Control and Prevention (Grant No. 5 NU38OT00306-03-00). NACCHO is grateful for this support. The contents do not necessarily represent the official views of the sponsor.

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To learn more about NACCHO's vector control programs and services, visit www.naccho.org/vector-control.

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Public Health
Prevent. Promote. Protect.

The mission of the National Association of County and City Health Officials (NACCHO) is to improve the health of communities by strengthening and advocating for local health departments.

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