Emergency Response Mosquito Management

Turnkey Solutions and Responsible Control

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VECTOR DISEASE CONTROL INTERNATIONAL

November 6th, 2019
2019 Hurricane Season

[Map of hurricane season with various storms labeled, including Barry, Chantal, Dorian, Erin, Fernand, Gabrielle, Humberto, Imelda, Karen, Lorenzo, Melissa, and Jerry.]

Legend:
- Tropical Depression ≤ 39 mph (≤62 km/h)
- Tropical Storm 39–73 mph (63–118 km/h)
- Category 1 74–95 mph (119–153 km/h)
- Category 2 96–110 mph (154–177 km/h)
- Category 3 111–129 mph (178–208 km/h)
- Category 4 130–156 mph (209–251 km/h)
- Category 5 ≥ 157 mph (≥252 km/h)

(From the Saffir–Simpson scale)
Is your community prepared?

- Downed Power Lines
- Flooding
- Chemical Spills
- Hazardous Waste
- Drinking Water
- Mosquitoes
What ___% does mosquito management play in your job role?

Outline

**MOSQUITO MANAGEMENT**
History, Capacity and Foundations

**TOOLS AND TECHNOLOGY**
Surveillance and Control

**EMERGENCY RESPONSE**
Natural Disasters + Disease Outbreak
History: Anti-Mosquito Movement

Late 19th Century – Discovery of Mosquitoes as Disease Vectors
- Patrick Manson (filariasis)
- Carlos Finlay (yellow fever)
- Roland Ross (malaria)
- Giovanni Grassi (malaria)
- The Reed Commission (yellow fever)
- Harris Graham (dengue)

20th Century to Present Day – American Anti-Mosquito Movement
- 1900 - 1942 Mechanical Era
- 1942 - 1972 Chemical Era
- 1972 – Present IPM Era
## History: American Anti-Mosquito Movement

### Mechanical Era
**1900 – 1942**

<table>
<thead>
<tr>
<th>Event</th>
<th>Details</th>
</tr>
</thead>
</table>
| 1st Abatement Districts | 1912 - 1915  
NJ, CA, FL, UT, and IL |
| 1st Aerial Applications | 1925 - Larvicide against anopheline mosquitoes |

<table>
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| Mosquito Control Integral | Great Depression  
- Federal Emergency Relief Administration (FERA)  
- Civilian Works Administration (CWA)  
- Creates 120K+ Jobs |

<table>
<thead>
<tr>
<th>Event</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>Malaria WWII</td>
<td>125,500+ cases of malaria in the U.S. with 1,000s of Army troops dying</td>
</tr>
</tbody>
</table>

First mosquito control districts in Florida were formed in Indian River and St. Lucie counties.
<table>
<thead>
<tr>
<th>History: American Anti-Mosquito Movement</th>
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</thead>
</table>

### Chemical Era 1942 – 1972

<table>
<thead>
<tr>
<th>DDT Arrival</th>
<th>US Department of Defense</th>
<th>National Malaria Eradication Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1943 Approved pesticide</td>
<td>1946 Air Force Aerial Spray Unit (AFASU)</td>
<td>1947 Cooperative of 13 States</td>
</tr>
</tbody>
</table>

- **DDT Arrival**
  - Success against malaria in Mexico
  - Crop dusters modified for mosquito control application

- **US Department of Defense**
  - Highlighting need for public health and humanitarian aid applications

- **National Malaria Eradication Program**
  - Removal of habitat, ditching
  - 4.6M+ homes treated, IRS
  - Consistent aerial application
  - Eliminated malaria by 1951 in U.S.
## History: American Anti-Mosquito Movement

<table>
<thead>
<tr>
<th>IPM Era</th>
<th>Greater Scientific Research</th>
<th>Product Discoveries</th>
<th>New Approaches</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Rutgers University</td>
<td>Increased efficacy of repellants</td>
<td>Ultra Low Volume Techniques</td>
</tr>
<tr>
<td></td>
<td>Florida Medical Entomology Laboratory</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mosquito Biology</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disease Biology</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **IMM Principles**
  - Rutgers University
  - Florida Medical Entomology Laboratory

**Product Discoveries**
- Discovery of Biopesticides Bti and Bs (1976 and 1980)
- Increased efficacy of repellants

**New Approaches**
- New Water Management Practices
- Ultra Low Volume Techniques
# Current Vector Control Capacity (NACCHO)

## Core Competencies

1. Routine mosquito surveillance through standardized trapping and species identification
2. Treatment decisions using surveillance data
3. Larviciding, adulticiding, or both
4. Routine vector control activities (e.g., chemical, biological, source reduction, or environmental management)
5. Pesticide resistance testing

## Supplemental Competencies

6. Licensed pesticide application
7. Vector control activities other than chemical control (e.g., biological, source reduction, or water management)
8. Community outreach and education campaigns regarding mosquito-borne diseases, how they spread, and how to prevent infection
9. Regular communication with local health departments regarding surveillance and epidemiology
10. Outreach (e.g., communication and/or cooperation) with nearby vector control programs

Fully Capable – performs all core and supplemental competencies
Competent – performs all core competencies
Needs Improvement – fails to perform one or more core competencies
Assessment and Ranking (NACCHO)

- **Fully Capable** – performs all core and supplemental competencies
- **Competent** – performs all core competencies
- **Needs Improvement** – fails to perform one or more core competencies
- **Cannot Assess** – 4%
- **Total** – 1083

*Circle indicates Competent level at 4%.*
### FEMA Requirements for Vector Control Reimbursement

<table>
<thead>
<tr>
<th>Finding 1:</th>
<th>More disease-carrying mosquitoes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Evidence of higher levels of disease-transmitting mosquitoes in the disaster area following the event or a significant number of disease-carrying mosquitoes in the area due to the increase in event-related standing water; or</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Evidence of the potential for disease transmission and human exposure to disease carrying mosquitoes based on the detection of arboviral diseases in sentinel organisms (poultry, wild birds, mosquito pools) in the impacted area prior to the storm event.</strong></td>
</tr>
<tr>
<td>Evidence 1:</td>
<td><strong>Surveillance data identifying the local jurisdiction’s mosquito population density estimates pre- and post-disaster, including information about species composition.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Arbovirus transmission activity indices, including information about the location of surveillance activities. Indices may consist of: infection rates in mosquitoes, seroconversion in sentinel chickens, equine cases, or human cases.</strong></td>
</tr>
</tbody>
</table>

**OR**

<table>
<thead>
<tr>
<th>Finding 2:</th>
<th>Increased biting mosquitoes pose a threat to emergency workers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>A determination that a significant increase in the mosquito population and/or the change of biting mosquito species poses a threat to emergency workers who are required to work out-of-doors; thereby significantly hampering response and recovery efforts.</strong></td>
</tr>
<tr>
<td>Evidence 2:</td>
<td><strong>Documentation reflecting an abnormal rise in landing rates or trap counts, significant changes in species composition or estimate of infection rates, when compared to pre-disaster surveillance results.</strong></td>
</tr>
</tbody>
</table>

Vector control measures in the disaster area may be eligible for assistance under the authority of 44 CFR §206.225(a)(3)(i). FEMA may provide reimbursement for such costs at the written request of the State or local public health officials after FEMA consults with the Centers for Disease Control and Prevention (CDC), based on the following information provided by the Applicant.
Most adult mosquitoes don’t survive high winds, the mosquitoes post-hurricane are hatching from eggs laid in soil prior. Flooding from heavy rain, overflowing rivers and tidal surges allows for massive hatches about 2 weeks later. Primarily nuisance species.
Surveillance Methods

CDC Light Traps

Landing Rates

Resident Phone Calls
Landing Rate Protocol

1. Do not stand in direct sunlight. Choose a shaded site near bushes or trees.
2. Disturb surrounding vegetation before starting the counts.
3. Stand still for three minutes before beginning the count. In high density situations, this step may not be necessary as mosquitoes will start landing immediately. Keep your arms out away from your body so as not stir up air around your legs and also to minimize the effect of insect repellent on your hands.
4. Take all landing rate counts from a standing position.
5. Count (or aspirate) only those mosquitoes that land on the front of one leg from the waist to the foot.
   a. Count for a <1- to 5-minute time period
      i. Use 1 minute or less if mosquito numbers are high (5 to 50+ per minute).
      ii. Use 5 minutes if mosquito numbers are low (1 to 5 per minute).
   b. Convert all counts to per minute (e.g., 20 mosquitoes in 5 minutes = 4 mosquitoes per minute)
6. Complete the “Mosquito Landing Rate Data Sheet”, using real numbers for the mosquito landing counts. For example, 25 or 75 are much more meaningful numbers than 50+ or 100+.
7. Optional: If aspirating mosquitoes, label the collection vial as in the following example and place it in a cooler with gel ice packs for later identification to species.
CDC Light Traps

CDC Light Traps
• Industry standard
• Portable
• Collect a wide variety of species
• Require CO2 source
  • Dry ice can be a difficult resource to obtain

Locating Trap Sites
• Proximity to water, human population, harborage and vegetative cover
• Vehicle and foot access can be an issue

Photo: Post Hurricane Irma
Surveillance Tools

Species abundance and diversity in Carteret, Johnston and Wilson Counties after Hurricane Florence in NC (2018)

<table>
<thead>
<tr>
<th>Mosquito Species</th>
<th>Total Collected</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aedes albopictus</td>
<td>341</td>
<td>1.3%</td>
</tr>
<tr>
<td>Aedes atlanticus</td>
<td>6,258</td>
<td>23.3%</td>
</tr>
<tr>
<td>Aedes canadensis</td>
<td>600</td>
<td>2.2%</td>
</tr>
<tr>
<td>Aedes cinereus</td>
<td>21</td>
<td>0.1%</td>
</tr>
<tr>
<td>Aedes dupreei</td>
<td>655</td>
<td>2.4%</td>
</tr>
<tr>
<td>Aedes fulvus pallens</td>
<td>25</td>
<td>0.1%</td>
</tr>
<tr>
<td>Aedes hensersoni</td>
<td>3</td>
<td>0.0%</td>
</tr>
<tr>
<td>Aedes infirmatus</td>
<td>1,108</td>
<td>4.1%</td>
</tr>
<tr>
<td>Aedes mitchellae</td>
<td>15</td>
<td>0.1%</td>
</tr>
<tr>
<td>Aedes sollicitans</td>
<td>2</td>
<td>0.0%</td>
</tr>
<tr>
<td>Aedes taeniorhynchus</td>
<td>370</td>
<td>1.4%</td>
</tr>
<tr>
<td>Aedes triseriatus</td>
<td>23</td>
<td>0.1%</td>
</tr>
<tr>
<td>Aedes vexans</td>
<td>3,687</td>
<td>13.7%</td>
</tr>
<tr>
<td>Anopheles crucians</td>
<td>941</td>
<td>3.5%</td>
</tr>
<tr>
<td>Anopheles perplexans</td>
<td>6</td>
<td>0.0%</td>
</tr>
<tr>
<td>Anopheles punctipennis</td>
<td>162</td>
<td>0.6%</td>
</tr>
<tr>
<td>Anopheles quadrimaculatus</td>
<td>265</td>
<td>1.0%</td>
</tr>
<tr>
<td>Coquillettidia perturbans</td>
<td>19</td>
<td>0.1%</td>
</tr>
<tr>
<td>Culex erraticus</td>
<td>133</td>
<td>0.5%</td>
</tr>
<tr>
<td>Culex nigripalpus</td>
<td>3</td>
<td>0.0%</td>
</tr>
<tr>
<td>Culex pipiens</td>
<td>571</td>
<td>2.1%</td>
</tr>
<tr>
<td>Culex quinquefasciatus</td>
<td>5</td>
<td>0.0%</td>
</tr>
<tr>
<td>Culex salinarius</td>
<td>3,407</td>
<td>12.7%</td>
</tr>
<tr>
<td>Culex spp.</td>
<td>52</td>
<td>0.2%</td>
</tr>
<tr>
<td>Culex territans</td>
<td>22</td>
<td>0.1%</td>
</tr>
<tr>
<td>Culiseta melanura</td>
<td>2,448</td>
<td>9.1%</td>
</tr>
<tr>
<td>Psorophora ciliata</td>
<td>76</td>
<td>0.3%</td>
</tr>
<tr>
<td>Psorophora columbiae</td>
<td>273</td>
<td>1.0%</td>
</tr>
<tr>
<td>Psorophora ferox</td>
<td>5,087</td>
<td>18.9%</td>
</tr>
<tr>
<td>Psorophora horrida</td>
<td>247</td>
<td>0.9%</td>
</tr>
<tr>
<td>Psorophora howardii</td>
<td>20</td>
<td>0.1%</td>
</tr>
<tr>
<td>Psorophora mathesoni</td>
<td>11</td>
<td>0.0%</td>
</tr>
<tr>
<td>Uranotaenia sapphirina</td>
<td>40</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Total: 26,896 100.0%
What comes after surveillance?

Abatement Measures

- Regardless of basis for request, the Applicant must describe the type of mosquito management required (e.g., aerial or ground-based adulticide applications, larvicide applications, breeding habitat removal or alteration, dissemination of information to direct residents to remove mosquito-breeding habitats), the duration of application to reduce the threat, and the areas where the interventions are needed.

Source


- Life Stage - Larval versus Adult
- Equipment - Aerial versus Ground application
- Chemical – Organophosphates versus Pyrethroids
Interventions targeting the larval stages of the mosquito have been used effectively for decades, but their effectiveness varies widely from species to species. In general, if habitats are large and amenable to environmental modification, the intervention is effective, but if habitats are small, widely dispersed, and transient the intervention is less effective.

10 lbs/acre  versus  ~1 oz/acre
Aerial Control (Planes) versus Ground (Trucks)

- Consistent coverage
- 40 – 50,000 acres/night
- Limited access
- 80 - 90 road miles (3,091) acres/night

 Irma – Florida (2017)
 18 Counties
 1,765,914 aerial acres
 2,123 truck miles (~75,000 acres)
Aerial Control (Planes) versus Ground (Trucks)

Both strategies use the same amount of product and specialized Ultra Low Volume (ULV) atomizers.


“The findings indicated ULV application in MC activities did not result in substantial pesticide exposure to humans.”

“The concentrations of naled, permethrin, and d-phenothrin used during emergency ULV applications might be too low to cause important human exposure.”
Do you know which class of chemical will work?
Insecticide Resistance testing is essential to success.

CDC
Bottle Bioassay
Emergency Response Mosquito Management

Snapshot of an Aerial Mission

1. Pre-Mission
   - Mapping
   - Pre-Flight
   - Product Preparation
   - Trapping
   - Count and ID
   - Public Relations

2. Mission
   Weather Permitting

3. Post-Mission
   - Trapping
   - Count and ID
   - Mission Details
   - Results to Customer
“Planning prevents an emergency from becoming a disaster”

Quote Credit: Edwin Kent Gray

Chief, Emergency Preparedness and Response Branch
National Center for Environmental Health
Centers for Disease Control and Prevention
Retired
“Planning Prevents an Emergency from Becoming a Disaster”

Emergency Response Mosquito Management

What can you do now to make some response efforts turnkey?

• Gather community stakeholders
• Determine your management preferences
• Align with local, state, and government organizations

What steps can you take now to practice responsible control during response efforts?

• Obtain baseline data for your community
• Conduct resistance monitoring
• Prepare public education materials on personal protection measures as well as community management efforts
Questions?

Visit our website
http://www.vdci.net/emergency-response

or

Get in touch with one of us...

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