West Nile Virus in Montana

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West Nile Virus in Montana

- Mosquitoes
  - Trapping & vector ecology
- WNV
  - Introduction & movement
  - Transmission
  - Immunity
  - Impacts
- Mosquito management
- A guess at the future
Mosquitoes

- WNV Statewide Surveillance 2003 – present
  - Species composition
  - Seasonal abundance
  - Distribution
  - Monitoring WNV activity

- Primary vector is *Culex tarsalis*


<table>
<thead>
<tr>
<th>Species</th>
<th>+/-tested</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cx. tarsalis</em></td>
<td>134/389</td>
</tr>
<tr>
<td><em>Ae. vexans</em></td>
<td>3/136</td>
</tr>
<tr>
<td><em>Cu. inornata</em></td>
<td>1/57</td>
</tr>
<tr>
<td><em>Cx. pipiens</em></td>
<td>0/53</td>
</tr>
<tr>
<td><em>Aedes spp.</em></td>
<td>0/12</td>
</tr>
<tr>
<td><em>Anopheles spp.</em></td>
<td>0/10</td>
</tr>
<tr>
<td><em>Cx. salinarius</em></td>
<td>0/1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>138/658</strong></td>
</tr>
</tbody>
</table>
Culex tarsalis

- Widely distributed in the Great Plains and western US
- LT catches <20% of total
- Associated with riparian zones, wetlands, irrigated hay/grass production
- Detected in most areas of Montana
- Higher densities east of Continental Divide
**Cx. tarsalis**

- Overwinter as adults

- Oviposits in fresh, standing water with vegetation (sloughs, wetlands, oxbows, irrigated fields)
**Cx. tarsalis** seasonal abundance

![Graph showing seasonal abundance of Cx. tarsalis from June to August.](image)
**Cx. tarsalis**

- Blood meal analyses – Medicine Lake NWR
  
  *Cx. tarsalis*
  
  60/109 avian: 17 species  
  49/109 mammalian: 4 species

  *Ae. vexans*
  
  9/78 avian: 2 species  
  69/78 mammalian: 4 species

  *Cs. inornata*
  
  4/38 avian: 4 species  
  34/38 mammalian: 3 species

Factors that regulate WNV transmission

Complex interaction of biological and environmental factors

• Biological: vector species, vector density, pathogen, susceptible animal host, reservoir and amplifying hosts, etc.

• Environmental: temperature, precipitation, wind, RH, vegetation, landscape, etc.

• Timing and convergence of biological and physical factors is critical for an outbreak to occur.

West Nile Virus

- **1999-2004**
  - Invasive phase
  - Chxt by explosive outbreaks

- **2002**
  - 1st entered plains states

- **2003**
  - Massive epidemic
  - U.S. approximately 10,000 human cases
  - Montana 222 cases, 4 deaths
West Nile Virus

- Equilibrium phase, 2005 – present
- Dampening of infection in birds and mammals
  - Recovery and survival
- Overall human cases declined in U.S.
  - Periodic, focal outbreaks
  - Montana 2007
  - U.S. 2012

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>222</td>
<td>4</td>
</tr>
<tr>
<td>2004</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>34</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>202</td>
<td>4</td>
</tr>
<tr>
<td>2008</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2011</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>
West Nile Virus

• > 300 species of birds killed
• WNV strain NY99 was more virulent to birds than Isr98 strain.
• Mid-west – corvids (crows and jays) became a hallmark of WNV transmission.
• Montana - hallmark species are greater sage-grouse and American white pelican
WNV - Montana

**Medicine Lake NWR**

- **Vector**
  - Extensive habitat for *Cx. tarsalis*

- **Reservoir and amplifying hosts**
  - 125 species of migratory birds
  - Opportunity to introduce virus

- **Susceptible animal hosts**
  - 2,000 pelican chicks, shorebirds, waterfowl, etc.

- **Biological and environmental factors conducive to amplification and transmission**
<table>
<thead>
<tr>
<th>Year</th>
<th>LTI</th>
<th>Pools + # tested</th>
<th>MIR/1,000</th>
<th>Vector Index</th>
<th>Chick Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>108</td>
<td>5/68</td>
<td>1.4</td>
<td>1.1</td>
<td>400</td>
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<tr>
<td>2006</td>
<td>6</td>
<td>2/64</td>
<td>0.6</td>
<td>0.4</td>
<td>385</td>
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<tr>
<td>2007</td>
<td>438</td>
<td>28/87</td>
<td>7.3</td>
<td>3.2</td>
<td>450</td>
</tr>
<tr>
<td>2008</td>
<td>12</td>
<td>1/9</td>
<td>2.2</td>
<td>2.4</td>
<td>&lt;50</td>
</tr>
<tr>
<td>2009</td>
<td>35</td>
<td>5/145</td>
<td>0.7</td>
<td>0.4</td>
<td>113</td>
</tr>
<tr>
<td>2010</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>&lt;50</td>
</tr>
<tr>
<td>2011</td>
<td>181</td>
<td>1/400</td>
<td>0.2</td>
<td>.03</td>
<td>&lt;50</td>
</tr>
<tr>
<td>2012</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>&lt;50</td>
</tr>
<tr>
<td>2013</td>
<td>--</td>
<td>13/54</td>
<td>--</td>
<td>--</td>
<td>250+</td>
</tr>
</tbody>
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WNV Transmission

• *Cx. tarsalis* may trigger the WNV epizootic
• Chick behavior may contribute to explosion
  • Chicks can amplify WNV
  • Bird to bird contact
  • Oral and cloacal swabs indicate viral shedding
• Other ectoparasites
• Pelican lice, other mosquito species, stable flies, soft ticks

WNV Immunity

• Pre- and post-WNV exposure 2006 – 2008
  • Medicine Lake, Chase Lake and Bitter Lake
  • 350 3 wk old chicks 5% + for WNV antibodies
  • 259 post WNV exposure, 39% + for WNV antibodies

• More variability in chick mortality which might suggest immunity is developing

• Significant number of chicks appear to be surviving infection

• Frequent exposure to WNV?
WNV population impacts

- Pelicans initially greatly impacted by WNV

- 2008 – 2012 more variability in chick mortality
  - Is this an increase in resistance or immunity to WNV infection?
  - Or due to other biological or environmental factors?

- Wildlife biologists are making cautious predictions

- Long lived species with low reproductive potential
WNV in Greater Sage-Grouse

WNV cycle

- *Cx. tarsalis* primary vector in sagebrush habitat
  - Bird-to-bird transmission possible
  - Other arthropod species unlikely

- Virus source migratory and resident birds (passerine)

- Amplifying host
  - Species are unclear but may involve sage-grouse

- Ideal weather pattern
  - Wet spring, hot summer, drought conditions
WNV in Greater Sage-Grouse

Mortality
• Confirmed in 10 states and 1 province
• Radio-collared and unmarked birds
• Mortality estimates w/o confirmation skeptical

Immunity
• High mortality rates during WNV outbreaks
• Low levels of immunity to WNV infection in captive and wild birds
• MT/WY
  • 2005, 10% seropositive birds (58)
  • 2006, <2% seropositive (109)
• Resistance to infection projected to increase slowly in the future
WNV in Greater Sage-Grouse

Population impacts

• Significant declines reported in local/regional populations
• Represents a continued risk to sage-grouse populations
• Distribution of *Cx. tarsalis* and WNV is not continuous across the landscape
• Unexposed birds can repopulate local affected areas when overall populations are high
Mosquito Management

• Difficult but not impossible to achieve in rural landscape
• Sites are numerous, may be difficult to find and access
• Insecticides are effective but require monitoring; timing of application is important
• Modifying sites can be effective but may result in producing habitat suitable for other pests or vectors
Future Prediction

- WNV is here to stay
- Represents a continued risk to sage-grouse populations

To facilitate protection:

- Identify areas of Cx. tarsalis production and monitor for WNV transmission
- Monitor bird populations for mortality and survival
- Develop mosquito management programs in sage-grouse areas highly vulnerable to WNV transmission