Vector-borne Diseases in West Virginia

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2017 Mid-Atlantic Mosquito Control Association Meeting
Feb. 1, 2017
Objectives

- Review endemic mosquito-transmitted diseases in West Virginia (La Crosse encephalitis (LAC)).
- Discuss the role of public health in reducing local transmission of mosquito-borne disease.
- Document the progression of tick-borne diseases (Lyme disease) in West Virginia.
## Human cases of mosquito-borne diseases, West Virginia 2007-2016

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>La Crosse encephalitis</td>
<td>11</td>
<td>14</td>
<td>14</td>
<td>8</td>
<td>26</td>
<td>14</td>
<td>11</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Malaria</td>
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<td>2</td>
<td>4</td>
<td>3</td>
<td>7</td>
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<td>West Nile encephalitis</td>
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<td>0</td>
<td>2</td>
<td>9</td>
<td>1</td>
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<td>0</td>
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<tr>
<td>Zika virus disease</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>11</td>
</tr>
<tr>
<td>Dengue fever</td>
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<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Chikungunya</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>St. Louis encephalitis</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

NR = Not Reportable
La Crosse Encephalitis

- LAC is caused by La Crosse virus (LACV).
- LACV is transmitted to humans through the bite of an infected mosquito.
- Most human LAC cases occur in the upper Midwest, Mid-Atlantic states, and southeastern states.
La Crosse Encephalitis (cont.’d)

- Although many people infected with LACV develop no symptoms, severe LACV infection can result in encephalitis.
- Severe disease occurs most often in children under 16 years of age.
LACV is the most commonly encountered California serogroup virus in the genus Orthobunyavirus, family Bunyaviridae.

- Bunyaviruses are single-stranded RNA viruses consisting of three genomic sequences.
- Mosquitoes, biting midges and ticks serve as arthropod vectors and small mammal, ungulates and birds serve as vertebrate reservoirs for members of the genus Orthobunyavirus.
- Other California serogroup viruses in the United States responsible for human disease include California encephalitis virus, Jamestown Canyon virus, and snowshoe hare virus.
Surveillance for LAC in West Virginia occurred following the death of a child with LAC at the Charleston Area Medical Center in 1987.
La Crosse Encephalitis (cont.’d)

- Most people infected with LACV have no apparent illness.
- Initial Symptoms
  - Fever
  - Nausea
  - Vomiting
  - Stiff neck
  - Drowsiness
- Severe Symptoms
  - Confusion
  - Slight mental alteration
  - Seizures
  - Coma
La Crosse Encephalitis (cont.’d)

Clinical Symptoms of LAC Cases Reported in West Virginia 2003-2006

- Headache: 83%
- Fever*: 74%
- Vomiting: 74%
- Photophobia: 51%
- Nausea: 50%
- Weakness: 42%
- Myalgia: 11%
- Arthralgia: 8%

*Temperatures
  - Mean 102.96
  - Median 103
  - Minimum 101
  - Maximum 105

N=86
Clinical Signs of LAC Cases Reported in West Virginia 2003-2006

- Confusion: 29%
- Stiff Neck: 35%
- Seizures: 23%
- Rash: 7%
- Coma: 5%
- Elevated WBC in CSF: 73%
- Elevated CSF protein: 22%

N=86
La Cross Encephalitis (cont.’d)

Age Group of LAC Cases Reported in West Virginia 2003-2006

N=86

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>1</td>
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<tr>
<td>1 to 4</td>
<td>18</td>
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<tr>
<td>5 to 14</td>
<td>56</td>
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<tr>
<td>15 to 24</td>
<td>6</td>
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<td>25 to 34</td>
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<td>35 to 44</td>
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<td>45 to 54</td>
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</tr>
<tr>
<td>55 to 64</td>
<td>0</td>
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<tr>
<td>&gt; 65</td>
<td>0</td>
</tr>
</tbody>
</table>
La Crosse Encephalitis (cont.’d)

Average Yearly Age Specific Incidence**
per 100,000 Population of LAC Cases
Reported in West Virginia, 2003-2006

**United States Census 2000 data used for incidence calculations
(http://www.census.gov/census2000/states/wv.html)

N=86
- LACV has traditionally been associated with forested areas in upper Midwest.
- LAC has recently emerged in the Appalachian region of the United States.

California serogroup virus neuroinvasive cases (mostly La Crosse virus) reported by state, 1964-2010.

La Crosse virus neuroinvasive disease cases reported by state, 2004-2013.

https://www.cdc.gov/lac
La Crosse Encephalitis (cont.’d)

LACV neuroinvasive disease average annual incidence by county, 2004-2013.

https://www.cdc.gov/lac
La Crosse Encephalitis (cont.’d)

Distribution of unsmoothed and smoothed incidence risk of LACV infection incidence risk in children 15 years and younger.

La Crosse Encephalitis (cont.’d)

The unsmoothed and smoothed cumulative incidence of LACV infection at the county and census tract levels in children 15 years and younger.

Spatial clustering of LACV infection risk at the county and census tract levels in children 15 years and younger.

La Crosse Encephalitis (cont.’d)

- Most LAC human cases occur in non-urban settings surrounded by hardwood forest.
Artificial and natural containers conducive to LACV mosquito development are often found near the residence of LAC human cases.
La Crosse Encephalitis (cont.’d)

Environmental Risk Factors For LAC Cases Reported in West Virginia, 2003-2006

- Home in or near wooded area (70): 81%
- Hardwood trees (59): 69%
- Evergreen trees (31): 36%
- Poorly drained gutter (14): 16%
- Plastic covers/tarps (24): 28%
- Tires (28): 33%
- Standing water (pools, puddles, ponds) (36): 42%
- Artificial container with standing water (47): 55%

N=86
La Crosse Encephalitis (cont.’d)

Fig. 4. Percentage of LACV cases with selected environmental risk factors in Mercer County from 2005–2010.

Fig. 4. Percentage of LACV cases with selected environmental risk factors in Nicholas County from 2005–2010.
La Crosse Encephalitis (cont.’d)

Month of Onset of LAC Cases Reported in West Virginia 2003-2006

N=86
La Crosse Encephalitis (cont.’d)

- **Vectors**
  - *Aedes triseriatus*: Eastern treehole mosquito
  - *Aedes albopictus*: Asian tiger mosquito
  - *Aedes japonicus*: Asian bush mosquito

- All three of these species are container breeders (ex. treeholes, concrete basins, tires, buckets, children wading pools)
La Crosse Encephalitis (cont.’d)

- All LACV competent vectors are widely distributed throughout West Virginia.
- LACV has been detected in *Ae. triseriatus*, *Ae. albopictus*, and *Ae. japonicus* from West Virginia.
La Crosse Encephalitis (cont.’d)

- Sciurid rodents, especially chipmunks and squirrels, serve as vertebrate hosts.
- Transmitted from mother to offspring in eastern treehole mosquito.
- Venereal transmission from male mosquitoes to female mosquitoes.
Local health departments (LHDs) are involved with reducing incidence of LAC and other mosquito-borne diseases.
Mosquito Control Partners (cont.’d)

- Training LHDs about mosquito species identification, mosquito biology, and environmental assessment around case sites.
- Future pesticide certification training events are being planned with the West Virginia Department of Agriculture.
Recommendations Made By LHDs to LAC Cases Reported in West Virginia, 2003-2006

- No recommendations: 17%
- Fill ditches: 30%
- Use mosquito dunks: 33%
- Maintain swimming pools: 35%
- Clean gutters: 51%
- Drill holes in tires and containers: 55%
- Drain birdbaths and pots: 56%
- Remove tires and containers: 72%
- Long sleeves and long pants: 79%
- Use repellant: 81%

N = 86
Completeness of Environmental Investigations of LAC Cases Reported in West Virginia, 2003-2006

92% completeness for environmental investigations for West Virginia

County of Case


N=86
Mosquito Control Partners (cont.’d)

- West Virginia Department of Environmental Protection Rehabilitation Environmental Action Plan (REAP) Tire Collection Events
- Community Cleanup Activities
West Virginia Department of Environmental Protection REAP ‘Pollution, Prevention, and Open Dump Program’ works to reduce open dump sites in West Virginia.
Mosquito Control Partners (cont.’d)

http://www.dep.wv.gov/dlr/oer/reap/ppod/Pages/ppod.html
• Litter Control Officers have authority to control mosquito breeding sites on private and public land.

• West Virginia Division of Natural Resources has authority to investigate mosquito breeding sites in containers on private property.
According to West Virginia code 16-3-6 (‘Nuisances affecting public health’), a public health officer “shall inquire into and investigate all nuisances affecting the public health within his jurisdiction” and is permitted (with judicial approval) to “restrain, prevent or abate the nuisance.”
THE IMPORTANCE OF ENVIRONMENTAL ASSESSMENTS

Environmental assessments are often used by public health to reduce the spread of mosquito-borne diseases. The information collected during an assessment can be used to guide public health action. An important reason for conducting environmental assessment is to prevent outbreaks or clusters of mosquito-borne diseases. For example, Aedes albopictus mosquitoes are not only able to transmit many different diseases (like La Crosse encephalitis and Zika), but they are also aggressive biters, meaning that if they are infected, they can spread disease to many people in a short amount of time. Mosquitoes do travel not long distances and remain within the same area throughout their entire lives.

Environmental assessment(s) should be conducted at the location(s) (e.g. home, day care, etc.) of suspected and confirmed mosquito-borne cases. Environmental Assessments may be impacted by capacity, cooperation of the case, and time of year.

Capacity: a member of the public health workforce (e.g. county sanitarian, district sanitarians, state entomologist) should have the ability to visit the case’s home. This is based on workload, training, and other factors (e.g. safety).

Willingness of the case: public health is given authority by the case or head of the household to conduct an environmental assessment.

Time of year: environmental assessment should be done during active mosquito biting season (May to September).

INSTRUCTIONS FOR CONDUCTING AN ENVIRONMENTAL ASSESSMENT

1. Obtain contact information about the (suspected) case from WVEDSS or from Regional Epidemiologist/Public Health Nurse. It is important to ensure that the case has been informed of their case status by public health prior to the assessment.
2. Make sufficient at least (three) attempts to contact the patient. Try to call at different times of the day.
3. Once the case has agreed to allow at assessment at its home, set up a date (preferably within 3 days of the call) to assess the area around the home. The “Case Information” and “Case Clinical and Exposure History” sections of the Environmental Assessment Form may be collected during the telephone interview/appointment (in the event an assessment is done when the case is not present) or this information may be collected during the assessment.
   a. If the case does not agree to an assessment, still attempt to share mosquito-borne disease prevention literature with the case. Giving a physical copy of literature is preferred (e.g. drop off the literature in the case’s mailbox or mail it). If the case has been symptomatic within the past two weeks, remind them to practice mosquito bite prevention strategies (e.g. wearing mosquito repellent, wearing long sleeves and pants when outdoors, using air conditioning vs. keeping windows open).
      i. Inform Miguella Mark-Carew, Zoonotic Disease Epidemiologist by email (miguella.p.mark-carew@wv.gov) that an attempt was made to conduct the assessment.
4. Complete the “Assessment of Outdoor Environment” on the Environmental Assessment Form.
5. Once an on-site assessment is completed, share the “Environmental Assessment Actions and Recommendations” page with the case or homeowner. This should preferably be done in person, but can also be mailed to the case or homeowner.
6. Fax Assessment Form to Miguella Mark-Carew in the Division of Infectious Disease Epidemiology at (304) 558-8736.
Environmental Assessment Form

Name of Assessor: ________________________________  Assessment Date:  /  /  

CASE INFORMATION

Last name  First name  Middle Name  Date of Birth

Home Street Address  City  Zip Code  County

(Coordinates should be in decimal degrees)  Latitude ____________________________  Longitude ____________________________

Arboviral Disease of Concern: [ ] La Crosse Encephalitis  [ ] West Nile Virus  [ ] Zika Virus  [ ] Other: ____________________________

ASSessment of OUTDOOR ENVIRONMENT

[ ] Owner present during assessment?  [ ] Yes  [ ] No

[ ] Containers holding water visible on property (If checked, indicate types of containers)
[ ] Tires  [ ] Pool (type) ____________________________  [ ] Animal watering containers  [ ] Flower pots  [ ] Containers without lids
[ ] Other: ______________________________________

[ ] Leaf litter and organic debris in yard
[ ] Assessor noticed larvae in containers on property
[ ] Screens on doors and windows in disrepair/missing

[ ] House gutters with visible debris
[ ] Other: ______________________________________

CASE CLINICAL AND EXPOSURE HISTORY

Has the case been symptomatic within the past two weeks?  [ ] Yes  [ ] No

If yes, indicate symptom onset date: ____________________________

Types of symptoms:  [ ] Fever  [ ] Rash  [ ] Joint pain  [ ] Conjunctivitis  [ ] Headache  [ ] Muscle aches  [ ] Encephalitis
[ ] Other: ______________________________________

Has the case traveled outside of West Virginia in the past two weeks?  [ ] Yes  [ ] No

If yes, indicate place of travel and travel dates.

City ____________________________  State ____________________________  Country ____________________________  Arrival Date:  /  /  20    Departure Date:  /  /  20

ACtIONS OF PUBLIC HEALTH OFFICIAL

[ ] Mosquito traps were set on property
[ ] Drained water holding containers
[ ] Conducted treatment for mosquito larvae
[ ] Recommended that case remain confined indoors/covered up (for symptomatic cases)
[ ] Shared mosquito bite prevention literature
[ ] Disposed of litter/organic debris around home
[ ] Showed owner larval/pupa mosquito stages

[ ] Other: ______________________________________
ENVIRONMENTAL ASSESSMENT ACTIONS AND RECOMMENDATIONS

Dear Property Owner/Occupant:

Thank you for allowing [enter health department here] to conduct an environmental assessment at your home. Environmental assessments are often used by public health officials to help reduce the spread of mosquito-borne diseases. The information collected during an assessment can be used to identify mosquito breeding sites and provide education about preventing mosquito-borne disease.

The following are recommendations or actions by public health officials during an environmental assessment of your home.

☐ Mosquito traps were set on property
☐ Shared disease specific literature
☐ Showed owner larval/pupae mosquito stages
☐ Conducted larvaciding
☐ Recommended that case remain confined indoors/covered up for at least seven days
☐ Other: ____________________________

If mosquito traps were set on your property, public health entomologist will be available to identify the different species of mosquitoes that are living near your home and test them for endemic disease (e.g. West Nile and La Crosse encephalitis).

It is recommended that cases prevent mosquito bites by wearing mosquito repellent, staying indoors and covering up as much as possible (i.e. wearing long sleeves and pants, sleeping under bed nets) because human cases of mosquito-borne disease can spread infections to mosquitoes (usually during the first week of infection).

Please take time to read the mosquito-borne disease prevention literature that was provided to you. The [enter health department here] sincerely appreciates your cooperation in making public health work for you. If you have additional questions or concerns feel free to contact us at [enter health department number here].
### Tick-borne Diseases by Causative Organism(s) and Presence of Tick Vectors in West Virginia

<table>
<thead>
<tr>
<th>Tick-borne Disease</th>
<th>Pathogen(s)</th>
<th>Tick Vector(s) Present in WV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tularemia</td>
<td><em>Franciscella tularensis</em></td>
<td>American dog tick (<em>Dermacentor variabilis</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td>Anaplasmosis</td>
<td><em>Anaplasma phagocytophilum</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Ehrlichiosis</td>
<td><em>Ehrlichia chaffeensis</em></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Ehrlichia ewingii</em></td>
<td>Gulf Coast tick (<em>Amblyomma maculatum</em>)</td>
</tr>
<tr>
<td></td>
<td>Panola Mountain <em>Ehrlichia</em> sp.</td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Ehrlichia muris</em>-like agent</td>
<td></td>
</tr>
<tr>
<td>Lyme disease</td>
<td><em>Borrelia burgdorferi</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Borrelia mayonii</em></td>
<td></td>
</tr>
<tr>
<td>Relapsing fever*</td>
<td><em>Borrelia miyamotoi</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Powassan encephalitis*</td>
<td>Powassan virus</td>
<td>Groundhog tick (<em>Ixodes cookei</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Babesiosis*</td>
<td><em>Babesia microti</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Rocky Mountain spotted fever and other</td>
<td><em>Rickettsia rickettsii</em></td>
<td>American dog tick (<em>Dermacentor variabilis</em>)</td>
</tr>
<tr>
<td>fever rickettsioses</td>
<td>(and other spotted fever group <em>Rickettsia</em>)</td>
<td>Brown dog tick (<em>Rhipicephalus sanguineus</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
</tbody>
</table>

*This tick-borne disease has not been reported in West Virginia.*
### Summary of four tick-borne diseases reported in West Virginia 2000-2010

<table>
<thead>
<tr>
<th>Disease Name</th>
<th>Total Reported</th>
<th>Annual Range</th>
<th>Annual Mean</th>
<th>Annual Median</th>
<th>Standard Deviation</th>
<th>Cumulative Incidence per 100,000</th>
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<tbody>
<tr>
<td>Tularemia</td>
<td>2</td>
<td>0-1</td>
<td>0.2</td>
<td>0</td>
<td>0.4</td>
<td>0.01</td>
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<tr>
<td>Ehrlichiosis</td>
<td>8</td>
<td>0-3</td>
<td>0.7</td>
<td>0</td>
<td>1.1</td>
<td>0.04</td>
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<tr>
<td>Rocky Mountain spotted fever</td>
<td>49</td>
<td>0-10</td>
<td>4.5</td>
<td>4</td>
<td>3.2</td>
<td>0.25</td>
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<tr>
<td>Lyme disease</td>
<td>772</td>
<td>17-201</td>
<td>70.2</td>
<td>39</td>
<td>58.1</td>
<td>3.88</td>
</tr>
</tbody>
</table>
Confirmed and probable Lyme disease cases reported by county—
West Virginia, 2000-2015

- Green circle: County with no reported cases of Lyme disease
- Yellow circle: County with 1-10 reported cases of Lyme disease
- Orange circle: County with 11-100 reported cases of Lyme disease
- Red circle: County with >100 reported cases of Lyme disease
Tick-borne Disease (cont.’d)

Confirmed and probable Lyme disease cases reported by county—West Virginia, 2016 (n=354)

Table includes only confirmed or probable cases that have been reviewed and closed by Zoonotic Disease Epidemiologist.

<table>
<thead>
<tr>
<th>Tickborne Diseasea</th>
<th># Confirmed or Probable Cases (2016) (as of January 9, 2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ehrlichiosis</td>
<td>6</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>354</td>
</tr>
<tr>
<td>Spotted fever group rickettiosesb</td>
<td>14</td>
</tr>
<tr>
<td>Q fever</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>375</td>
</tr>
</tbody>
</table>

aTable includes only confirmed or probable cases that have been reviewed and closed by Zoonotic Disease Epidemiologist.
bIncludes Rocky Mountain spotted fever
Reported Cases of Lyme Disease by Year - West Virginia, 2000-2016*

*Updated as of January 9, 2017
In collaboration with the National Park Service and the United States Army Institute of Public Health Command, the West Virginia Department of Health & Human Resources began an active tick surveillance program for *Ixodes scapularis* at Harper’s Ferry National Historic Park (Jefferson County) and New River Gorge National Park (Fayette, Raleigh, and Summers counties) from September 14, 2011 through May 25, 2012.

- Regular, weekly tick drags in Kanawha County starting in May 6, 2014.
- Sporadic tick drags to search for *Ixodes scapularis* populations infected with *Borrelia burgdorferi*. 
Since 2013, West Virginia veterinarians who participated in the West Virginia Veterinary Tick Submission Project (WVVTP) sent ticks collected from animals seen at their practices to the state public health entomologist.

A new interactive map shows the tick species collected from WVVTP participating veterinary clinics.

## Summary of veterinary tick submissions for the current reporting period in West Virginia.

1. **Dermacentor variabilis**
   - # of ticks submitted and identified (2013): 470
   - # of ticks submitted and identified (2014): 998
   - # of ticks submitted and identified (2015): 677
   - # of ticks submitted and identified (2016): 723

2. **Amblyomma americanum**
   - # of ticks submitted and identified (2013): 5
   - # of ticks submitted and identified (2014): 16
   - # of ticks submitted and identified (2015): 85
   - # of ticks submitted and identified (2016): 109

3. **Ixodes scapularis**
   - # of ticks submitted and identified (2013): 121
   - # of ticks submitted and identified (2014): 179
   - # of ticks submitted and identified (2015): 410
   - # of ticks submitted and identified (2016): 171

4. **Ixodes cookei**
   - # of ticks submitted and identified (2013): 7
   - # of ticks submitted and identified (2014): 18
   - # of ticks submitted and identified (2015): 86
   - # of ticks submitted and identified (2016): 27

5. **Haemaphysalis leporispalustris**
   - # of ticks submitted and identified (2013): 1
   - # of ticks submitted and identified (2014): 8
   - # of ticks submitted and identified (2015): 0
   - # of ticks submitted and identified (2016): 3

6. **Amblyomma maculatum**
   - # of ticks submitted and identified (2013): 0
   - # of ticks submitted and identified (2014): 1
   - # of ticks submitted and identified (2015): 0
   - # of ticks submitted and identified (2016): 1

7. **Rhipicephalus sanguineus**
   - # of ticks submitted and identified (2013): 0
   - # of ticks submitted and identified (2014): 0
   - # of ticks submitted and identified (2015): 4
   - # of ticks submitted and identified (2016): 119

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1. Vector of tularemia and Rocky Mountain spotted fever
2. Vector of ehrlichiosis, tularemia, STARI, and spotted fever rickettsioses
3. Vector of Lyme disease, anaplasmosis, babesiosis, and Powassan encephalitis
4. Vector of Powassan encephalitis
5. Vector of tularemia in rabbits
6. Vector of spotted fever rickettsioses
West Virginia Division of Natural Resources biologists examined 30 white-tailed deer at each of the 20 official game checking stations.

- Biologists collected representative sample of all external parasites.
- Human pathogen testing conducted by Cornell University’s Animal Health Diagnostic Laboratory.
Deer Ectoparasite Study (cont.’d)
- **282** *Ixodes scapularis* from white-tailed deer in 2013
- **120** *Ixodes scapularis* from white-tailed deer in 2014
Tick Species Distribution in West Virginia

- A new interactive map function shows the county-scale distribution of tick species from West Virginia.

Reported Cases of Lyme Disease -- United States, 2001

1 dot placed randomly within county of residence for each reported case

https://www.cdc.gov/lyme/stats/maps.html
Lyme disease vector distribution 1907-1998

- *Ixodes scapularis* reported (blue) or established (red) in county
- *Ixodes pacificus* reported (yellow) or established (green) in county

Lyme Disease Geographic Distribution

Reported Cases of Lyme Disease -- United States, 2015

1 dot placed randomly within county of residence for each confirmed case

https://www.cdc.gov/lyme/stats/maps.html
Ixodes scapularis reported (blue) or established (red) in county
Ixodes pacificus reported (yellow) or established (green) in county

Update to Eisen et al. (2016) to include data collected from August 25 through December 30, 2015.

Summary

- LAC is the major mosquito-borne disease in West Virginia.
- Human incidence of LAC can be reduced through personal mosquito bite prevention and environmental management.
- Lyme disease is the most prevalent tick-transmitted disease in West Virginia.
- Human cases of Lyme disease have been recently increasing.
- West Virginia has recently been designated a ‘high’ incidence state for Lyme disease.
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