West Nile Virus
Trends in Human and Mosquito Populations in Fairfax County, Virginia

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"Holy Grail" of WNV mosquito surveillance

The challenges

- Diagnosed case numbers are low in our area
- Small difference between "good" and "bad" years
- 80% asymptomatic
- 20% with symptoms (mostly undiagnosed)
- <1% serious symptoms
Linking Mosquito and Human WNV Data (cont.)

- Small population size hard to make connections
- Disproportionately affects older adults
- Little data sharing between jurisdictions
- Which data should be shared?
- County-level data not shared during season
West Nile Virus 2019

Human disease cases
Reported to CDC ArboNET by county of residence

- 1-10
- 11-20
- 21-50
- >50
- Reports state level data only
74 trap sites
- Gravid Trap
- CDC Trap
- 29 with BG Sentinel Trap
- ~1 trap site per 5-6 square miles
Gravid trap

- Large numbers of *Culex* mosquitoes
  - *Culex pipiens* and *Culex restuans* (primary WNV vectors in NoVa)
  - Have already fed on a host
  - That host was likely a bird, where WNV circulates
Terms

- Epiweek
- *Culex* spp.
- Infection Rate (*Culex*) per thousand
  - MIR - Minimum Infection Rate
  - MLE - Maximum Likelihood Estimate
- Cumulative Infection Rate (weeks 21-40)
- Vector Index
- Neuroinvasive Cases (Neuro)
Culex Mean Infection Rate (MLE) and WNV Cases in Fairfax County, 2006-2019

- **Mean Infection Rate (MLE)**
- **WNV Case Onset**
- **Infection Rate (MLE)**

Graph showing the trend of infection rate and WNV cases from 2006 to 2019.
Graph showing the $Culex$ Infection Rate (MLE) in Fairfax County, Virginia from 2017 to 2019.
Culex WNV Infection Rate (MLE), 2004-2018

Mean IR of 0 Case Years (2005, 2014, 2016)

Mean IR of 1-3 Case Years (2004, 2006-2011, 2013)

Mean IR of >3 Case Years (2012, 2015, 2017, 2018)
Thresholds

When should we respond?

- Early season indicators
- Host-seeking trap positives
- Bridge vector positives
- High Infection Rate
- High *Culex* abundance
- High Vector Index
Epiweek of 5th WNV Positive Mosquito

Epiweek

WNV Neuro Cases

- 2012
- 2015
- 2017
- 2013
- 2019
- 2010
- 2011
- 2008, 2007
- 2006
- 2016
Mean Number of West Nile Positive Pools by Epiweek in Low, Medium and High WNV Case Years, Fairfax County, Virginia

- >3 Case Years (2012, 2015, 2017, 2018)
- 1-3 Case Years (2006-2011, 2013, 2019)
- 0 Case Years (2014, 2016)
WNV Positive CDC Traps and Neuro Cases in Fairfax County, Virginia

R² = 0.5907
Aedes albopictus
Aedes japonicus
Aedes vexans
Culex erraticus
Culex salinarius

Legend
- WNV Cases 2018
- Bridge Vector Positive
- Mosquito Trap Site
Cumulative WNV Infection Rate (MLE) from Gravid Mosquito Traps and Neuroinvasive WNV Case Numbers by Year, 2004-2018
Culex Infection Rate (MLE) in Fairfax County, Virginia

Threshold

2017 IR

2018 IR

2019 IR

Epiweek

Infection Rate
How would we like to respond?

**Adulticiding**—wide-scale, repeated applications
- To reduce Infection Rate
- To reduce Vector Index (by reducing abundance) until Infection Rate drops

**Larviciding**
- Inspecting and treating areas not previously inspected
- Increasing frequency

**Outreach**
- Improved public notification
2018 *Culex* Vector Index and Human WNV Cases by Week of Symptom Onset

[Graph showing the Vector Index and Human WNV Cases by Week of Symptom Onset. The x-axis represents Epiweek from 20 to 44, and the y-axis represents Vector Index from 0.00 to 1.20 and Human Cases from 0.00 to 2.00. The graph includes two lines: one for WNV case (yellow) and one for Vector Index (green).]
Fairfax County makes up a smaller proportion of total VA cases

<table>
<thead>
<tr>
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<th>Population (2010 Census)</th>
<th>Neuro WNV Cases (06-19)</th>
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<tbody>
<tr>
<td>Virginia</td>
<td>8,001,024</td>
<td>124</td>
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<tr>
<td>Fairfax County</td>
<td>1,081,726 (13.5%)</td>
<td>32 (25.8%)</td>
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When compared to surrounding jurisdictions:
- Lower infection rates in mosquitoes
- Lower incidence
Mid-Atlantic region pattern
WNV in mosquitoes precedes human cases
Epiweek of 5th positive early season indicator
Positives from host seeking traps/bridge vectors may be more common in “big years” but not geographically predictive of cases
Incidence related to population density
Cumulative infection rate (linked to case numbers) can set thresholds
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