Mosquito Surveillance for EEE and Other Arboviruses in CT

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The Connecticut Agricultural Experiment Station
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Connecticut Mosquito Management Program

- **Established 1997 by Public Act 97-289**

- **Comprised of 5 State Agencies**
  - **The CT Agricultural Experiment Station** (*mosquito surveillance, virus testing*)
  - **Department of Public Health** (*epidemiology of human, veterinary cases*)
  - **Department of Energy & Environmental Protection** (*mosquito control, habitat restoration*)
  - **Department of Agriculture** (*veterinary cases*)
  - **Pathobiology Department at UCONN** (*necropsy, initial veterinary testing*)
Mosquito Trapping Locations

- **Rural Areas**
  - Permanent swamps and bogs
  - Marsh areas (fresh and salt)

- **Urban / Suburban Sites**
  - Neighborhood parks and schools
  - Along waterways and streams
  - Sewage treatment plants
  - Horse stables
Litchfield
Hartford
Tolland
Windham
Litchfield
Hartford
Tolland
Windham

New Haven
Middlesex
New London
Fairfield

WNV
EEE

O = Mosquito Trapping Stations (92)
Mosquito Surveillance

- Mosquito trapping from June – October
- 92 permanent trapping stations (ADD 15 in 2020)
  - 91 Sites maintained by CAES
  - 1 Site maintained by US Navy
- Trap on a Rotational Basis (about every 10 days)
  - If WNV or EEE isolates from mosquitoes
    - Trap Weekly (twice if possible)
- 2 or 3 types of trap per location

Detect virus in mosquitoes prior to human or animal cases
CDC Light Trap

- Host seeking females
  - Out for blood
- Collects a large & diverse number of mosquitoes
  - Aedes/Ochlerotatus
  - Coquillettidia
  - Culex
  - Culiseta
  - Psorophora
• Host seeking females
• Out for blood
• Collects a large & diverse number of mosquitoes
• Aedes/Ochlerotatus
• Coquillettidia
• Culex
• Culiseta
• Psorophora

CDC Light Trap
CDC Gravid Trap

- Hay-yeast-lactalbumin infusion

- *Culex pipiens* & *Cx. restuans*
  - Ready to lay eggs
  - Obtained blood meal
  - More Likely to be WNV (+)
  - 90% of collection

- Accounts for >75% of WNV (+) isolates from *Cx. pipiens* and *Cx. restuans*
BG Sentinel Trap

- Designed for *Ae. albopictus*
  - Used at sites to evaluate population size

- Small populations in CT
  - Coastal Fairfield and New Haven counties

- Invasive Species

- Aggressive Human Biter
  - Secondary vector of Zika, Chikungunya and Dengue
Mosquito Identification

- Females identified to species
  - 43 species collected in 2019
- Completed on day of collection
  - 6 identifiers during peak season
- Pooled by species, site and trap type
  - Maximum of 50 / pool
- All species tested for arboviruses
Virus Isolation & Identification

• Biosafety Level 3 Laboratory

• Virus isolation in Vero cell cultures (African Green Monkey)
  – Incubate for 7 days at 37°C in 5% CO₂
  – Examine daily for virus growth

• Virus identification by Real time PCR, RT-PCR, molecular techniques
Mosquito-Borne Viruses in Connecticut

- West Nile Virus
- Eastern Equine Encephalitis
- Jamestown Canyon
- Cache Valley
- La Crosse
- Trivittatus
- Potosi
- Highlands J
- Flanders

Can detect Zika, Chikungunya, or other exotic viruses

Cause Human Disease
<table>
<thead>
<tr>
<th>Virus</th>
<th>No. isolations *</th>
<th>No. locations *</th>
<th>Reservoir</th>
<th>Age Group</th>
<th>Human disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Nile</td>
<td>2,440</td>
<td>106</td>
<td>Bird</td>
<td>Elderly</td>
<td>Moderate to severe, fever, encephalitis</td>
</tr>
<tr>
<td>Eastern Equine Encephalitis</td>
<td>534</td>
<td>48</td>
<td>Bird</td>
<td>Children, Elderly</td>
<td>Severe, encephalitis</td>
</tr>
<tr>
<td>Jamestown Canyon</td>
<td>557</td>
<td>88</td>
<td>White-tailed deer</td>
<td>All ages</td>
<td>Fever, meningitis, encephalitis</td>
</tr>
<tr>
<td>Cache Valley</td>
<td>226</td>
<td>71</td>
<td>Deer, horse, sheep</td>
<td>All ages</td>
<td>Fever, meningitis, encephalitis</td>
</tr>
<tr>
<td>Trivittatus</td>
<td>104</td>
<td>25</td>
<td>Rabbit, squirrel, raccoon, opossum</td>
<td>All ages</td>
<td>Febrile illness</td>
</tr>
<tr>
<td>La Crosse</td>
<td>5</td>
<td>3</td>
<td>Squirrel, chipmunk</td>
<td>Children</td>
<td>Severe, encephalitis</td>
</tr>
</tbody>
</table>

* = 1997-2019
Reporting of Results

• EEE, WNV, or exotic virus identified
  • Notify CT DPH, DEEP
    • DPH contacts local Health Dept.
  • Report to CDC (ArboNet)

• Post on CAES/Mosquito Management Website
  • www.portal.ct.gov/caes
  • www.portal.ct.gov/mosquito

• Map

• Weekly & Cumulative Results Tables

• Press Release may be issued (state or local)
Northeastern US EEE Virus Transmission Cycle

Culiseta melanura

Enzootic Cycle

Virus

Wild Passerine Bird Reservoir and Amplifying Hosts

July to October
Northeastern US EEE Virus Transmission Cycle

**Enzootic Cycle**

- *Culiseta melanura*
- **July to October**
- Virus

**Epidemic / Epizootic Transmission**

- *Coquillettidia perturbans*
- *Culiseta melanura*
- *Aedes and Ochlerotatus species*
- **August to October**

**Wild Passerine Bird Reservoir and Amplifying Hosts**

- "Incidental" Infections
Eastern Equine Encephalitis Activity, 1996-2019

Infected Mosquitoes (1996-2019)
- • Not Detected
- ○ 1 yr
- ● 2 yrs.
- ▲ 3 yrs.
- ⭕ ≥ 5 yrs.

= Horse Cases (1938 - 2019) = Human Case

Virus Isolations per Year
Total = 534
Weekly Isolations of EEE virus from field collected mosquitoes in Connecticut

No. EEE virus isolations

Week

1996-2018
2019 Eastern Equine Encephalitis Activity per Week

- Non-mammalian biter (n=90)
- Mammalian biter (n=32)

* = onset of illness symptoms

- = Human Case* (n=4)
= Horse Case* (n=6)
= Pheasant or Partridge* (n=2)
### EEE Isolations from Mosquito Pools - CT 1996-2019

<table>
<thead>
<tr>
<th>Species</th>
<th>Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Culiseta melanura</em></td>
<td>344</td>
</tr>
<tr>
<td><em>Ochlerotatus canadensis</em></td>
<td>37</td>
</tr>
<tr>
<td><em>Aedes cinereus</em></td>
<td>20</td>
</tr>
<tr>
<td><em>Aedes vexans</em></td>
<td>19</td>
</tr>
<tr>
<td><em>Uranotaenia sapphirina</em></td>
<td>19</td>
</tr>
<tr>
<td><em>Culex salinarius</em></td>
<td>16</td>
</tr>
<tr>
<td><em>Coquillettidia perturbans</em></td>
<td>10</td>
</tr>
<tr>
<td><em>Culex pipiens</em></td>
<td>10</td>
</tr>
<tr>
<td>Other Species (11)</td>
<td>58</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>534</strong></td>
</tr>
</tbody>
</table>

- **Cs. melanura** - 63%
- **Oc. canadensis** - 7%
- **Ae. cinereus** - 4%
- **Ae. vexans** - 3%
- **Cx. salinarius** - 3%
- **Ur. sapphirina** - 2%
- **Other Species** - 11%
- **Cx. pipiens** - 2%

**TOTAL** 534 isolates.
Northeastern US West Nile Virus Transmission Cycle

*Culex pipiens*
*Culex restuans*
*Culiseta melanura*

Enzootic Cycle

June to October

Virus

Wild Passerine Bird Reservoir and Amplifying Hosts
Northeastern US West Nile Virus Transmission Cycle

Enzootic Cycle

- Culex pipiens
- Culex restuans
- Culiseta melanura

Virus

June to October

Epidemic / Epizootic Transmission

- Culex salinarius
- Culex pipiens
- Aedes vexans

“Incidental” Infections

Wild Passerine Bird Reservoir and Amplifying Hosts

July to October
West Nile Virus Isolates from Mosquitoes, 1999-2019

Infected Mosquitoes
- 1-3 yr.
- 4-6 yrs.
- 7-9 yrs.
- 10-12 yrs.
- 13+ yrs.
- Not Detected

Total = 2,440
### WNV Isolations from Mosquito Pools, CT 1999-2019

<table>
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<th>Species</th>
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<tr>
<td>Culex pipiens</td>
<td>1,695</td>
</tr>
<tr>
<td>Culex restuans</td>
<td>341</td>
</tr>
<tr>
<td>Culex salinarius</td>
<td>171</td>
</tr>
<tr>
<td>Culiseta melanura</td>
<td>118</td>
</tr>
<tr>
<td>Aedes vexans</td>
<td>19</td>
</tr>
<tr>
<td>Aedes cinereus</td>
<td>13</td>
</tr>
<tr>
<td>Coquillettidia perturbans</td>
<td>14</td>
</tr>
<tr>
<td>Ochlerotatus japonicus</td>
<td>10</td>
</tr>
<tr>
<td>Oc. canadensis</td>
<td>12</td>
</tr>
<tr>
<td>Oc. taeniorhynchus</td>
<td>6</td>
</tr>
<tr>
<td>Other Species (14)</td>
<td>52</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>2,440</strong></td>
</tr>
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</table>

**Pie Chart**
- Culex pipiens: 69%
- Culex restuans: 14%
- Culex salinarius: 7%
- Culiseta melanura: 5%
- Other species (19): 5%
WNV Epidemic Curve

No. WNV Isolates

Week


10 yr Mean Human
10 yr Mean Mosq.
Neurological illness in humans is rare
  • 4-10% of the CT residents have antibody to the virus
  • About ~1 case/year reported in US prior to 2013
  • 181 human cases reported 2013-2018
    • Neuroinvasive cases in Northeast (CT, MA, ME, NH, NJ, NY, RI)

Human Symptoms
  • Mild
    • Flu-like
    • Fever, headache, fatigue
  • Severe
    • Meningitis, encephalitis
  • All ages affected

Human Case – CT, 2018
  • Meningitis
  • Bethlehem (Litchfield County)
  • Onset of Symptoms on September 4th
  • 1st CT case documented since 2001
Jamestown Canyon Virus

- Enzootic Cycle between deer and mammal-biting mosquitoes
  - Wide-spread distribution in CT (88 sites)
  - Higher prevalence in June & July
  - 25 species
  - “Snow-pool” *Ochlerotaus, Aedes* species

- 23 Virus Isolations – CT, 2019
  - 15 sites in 15 towns
  - June 4th – September 9th
  - 9 species
Weekly Jamestown Canyon Virus Isolations from Mosquitoes

Mean no. mosquitoes / light trap

MLE = 0.03 - 0.39
Acknowledgements

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Questions?

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Mosquito Surveillance: www.portal.ct.gov/caes
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