Mosquito Control Practices in Florida

Phil Koehler, Professor
FPMA Endowed Professor of Urban Entomology
Margie & Dempsey Sapp Endowed Professor of Structural Pest Control
Entomology & Nematology Dept.
University of Florida
pgk@ufl.edu

Preparing the Industry for Change: Facing Zika

The Moment Before Change

Facing Zika

Zika Vector Control is a Great Opportunity
(PCT, April 17, 2017, Specialty Consultants)

• 33% of the professional pest control industry = 7,000 companies, offered mosquito control services
  – 50% of companies in Southeast and South Central regions offered a mosquito control service to their residential and commercial customers.
• 2016– Nationwide, pest control companies generated an estimated $157.7 million in service revenue, primarily (93.3%) from residential accounts
• 2,100 governmental agencies (city, county, state), including 950 Mosquito Abatement Districts

Zika (ZIKV) Distribution

• Mosquito-transmitted virus that has recently spread to the Americas
• Discovered in 1947 in Africa, isolated from a Rhesus monkey in Uganda
• 44 countries have local transmission of ZIKV, others have travel-related cases
Zika in USA (March 8, 2017)

$173 million in free advertising from news coverage in 2016

Zika Transmission in Florida

Florida cases seen as first sign Zika transmitted locally in U.S.

July 29, 2016

• ***Mosquitoes***
• Sex
• Blood transfusions

Cases of Zika in Florida

4/12/2017

• Total
  – 1089 travel-related
  – 277 locally spread
• Locally spread
  – 1 Broward
  – 260 Miami/Dade
  – 5 Palm Beach
  – 1 Pinellas

<table>
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<tr>
<th>Year</th>
<th>Infection Type</th>
<th>Infection Count</th>
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<tbody>
<tr>
<td>2016</td>
<td>Travel-related infections Of Zika</td>
<td>103</td>
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<tr>
<td>2016</td>
<td>Locally acquired infections Of Zika</td>
<td>278</td>
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<tr>
<td>2016</td>
<td>Undetermined</td>
<td>32</td>
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<tr>
<td>2017</td>
<td>Travel-related infections Of Zika</td>
<td>13</td>
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<tr>
<td>2017</td>
<td>Locally acquired infections Of Zika</td>
<td>0</td>
</tr>
<tr>
<td>2017</td>
<td>Undetermined</td>
<td>0</td>
</tr>
</tbody>
</table>

Reasons to Control Container-Breeding Mosquitoes

Chikungunya Virus 2017

Chikungunya is found worldwide, particularly in Africa, Asia, and India

Reasons to Control Container-Breeding Mosquitoes

Dengue Virus 2016

• One-third of the world’s population live in areas at risk for infection.
• A leading cause of illness and death in the tropics and subtropics.

Microcephaly & Zika Virus

• 80% of infected people have no symptoms
• During pregnancy, Zika can cause microcephaly & miscarriages
  – 24/250 pregnant U.S. women (~10%) had a fetus or baby with Zika-related birth defects (2016 data reported by CDC, April 4, 2017)
• Zika can cause Guillain-Barre syndrome (immune system attacking the nervous system)
Pregnant Women with Lab Evidence of Zika

CDC; April 19, 2017

- U.S. & DC—1,762
- U.S. Territories—3,592
  - “Registries” as of April 11, 2017
- U.S. & DC—5,238
- U.S. Territories—36,569
  - “ArboNET” as of April 9, 2017
- Assuming 10% birth defect rate =
  - U.S. & DC = 176-523 affected babies
  - U.S. Territories = 359-3,656 affected babies

Zika Vectors

- Aedes aegypti
  - Most important vector of Zika, Dengue, and Chikungunya viruses
- Aedes albopictus
  - Most important container-breeding mosquito in U.S.
  - Also a vector of Zika, Dengue, and Chikungunya viruses
- 3 factors that make Zika vectors difficult to control
  - Container-breeding mosquitoes
  - Daytime fliers
  - Limited flying distance

Zika Vectors Breed in Small Bodies of Water

Other Mosquito Breeding

Zika Vectors Fly Short Distances

- <1/4 mile for Zika vectors
- 1-2 miles for West Nile Virus & malaria vectors
- 5-50 miles for salt marsh mosquitoes

Zika Vectors are Daytime Biters

2nd Amendment and Mosquitoes
SUSTAINABLE CONTAINER MOSQUITO CONTROL

Phil Koehler, Professor, Entomology Department, University of Florida

OPERATION BLESSING (FOUNDED BY PAT ROBERTSON)
* ONE OF THE LARGEST CHARITIES IN AMERICA
* PROVIDES RELIEF IN 39 COUNTRIES AROUND THE WORLD

MONTE VERDE, HONDURAS

- Suburb of San Pedro Sula

WEEKLY WATER DELIVERY TO MONTE VERDE, HONDURAS

DRINKING WATER STORAGE IN MONTE VERDE, HONDURAS

WELLS IN MONTE VERDE, HONDURAS LINED WITH TIRES:
HIGH RISK CONDS FOR AGUIE AEGYPTI
**PILA = WATER STORAGE**
- Bathroom sink
- Kitchen sink
- Laundry

**Operation Blessing & UF Program in Monte Verde, Honduras**
- Integrated Mosquito Control Program
- Trained Volunteers & Community
- Larvicial Chips and Stickers
- Copepods
- Turtles
- Fish - top feeding minnows

**Education of School Kids**

**Data Form for Evaluating Treatments**

**Problem: Chips Were Accidentally Dumped Out of Containers**
ZZZERO STICKERS
Currently in the process to be sold throughout world

EVALUATION OF STICKERS FOR CONTROL OF MOSQUITOES IN CONTAINERS
Collection of larvae in containers containing stickers of Pyriproxyfen, and placed in mesh bags floating in a drum

STICKERS DO NOT REPEL MOSQUITOES FROM LAYING EGGS IN TREATED CONTAINERS
Pyriproxyfen-atraction experiments being commenced at a volunteers house. One cup with 1 dot of Pyriproxyfen sticker and the other cup as a control, placed about 1 foot apart.

MORPHOLOGICAL DEFECTS OF AE. AEGYPTI PUPAE AND ADULTS DUE TO EXPOSURE TO PYRIPROXYFEN
PICTURES: KRISTEN STEVENS
• 90-100% mortality for 6 months
• A) and B) An adult unable to fully emerge from the pupal exuviae, shows part of the exposed undeveloped thorax.
• C) Adult before emerging, legs are visible in cephalothorax.
• D) "Albino" pupae, lacking any darkening and hardening of cuticle.
• E) and F) Deformed Ae. aegypti adults, trapped in pupal exuviae.

INTRODUCTION OF COPEPODS INTO WELLS
Only the largest copepod species (body length > 1.4 mm)
• Kill mainly 1” instar mosquitoes.
• >40 Aedes larvae/copepod/day
• Most field testing has been in Aedes container-breeding habitats.

Field tests:
• The most effective copepod species maintain large populations in a container habitat for as long as there is water.
• Reduce Aedes production by 99-100%.
• Cause local eradication of container-breeding Ae. aegypti mosquitoes if present in a high percentage of breeding sites
(Marten & Reid 2007)

INTRODUCTION OF TURTLES & FISH INTO WELLS
• Turtles certified free of Salmonella
• 150 fish to 80 homes
• 15 turtles to wells & pilas
MONITORING OF WELLS AND CISTERNS

Copepods were monitored in Wells, tires in Wells and cisterns. Copepods were observed in tires of Wells. Copepods were not able to be observed in cisterns because of their design. We were able to observe copepods in some well bottoms.

SUSTAINABLE CONTAINER MOSQUITO CONTROL

• Monte Verde Integrated mosquito management with copepods, turtles, fish, larvicidal stickers, and chips
  • Larvicidal chips & stickers in all pilas, drums, buckets, and cisterns
  • Copepods in wells, cisterns, and drums
  • Turtles and fish in wells
  • Chips & stickers worked for ~6 months
  • ZZZero chips and stickers are in the process of being developed for people throughout the world.

RESULTS: SUCCESS!

• Disease situation in Choloma near Monte Verde, Honduras
  • 71 Dengue
  • 3 Zika
  • 1 Chikungunya
  • No disease reported at Monte Verde

RESOLUTION

• Disease situation in Choloma near Monte Verde, Honduras
  • 71 Dengue
  • 3 Zika
  • 1 Chikungunya
  • No disease reported at Monte Verde

MOSQUITO LIGHT TRAPS

• MosClean
  • UV LED
  • Fan
  • Catches ~10x more than CDC light trap
  • Donated to UF
  • Hung in stairwells
  • Thousands of mosquitoes captured

Methods of Controlling Container-Breeding Mosquitoes

Integrated Mosquito Management Program
• Customer education
• Inspection
• Treatment
  – Residual adulticides
  – Space spray adulticides
  – Larvicides
• Monitoring
  – Quality control

Customer Education
Source Reduction for Container-Breeding Mosquitoes

Breeding sites need to be
• dumped
• scrubbed to remove eggs

Inspection: Container Mosquito Survey

Survey properties for Larvae
• Basic survey unit is the house or premise
• Search for water holding containers
• Look in each container for mosquito larvae and pupae
• Search may be
  – ended as soon as larvae are found,
  – continued until all containers have been examined

Container Mosquito Survey

• Use a Turkey Baster to Survey
• Pull water from containers
• Put in a white cup
  – It is easier to see mosquito larvae in a white cup

House Index

Survey for Larvae
• House Index (HI)
  – Percent of properties infested
  – Most appropriate for planned communities
  – Number > 5% requires treatment
• HI = \frac{\text{No. of houses infested}}{\text{No. of inspected houses}} \times 100
• Example
  – HI = \frac{20}{55} \times 100 = 36%

Container Index

Survey for Larvae
• Container Index (CI): percentage of infested water holding containers
  – Number > 10% requires treatment
• CI = \frac{\text{Number of infested containers}}{\text{Number of inspected containers}} \times 100
• CI = 10/17 \times 100 = 59%

Free Container Inspection

• When a customer asks for ANY service:
  – “Would you like a free inspection for mosquitoes?”
• Every technician should do a free Container Survey as part of service to upsell customers
The Industry that Could Help Control Zika Vectors: Florida Pest Management Industry

- >20% of the nation’s pest management companies
- 4000 locations
- 7000 certified operators
- >20,000 technicians
- Pest management industry services all parts of Florida
- One of the largest Florida pest control companies has
  - 1,800 technicians & managers
  - 135 service centers in several states
  - 488,000 customers

Pest Control and Mosquito Control

- Mosquito Control should require cooperation
  - Mosquito Control Districts
  - Pest Control Industry
- Zika vectors breed in people’s back yards
  - Mosquito districts do not always have the authority to enter private property
- The pest control industry regularly enters millions of customers’ properties for pest control
  - It makes sense for the pest control industry to cooperate in providing Zika vector control for Floridians

Space Spray Attributes/Limitations

- Aerial treatments were the main method used for Zika vector control in 2016
- Zika vectors fly during day so most are not killed with nighttime applications

Daytime Space Sprays Are Not Effective

- Air cool
- Convection
- Mosquito flight zone
- Ground hot

Nighttime Space Sprays Are Best

- Air warm
- Inversion
- Mosquito flight zone
- Ground cool
Barrier Sprays
Backpack Sprayer vs Mist Blower

Mosquitoes rest on bottom of leaves

Backpack sprayer

Backpack mist blower

Top of leaves

Bottom of leaves

Could you treat this vegetation & house thoroughly with a compressed air sprayer?

Which vegetation should be treated?

Barrier Spray Attributes

Residual Spray

To vegetation

Under sides of leaves

Any time of day

Residual Mist Blower Treatment for *Aedes albopictus*

- Immediate reduction
- 8 weeks of ~100% Control

Quality Control: Monitoring Mosquitoes

- BG Sentinel trap

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<tr>
<th>Product</th>
<th>Description</th>
<th>% Control</th>
<th>Weeks after Treatment</th>
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<tr>
<td>Demand CS + Archer</td>
<td>Immediate reduction, 8 weeks of ~100% Control</td>
<td>100%</td>
<td>0-8 weeks</td>
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<tr>
<td>Demand CS</td>
<td>Immediate reduction</td>
<td>70%</td>
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<tr>
<td>Archer</td>
<td>Immediate reduction</td>
<td>60%</td>
<td>0-8 weeks</td>
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**BG Sentinel vs CDC Trap Data**

<table>
<thead>
<tr>
<th>Trap</th>
<th>No. Sites</th>
<th>Mosquitoes Trapped</th>
<th>Female</th>
<th>Male</th>
<th>Mosquitoes Female</th>
<th>a. albopictus &amp; a. hygroa</th>
<th>a. aquasalis</th>
<th>Estimated No. of previously blood-fed mosquitoes</th>
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- BG Traps catch 1 bloodfed mosquito every 2 days
- If infection rate is 1 per 1000 mosquitoes, it would take 174,000 trap-days to get one infected mosquito

**After-Treatment Monitoring**

- Eggs per trap
  - Average of 10 eggs per trap requires re-treatment

**Monitoring After Treatment**

- Demand CS & Archer

**Mosquito Control Does Not Have to be Fancy**

- Screens were Responsible for Eradicating Malaria from Florida

**Organized Community-wide Container Clean-up Campaigns**

**CONFUSED?**

About the FDACS Comprehensive Toolbox?

**GOOD.**
Zika will Continue to be a Big PROBLEM

ALL PROBLEMS ARE OPPORTUNITIES IN DISGUISE