The ZUMBA Trap: A Novel Surveillance Tool for Host-Seeking Mosquitoes

Hina Bhalala, M.P.H. and Jorge Arias, Ph.D.
Fairfax County Health Department
Fairfax County, VA

400 square miles
1 million people
Peri-urban
Background

- West Nile virus (WNV) in Fairfax County since 2000
- Intensive mosquito surveillance program with WNV laboratory testing
- Variety of WNV vector species in the area
Mosquito Species

- Culex
  - Culex pipiens
  - Culex restuans
  - Culex erraticus

*Photo Courtesy of CDC Library*
Mosquito Species

- **Culex**
  - *Culex pipiens*
  - *Culex restuans*
  - *Culex erraticus*

- **Aedes**
  - *Aedes albopictus*
  - *Aedes vexans*

*Photo Courtesy of CDC Library*
Research Study

1. Which trap, baited with BG-Lure and CO₂, is more effective at collecting WNV-vector species?

- Zumba
- BG-Sentinel
- Faye-Prince
- CDC Miniature Light
1. Which trap is more effective at collecting WNV-vector species?
   - Zumba
   - BG-Sentinel
   - Faye-Prince
   - CDC Miniature Light

2. Should we include the Zumba mosquito trap into our surveillance program?
Zumba trap

- **Visual stimuli**
  - Color (black and green)
  - Size (human-like)

- **Chemical stimuli**
  - Lure
  - CO₂

- **Collapsible**

- **Portable**
Zumba trap

- Shelf built into trap to place the lure
- Odor dissemination and direction

BG-Lure inside the trap
Zumba trap

- CO₂ source: dry ice in a cooler
- CO₂ attached to trap with rubber tubing
- CO₂ dissemination directly into the catch area
Other traps

- **BG-Sentinel**
  - Black and white coloration
  - Mimics convection currents created by human body

- **CDC Miniature Light**
  - Light bulb
  - Gold-standard trap for host-seeking mosquitoes

- **Faye-Prince**
  - Black and white coloration
  - Wind-orienting cover
# Latin Square Design

<table>
<thead>
<tr>
<th>Site</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site A</td>
<td>BG</td>
<td>Zumba</td>
<td>FP</td>
<td>CDC</td>
</tr>
<tr>
<td>Site B</td>
<td>CDC</td>
<td>BG</td>
<td>Zumba</td>
<td>FP</td>
</tr>
<tr>
<td>Site C</td>
<td>FP</td>
<td>CDC</td>
<td>BG</td>
<td>Zumba</td>
</tr>
<tr>
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<td>BG</td>
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BG = BG-Sentinel  
FP = Faye-Prince  
CDC = CDC Miniature Light

*Variations: location, day and trap types*
Study Design

- 4x4 Latin Square
- 14 replicates
- 224 trap nights

- Chemical stimuli for all traps
  - BG-Lure
  - Carbon dioxide
BG-Lure

- Made up of ammonia, lactic acid and fatty acids
- Efficacy illustrated in 2006 study
- Determine efficacy of the BG-lure in all four trap types
Each morning, traps were rotated through the four trapping stations.
Trapping Stations

- 30m apart and 25m in the woods
- Tarps permanently installed at a height of 2m
- Cross wire (rope) to hang traps, BG-Lure and CO\textsubscript{2} (dry ice) coolers
Results

1. Species composition

- Total number of species
- Mean number of mosquitoes
Species Composition
Zumba

- Cx. pipiens: 49%
- Cx. spp: 8%
- Ae. albopictus: 32%

11 species
## Trap Performance Summary

<table>
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<tr>
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<th>FP</th>
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<tr>
<td>Overall # of Species</td>
<td>11</td>
<td>14</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Mean # of Mosquitoes*</td>
<td>35.51</td>
<td>29.02</td>
<td>7.96</td>
<td>6.73</td>
</tr>
<tr>
<td>Mean # of <strong>♀</strong> Ae. <em>albopictus</em></td>
<td>12</td>
<td>22</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Mean # of <strong>♀</strong> <em>Culex</em></td>
<td>20.6</td>
<td>3.24</td>
<td>1.2</td>
<td>0.86</td>
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* Per Trap Night

BG = BG-Sentinel  FP = Faye-Prince  CDC = CDC Miniature Light
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Results (2)

1. Species composition
   - Total number of species
   - Mean number of mosquitoes

2. Trap performance
   - Mean number of WNV vector species
   - Infection rates
Mean number of female mosquitoes collected significantly affected by trap type

- Not affected by trap location and trap day

<table>
<thead>
<tr>
<th></th>
<th>F test</th>
<th>p - value</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ae. albopictus</em></td>
<td>47.614</td>
<td>&lt; .01</td>
</tr>
<tr>
<td><em>Culex</em></td>
<td>43.929</td>
<td>&lt; .01</td>
</tr>
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</table>

*Data analyzed using Latin square ANOVA analysis in SPSS*
Ae. albopictus

*Photo Courtesy of CDC Library*
Mean Number of *Ae. albopictus* per Trap Night

- **BG**: 25x (p < .01) compared to other trap types.
- **CDC**: Lower mosquito count compared to BG, FP, and Zumba.
- **FP**: Intermediate mosquito count between BG and Zumba.
- **Zumba**: Similar mosquito count to FP.

Graph showing the comparison of mosquito counts per trap type.
Mean Number of *Ae. albopictus* per Trap Night

No. of mosquitoes / trap night

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<th>CDC</th>
<th>FP</th>
<th>Zumba</th>
</tr>
</thead>
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<tr>
<td><strong>No. of mosquitoes</strong></td>
<td>25</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
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9x (p < .01)
Culex (Cx. pipiens, Cx. restuans)

*Photo Courtesy of CDC Library*
Mean Number of *Culex* per Trap Night

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<tr>
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<td>1</td>
</tr>
<tr>
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</tr>
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**19x (p < .01)**
URBAN
Alexandria, VA

vs.

PERI-URBAN
Fairfax County, VA
2007 *Ae. albopictus* Population Density in the BG-Sentinel trap for Alexandria and Fairfax County, VA

![Graph showing population density over epiweeks with peak density in late summer and early fall, indicative of rain events.]
Comparisons with Routine Surveillance in Fairfax County, VA

- Gravid and CDC traps
- 70 trap sites (6 sq. miles)
- 140 trap nights per week
Ae. albopictus

*Photo Courtesy of CDC Library*
2007 Population Density and Rain events for *Ae. albopictus* in the Zumba, BG-Sentinel and Routine (CDC) traps
2007 Population Density and Infection Rates for *Ae. albopictus* in the Zumba, BG-Sentinel and Routine (CDC) traps

IR = iR/1000
Culex

*Photo Courtesy of CDC Library*
2007 Population Density of *Culex* in the Zumba and Routine traps

![Graph showing the population density of Culex over different epiweeks with marked rain events.](image-url)
2007 Infection Rate for *Culex* in the Zumba and Routine Gravid traps
Results

- Zumba collected 11 different species
  - Majority of *Ae. albopictus* and *Cx. pipiens*

- Zumba most productive traps
  - Mean number of mosquitoes collected, 35.51, per trap night

- Zumba collected significantly more *Culex* than other traps

- Both Zumba and BG-Sentinel collected significantly more *Ae. albopictus* than CDC and Faye-Prince traps

- CDC and Faye-Prince less efficient at collecting WNV vector species
Results

- Zumba and BG-Sentinel collected WNV-positive *Ae. albopictus*

- Only Zumba collected WNV-positive host-seeking *Culex*

- Infection rates higher than the Routine surveillance for both species
Conclusions

- Zumba more efficient in collecting WNV vector species
- BG-Sentinel only efficient in collecting Ae. albopictus
- CDC Miniature Light and Faye-Prince traps may not be the most sensitive
Conclusions

Zumba may be the next most important WNV surveillance tool!
Acknowledgments

- Fairfax County Health Department Staff

  DCIP Staff:
  Brent O’Dea, M.S.
  Joshua Smith, M.S.
  Carl Sivertsen
  Josh Frescholtz

  DCIP Summer Staff

- Alexandria Health Department

  Holly Feltner, M.S.
  Diana Brown