Vector-borne Diseases in West Virginia

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

WEST VIRGINIA Department of Health & Human Resources
BUREAU FOR PUBLIC HEALTH

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.

Mosquito-borne Disease

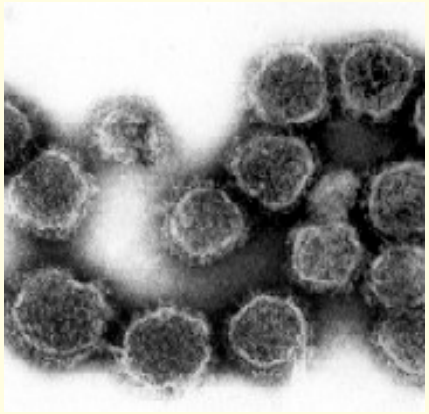
Human cases of mosquito-borne diseases, West Virginia 2007-2016

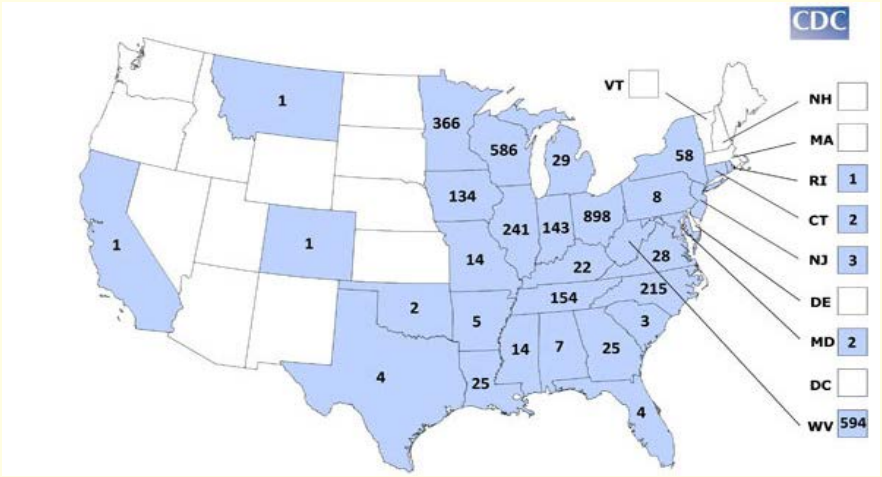
Disease	No. of human cases (2007)	No. of human cases (2008)	No. of human cases (2009)	No. of human cases (2010)	No. of human cases (2011)	No. of human cases (2012)	No. of human cases (2013)	No. of human cases (2014)	No. of human cases (2015)	No. of human cases (2016)
La Crosse encephalitis	11	14	14	8	26	14	11	2	4	8
Malaria	1	2	4	3	7	2	2	2	2	1
West Nile encephalitis	0	1	0	0	2	9	1	0	0	1
Zika virus disease	NR	NR	NR	NR	NR	NR	NR	NR	NR	11
Dengue fever	1	1	0	2	0	0	2	1	1	0
Chikungunya	NR	NR	NR	NR	NR	NR	NR	2	0	0
Eastern equine encephalitis	0	0	0	0	0	0	0	0	0	0
St. Louis encephalitis	0	0	0	0	0	0	0	0	0	0

NR = Not Reportable

La Crosse Encephalitis

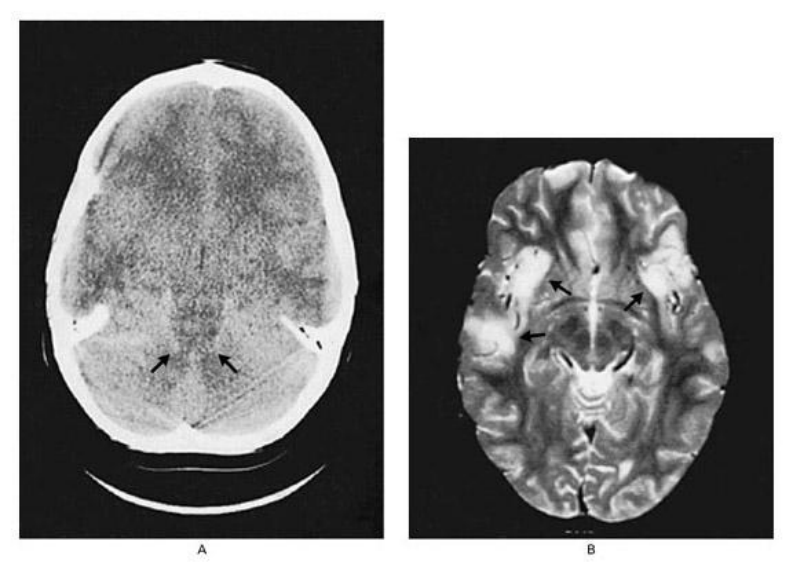
- LAC is caused by La Crosse virus (LACV).
- LACV is transmitted to humans through the bite of an infected mosquito.
- Most human LAC cases occur in the upper Midwest, Mid-Atlantic states, and southeastern states.

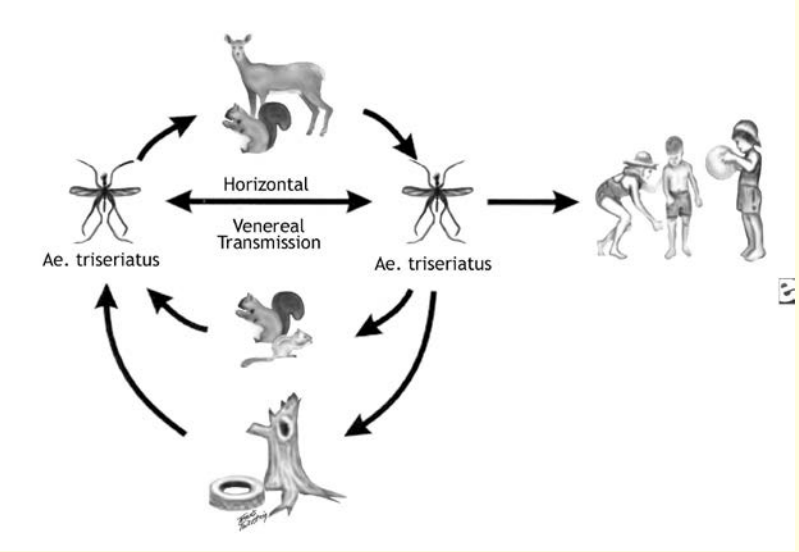




La Crosse Encephalitis (cont.'d)

- 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.



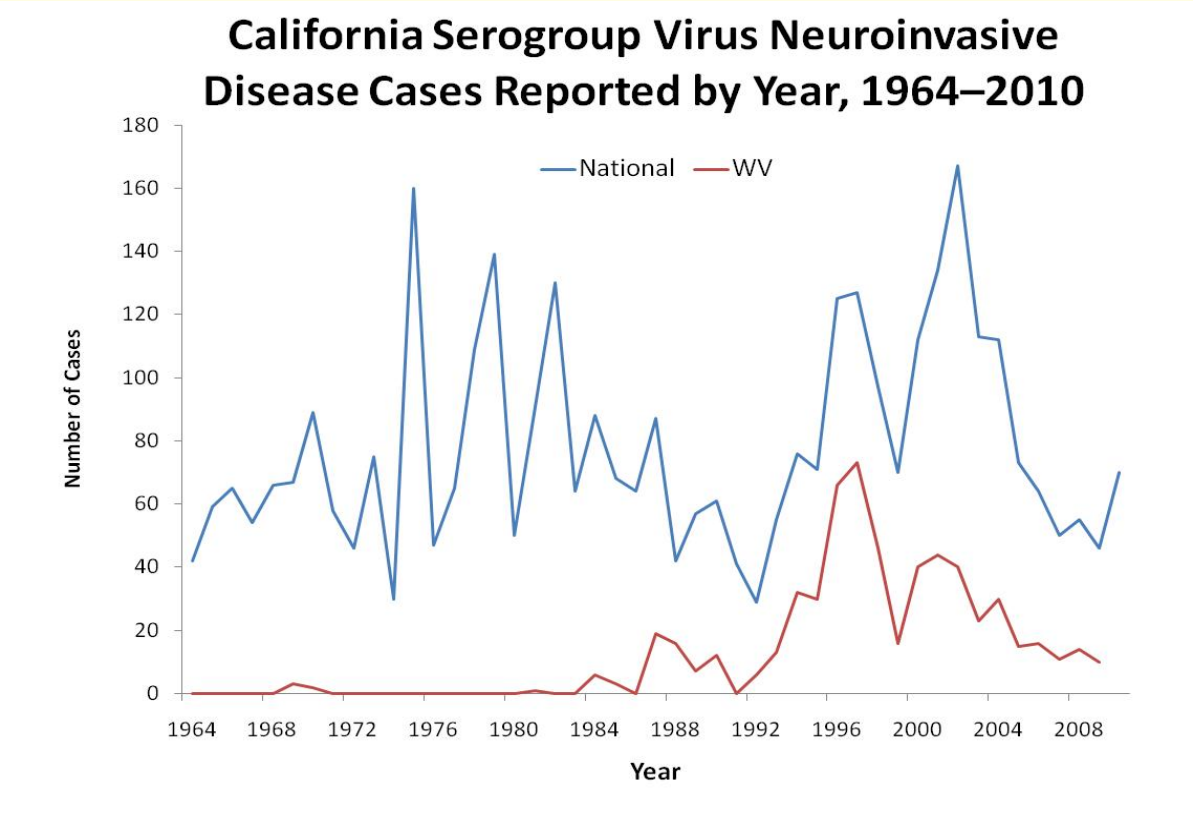


La Crosse Encephalitis (cont.'d)

- 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.

La Crosse Encephalitis (cont.'d)

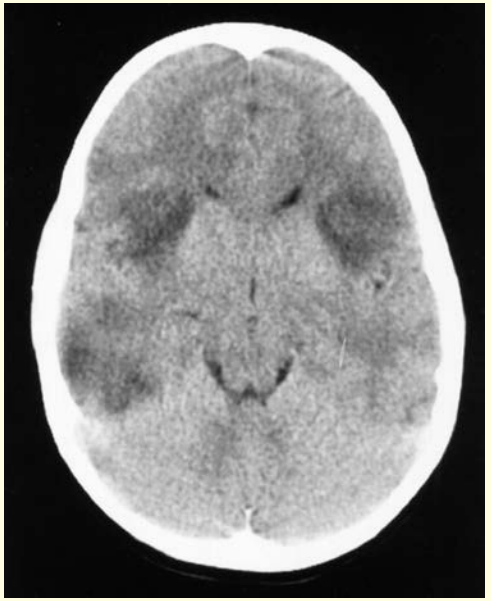
- **Surveillance for LAC in West Virginia occurred following the death of a child with LAC at the Charleston Area Medical Center in 1987.**

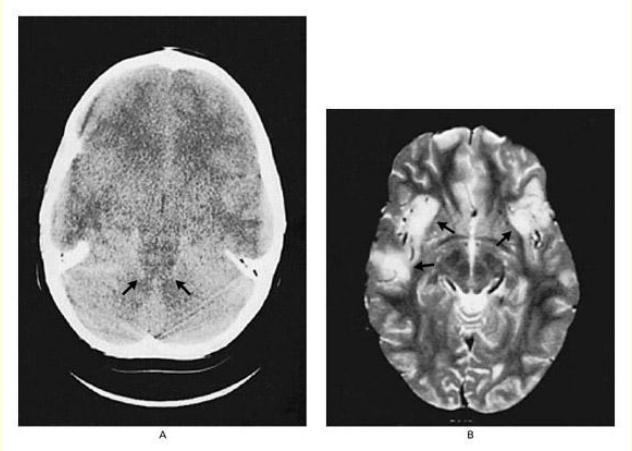


https://www.cdc.gov/lac

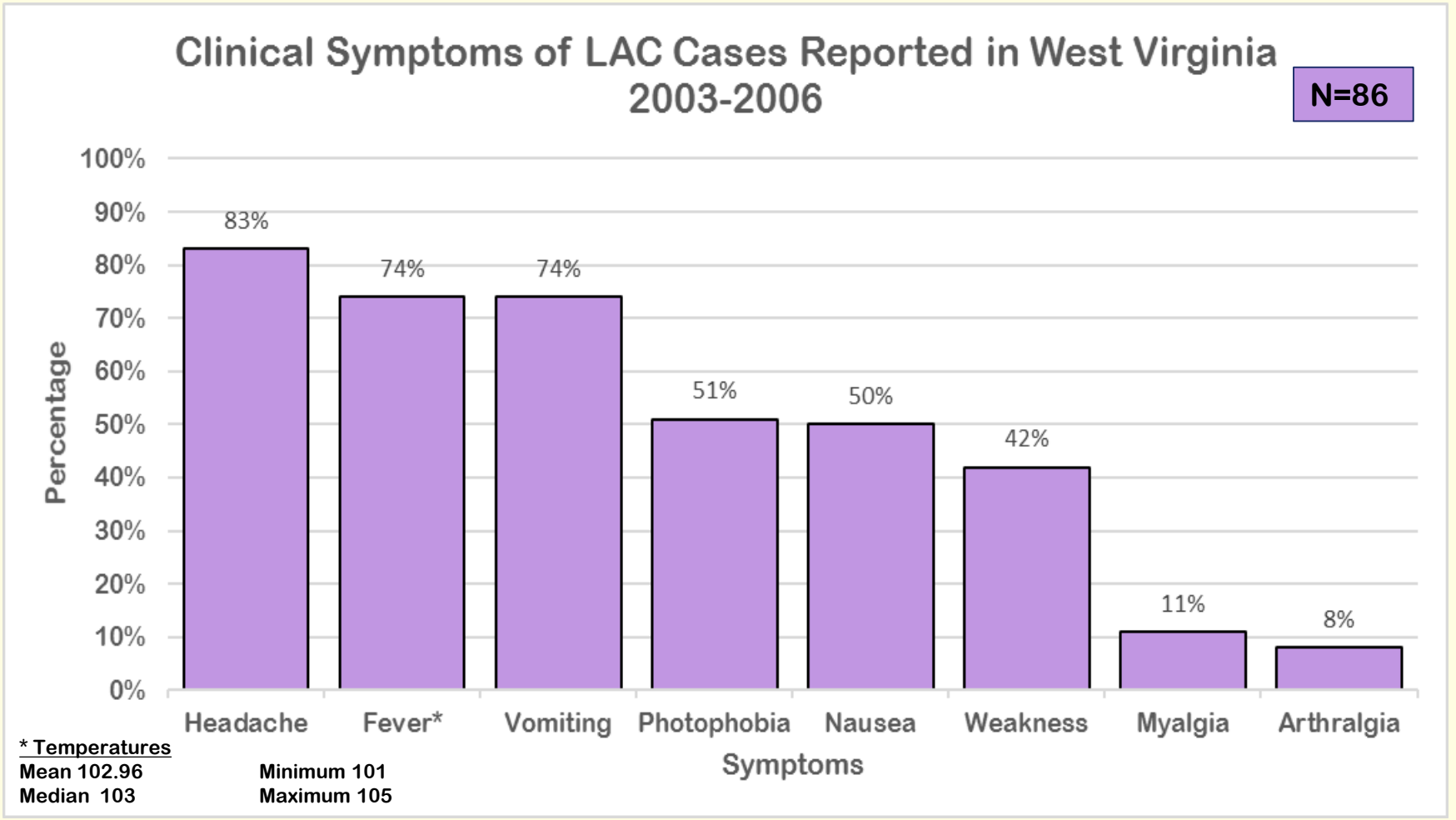
La Crosse Encephalitis (cont.'d)

- 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

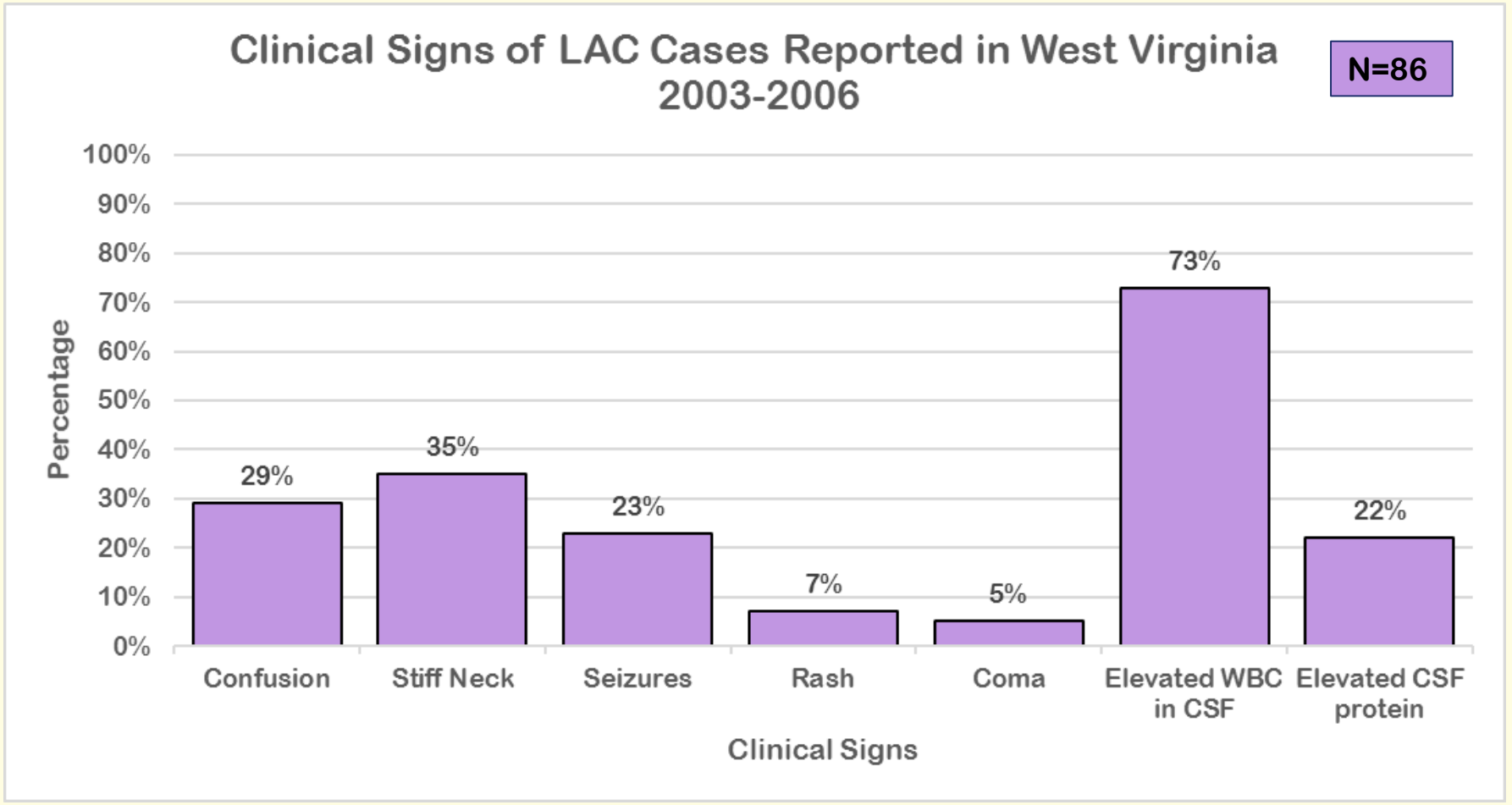




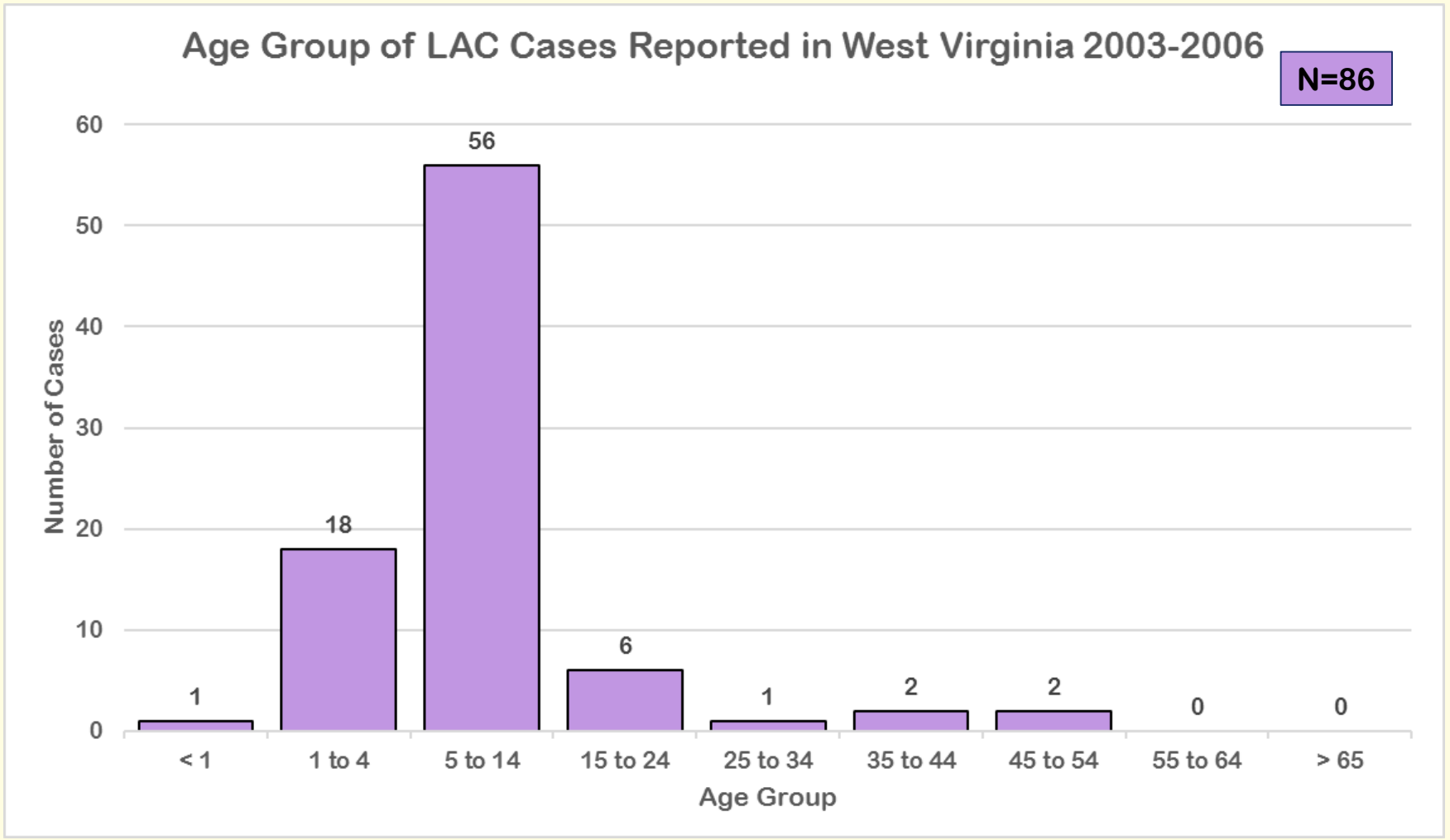
La Crosse Encephalitis (cont.'d)



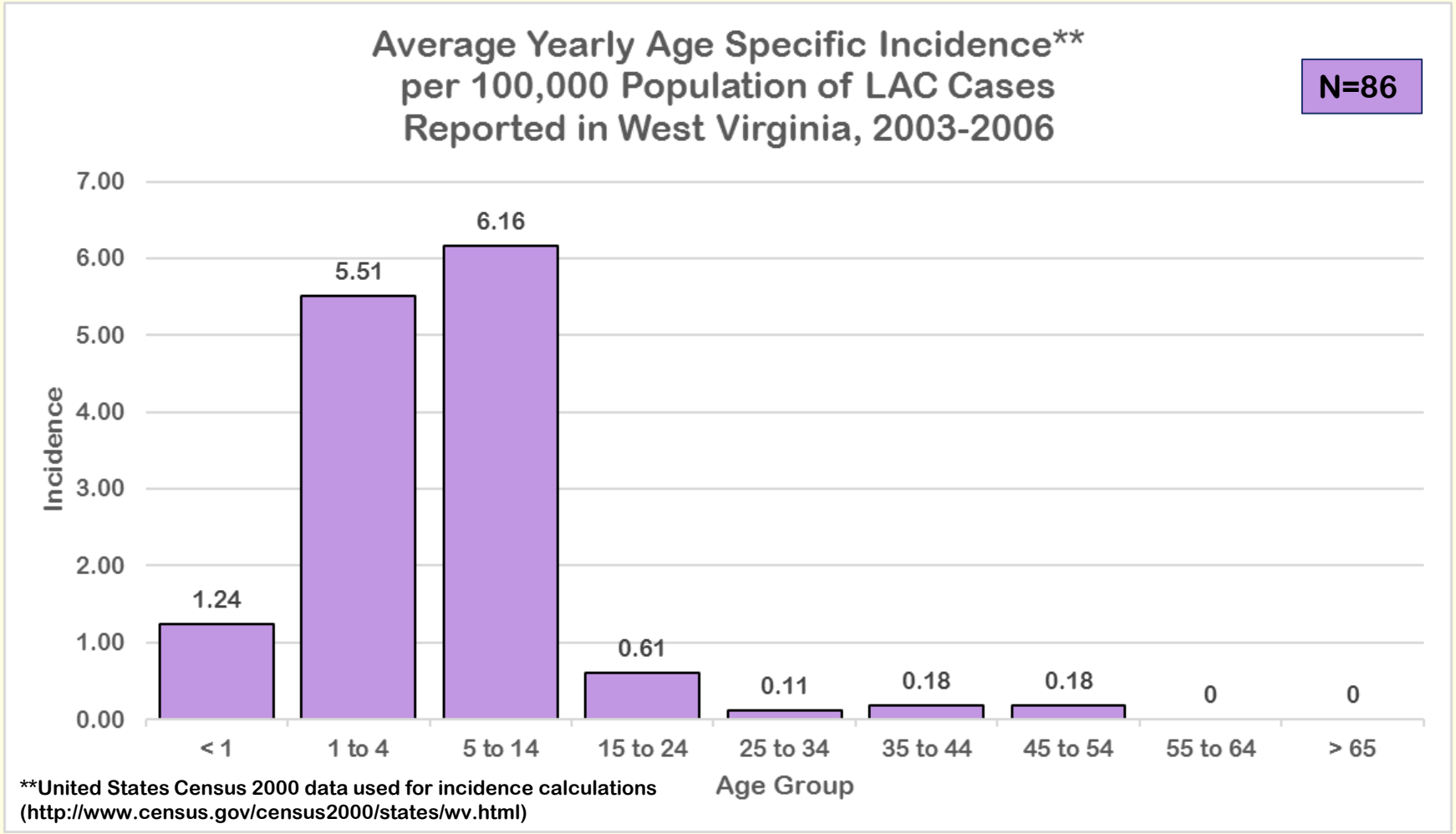
La Crosse Encephalitis (cont.'d)



La Cross Encephalitis (cont.'d)



La Crosse Encephalitis (cont.'d)



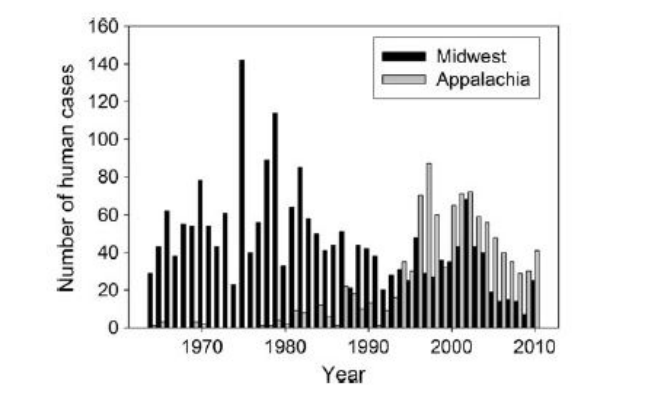
**United States Census 2000 data used for incidence calculations (http://www.census.gov/census2000/states/wv.html)

La Crosse Encephalitis (cont.'d)

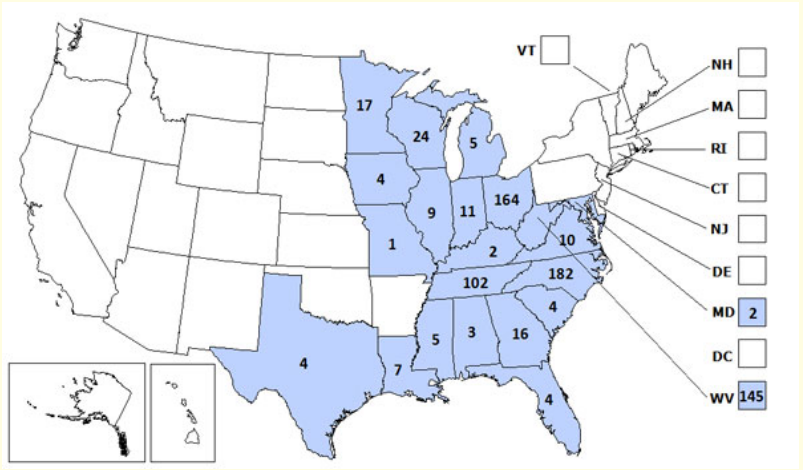
- LACV has traditionally been associated with forested areas in upper Midwest.
- LAC has recently emerged in the Appalachian region of the United States.

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

California serogroup virus cases from Midwestern (Ohio, Wisconsin, Minnesota, Illinois) and Appalachian (West Virginia, North Carolina, Tennessee) states in the United States, 1964-2010.



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



https://www.cdc.gov/lac

La Crosse Encephalitis (cont.'d)

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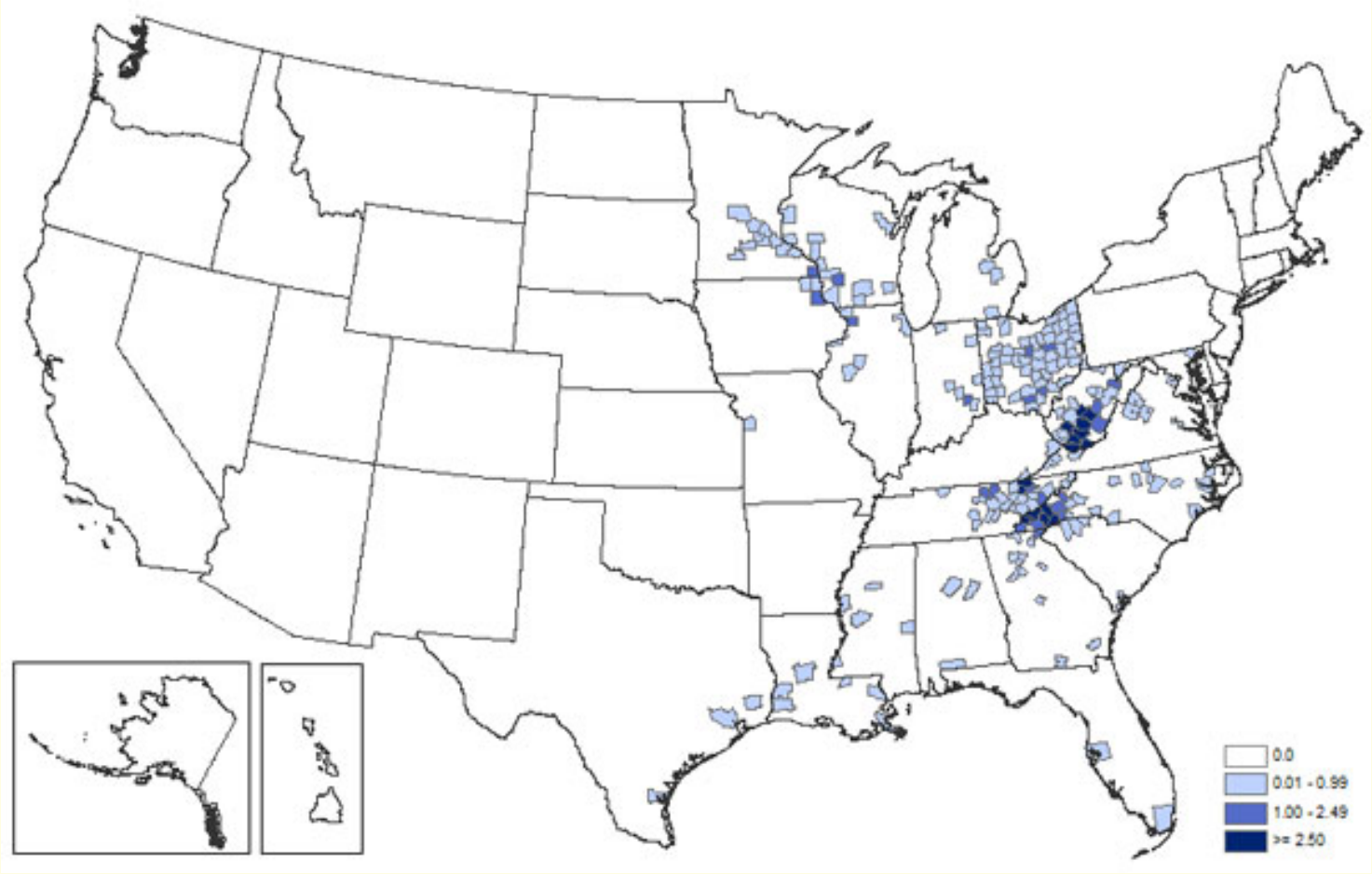
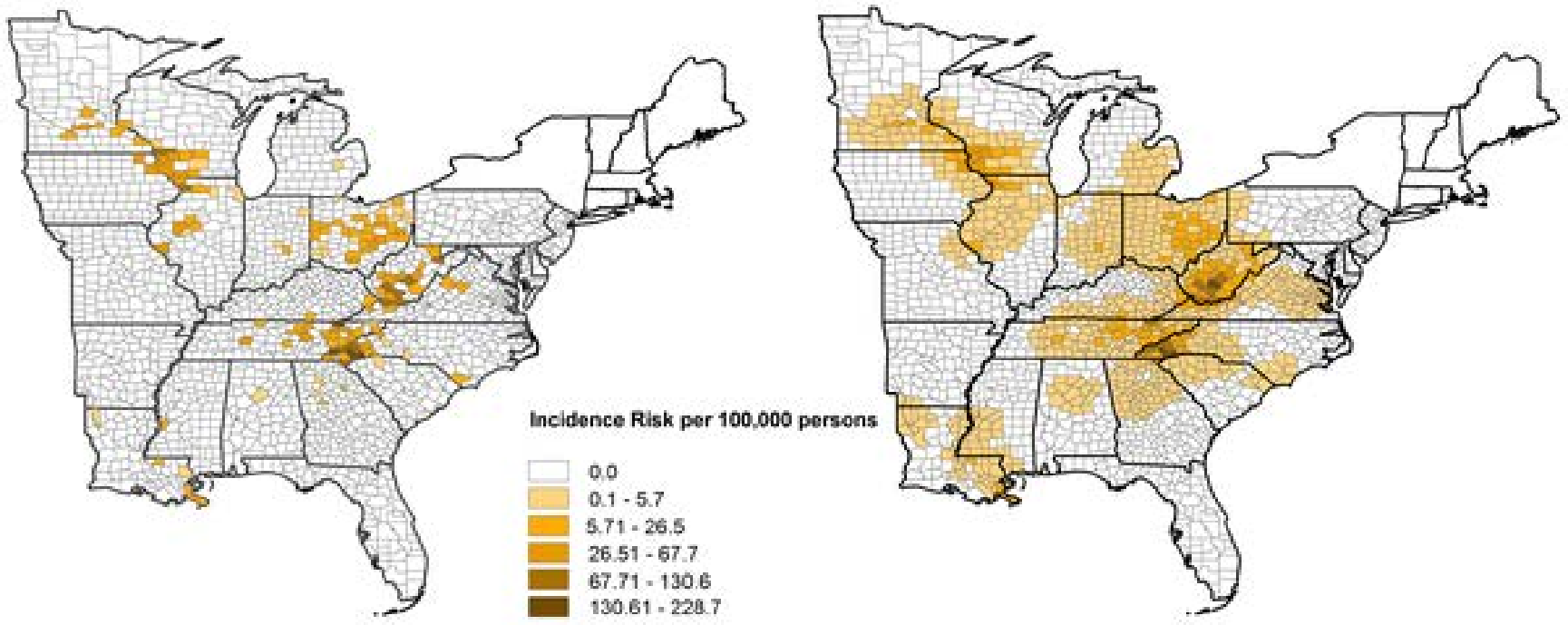
LACV neuroinvasive disease average annual incidence by county, 2004-2013.



https://www.cdc.gov/lac

La Crosse Encephalitis (cont.'d)

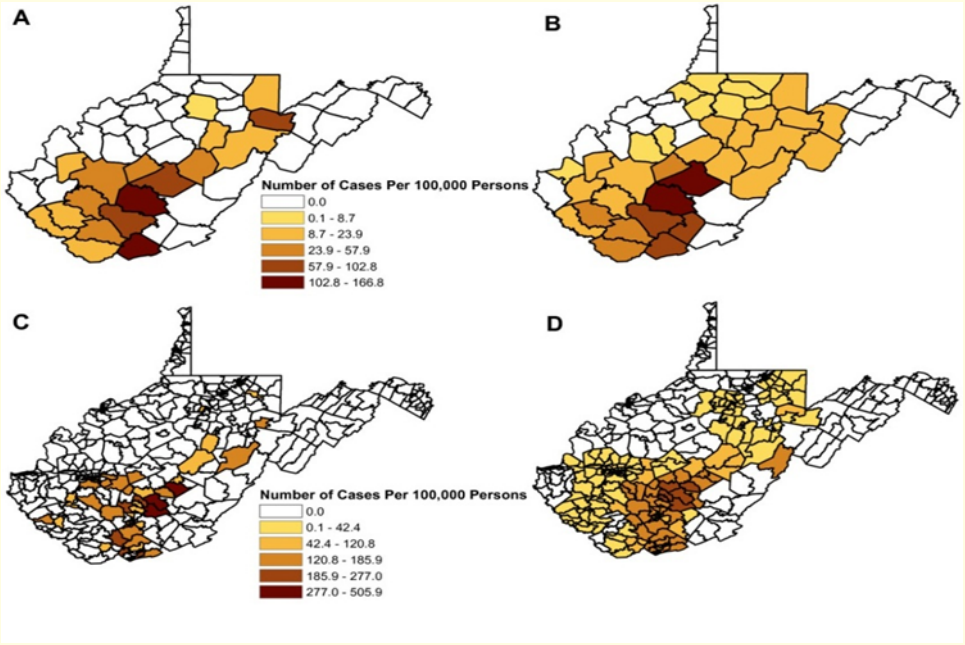
Distribution of unsmoothed and smoothed incidence risk of LACV infection incidence risk in children 15 years and younger.



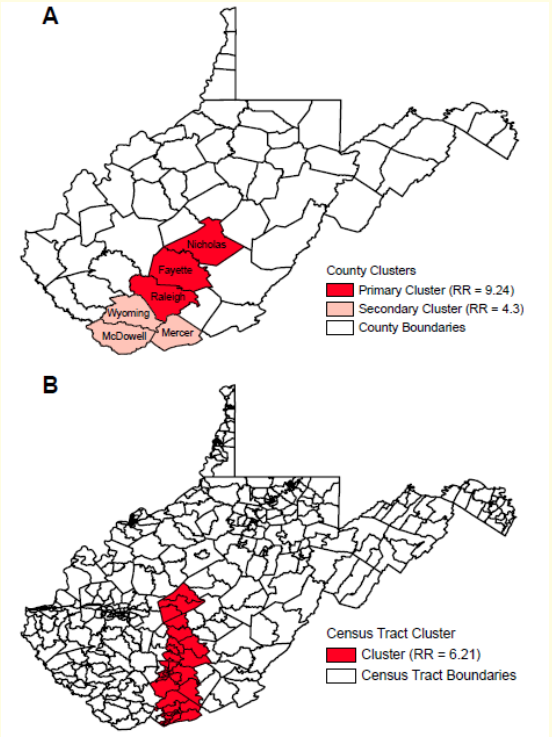
Haddow, A. D. & A. Odoi. 2009. The incidence risk, clustering, and clinical presentation of La Crosse virus infections in the eastern United States, 2003-2007. *PLoS ONE* **4** (**7**): e6145. doi: 10.1371/journal.pone.0006145.

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.



Haddow, A. D., D. Bixler & A. Odoi. 2011. The spatial epidemiology and clinical features of reported cases of La Crosse Virus infection in West Virginia from 2003 to 2007. *BioMed Central Infectious Diseases* **11**: 29.

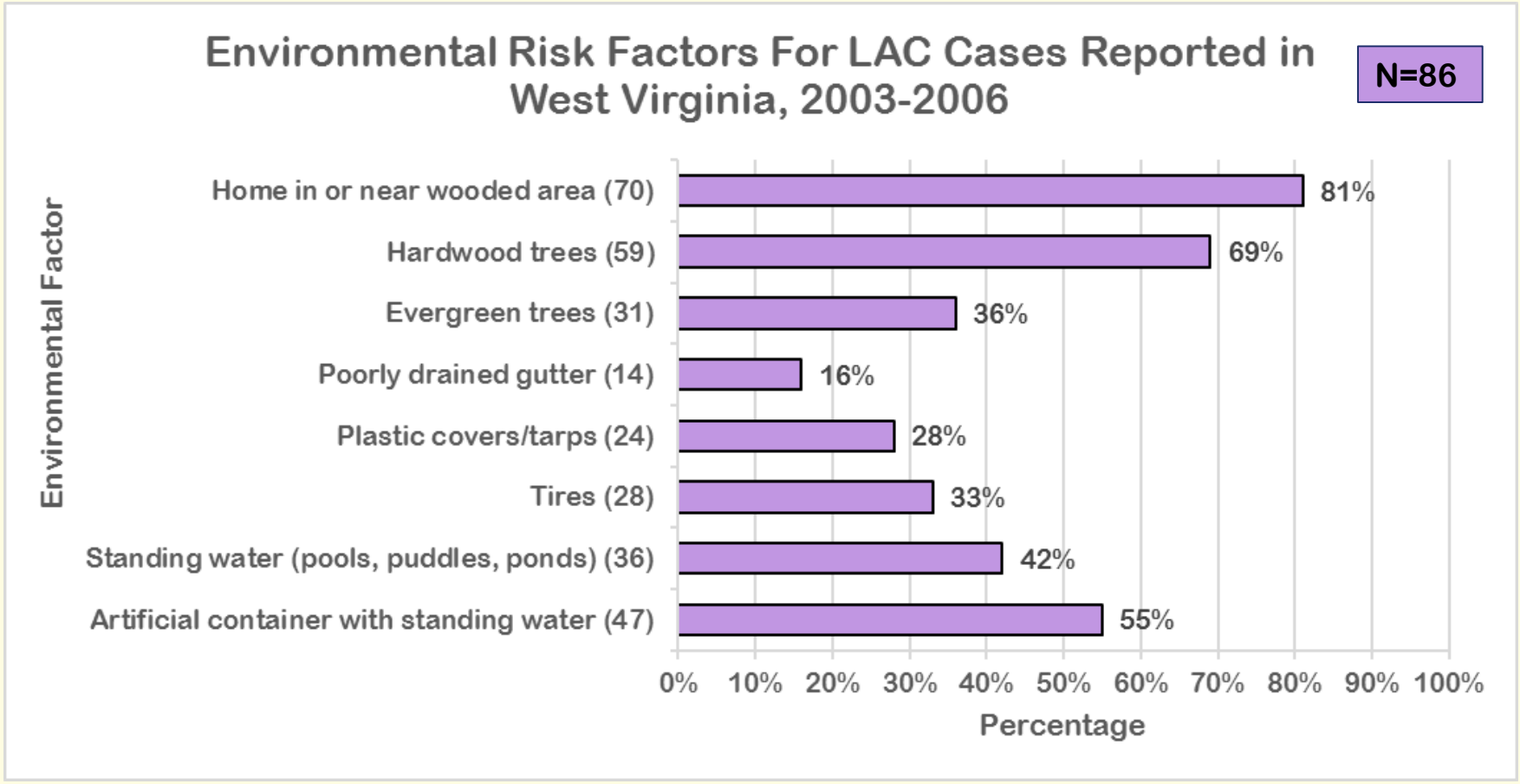
La Crosse Encephalitis (cont.'d)

- **Most LAC human cases occur in non-urban settings surrounded by hardwood forest.**

La Crosse Encephalitis (cont.'d)

- **Artificial and natural containers conducive to LACV mosquito development are often found near the residence of LAC human cases.**

La Crosse Encephalitis (cont.'d)



La Crosse Encephalitis (cont.'d)

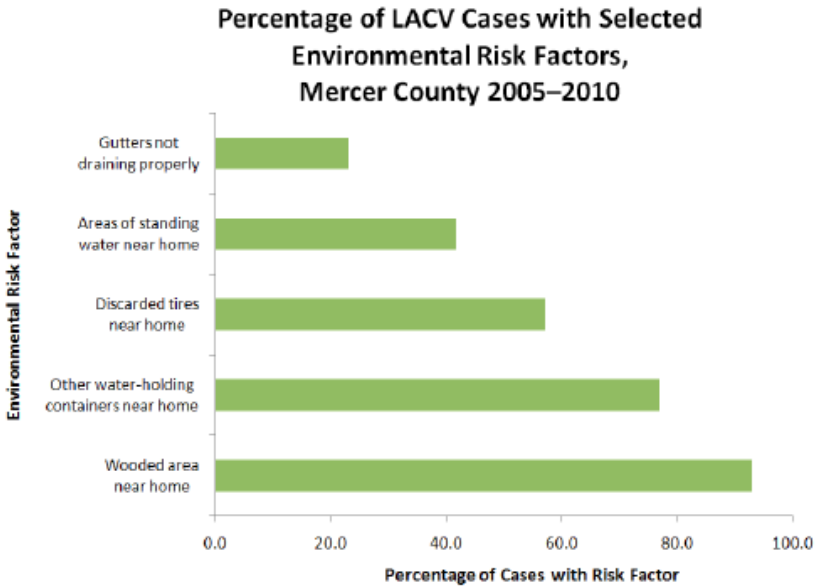


Fig 4. Percentage of LACV cases with selected environmental risk factors in Mercer County from 2005–2010.

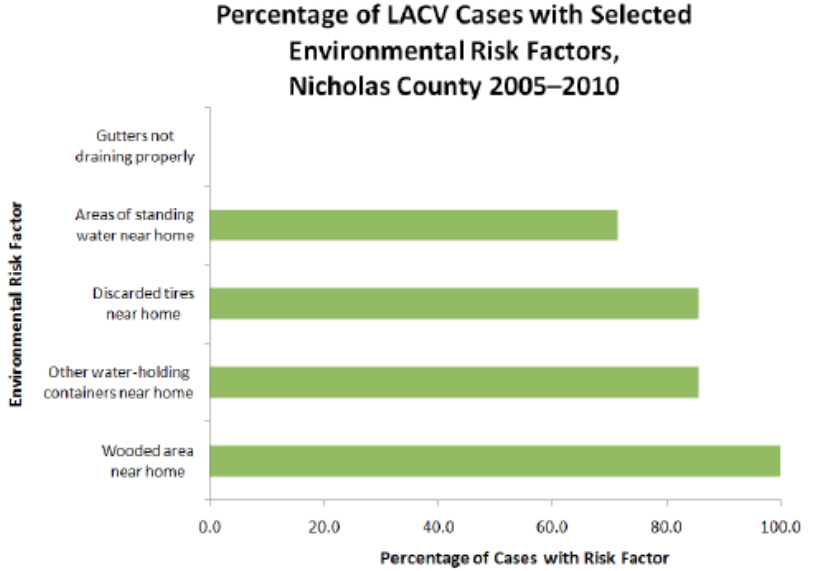
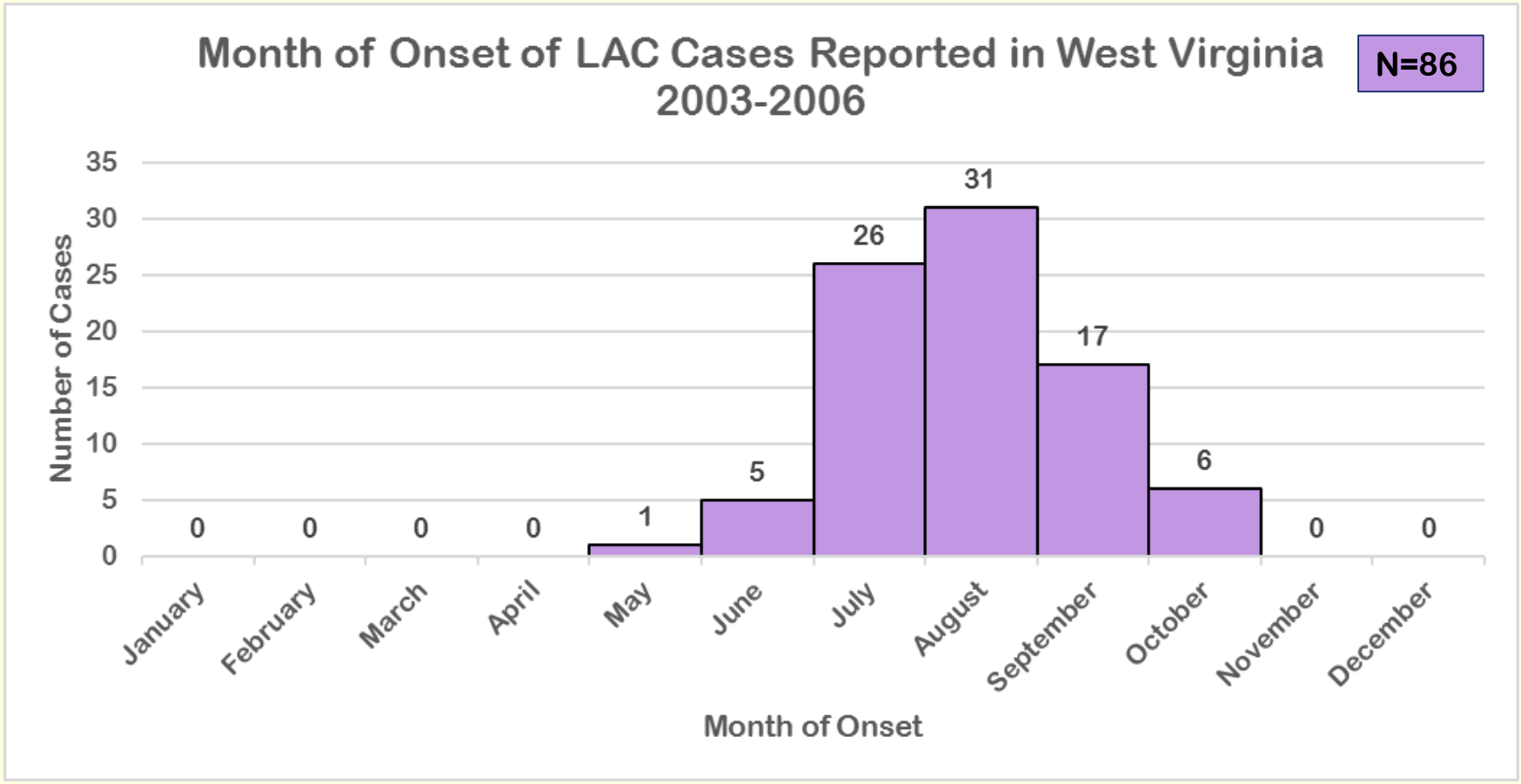


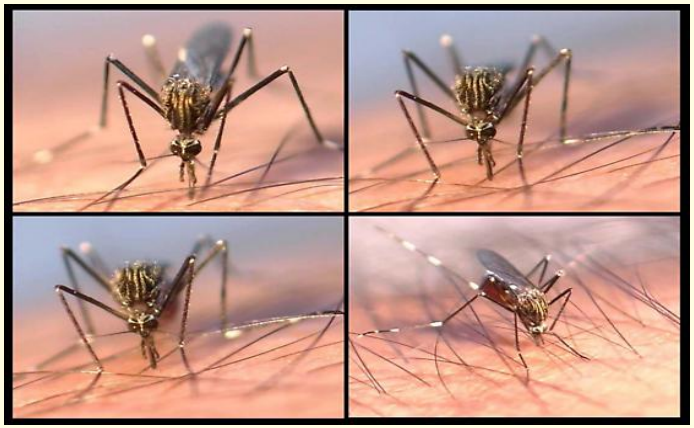
Fig 4. Percentage of LACV cases with selected environmental risk factors in Nicholas County from 2005–2010.

La Crosse Encephalitis (cont.'d)



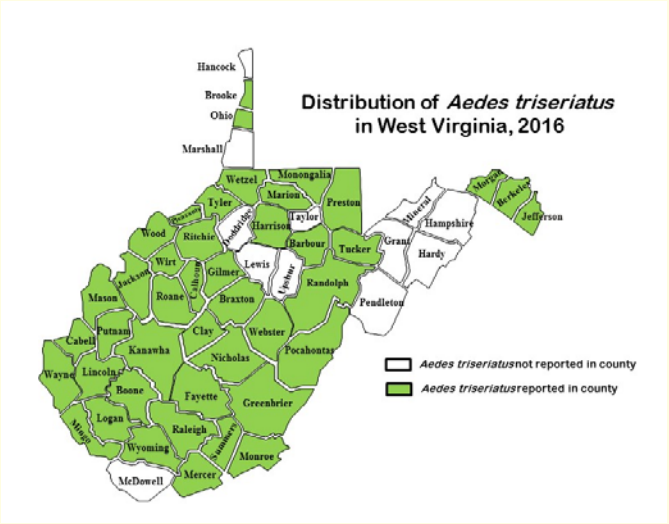
La Crosse Encephalitis (cont.'d)

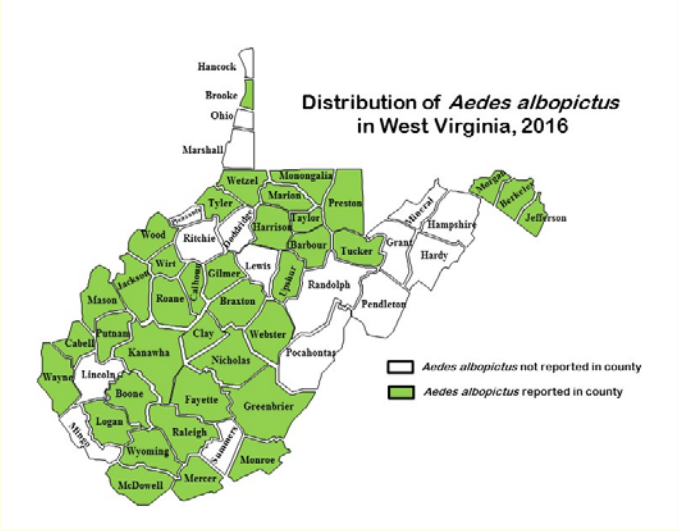
- **Vectors**
  - ***Aedes triseriatus*: Eastern treehole mosquito**
  - ***Aedes albopictus*: Asian tiger mosquito**
  - ***Aedes japonicus*: Asian bush mosquito**
- **All three of these species are container breeders (ex. treeholes, concrete basins, tires, buckets, children wading pools)**

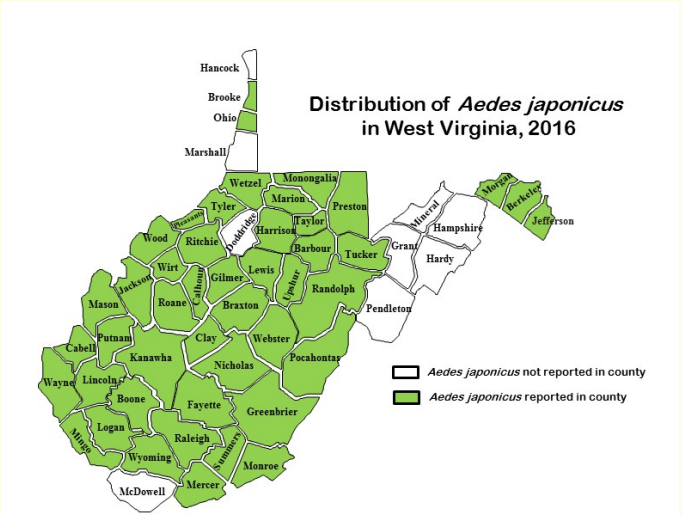


La Crosse Encephalitis (cont.'d)

- 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.

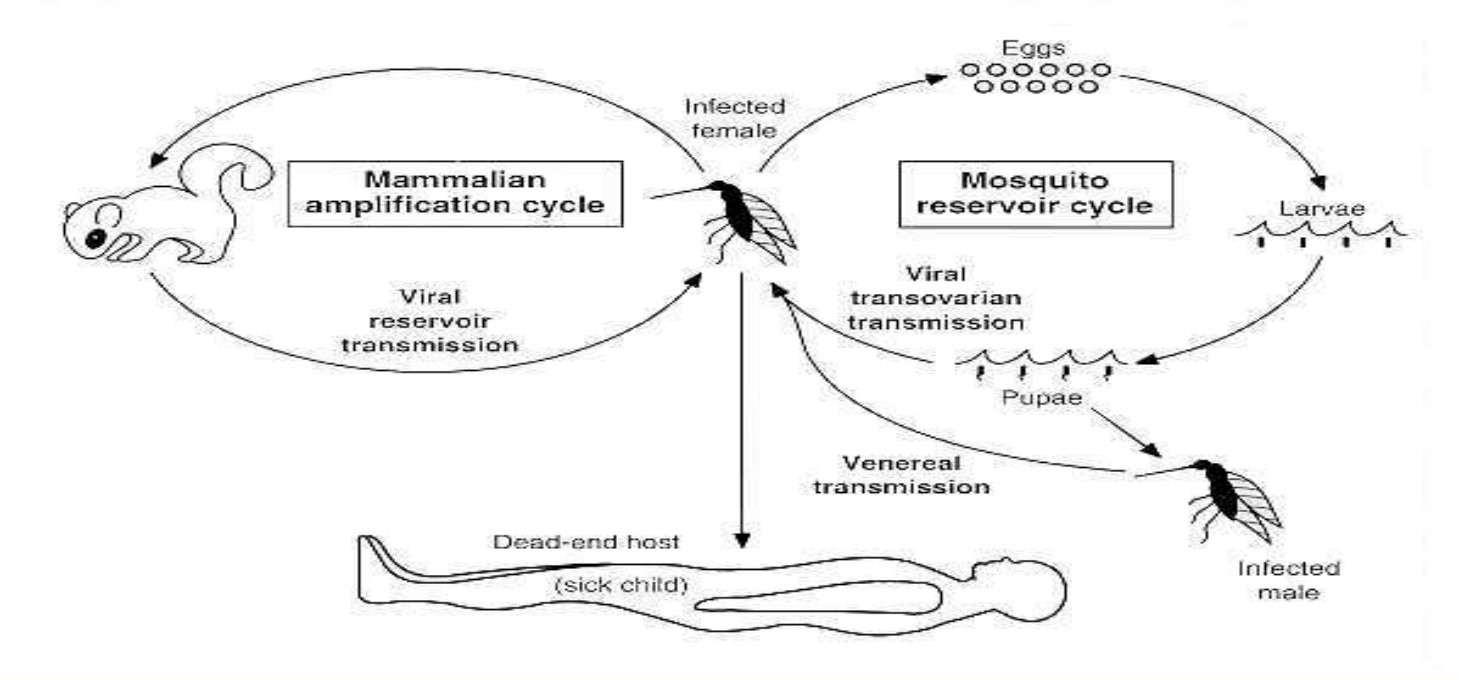






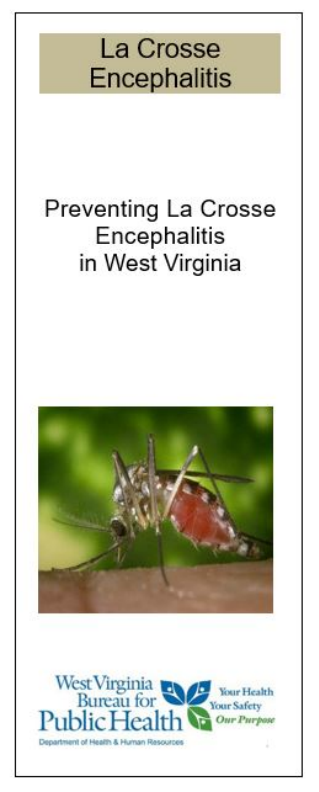
La Crosse Encephalitis (cont.'d)

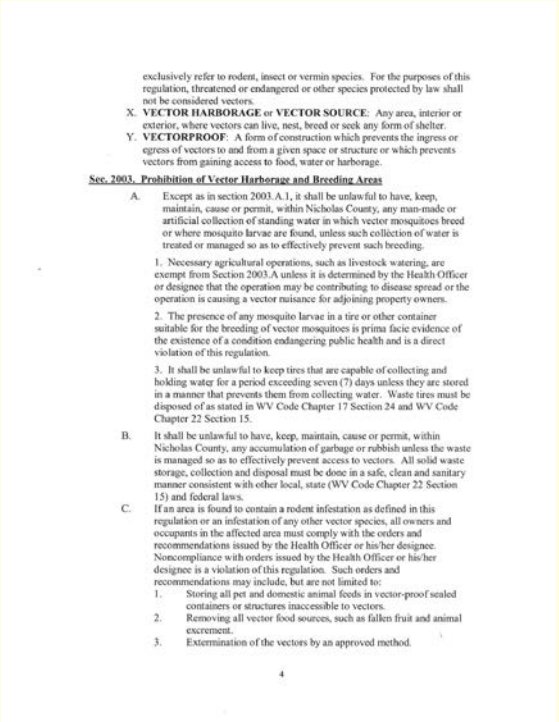
- Sciurid rodents, especially chipmunks and squirrels, serve as vertebrate hosts.
- Transmitted from mother to offspring in eastern treehole mosquito.
- Venereal transmission from male mosquitoes to female mosquitoes.



Mosquito Control Partners

- **Local health departments (LHDs) are involved with reducing incidence of LAC and other mosquito-borne diseases.**





exclusively refer to rodent, insect or vermin species. For the purposes of this regulation, threatened or endangered or other species protected by law shall not be considered vectors.

X. **VECTOR HARBORAGE** or **VECTOR SOURCE**: Any area, interior or exterior, where vectors can live, nest, breed or seek any form of shelter.

Y. **VECTORPROOF**: A form of construction which prevents the ingress or egress of vectors to and from a given space or structure or which prevents vectors from gaining access to food, water or harborage.

Sec. 2003. Prohibition of Vector Harborage and Breeding Areas

A. Except as in section 2003.A.1, it shall be unlawful to have, keep, maintain, cause or permit, within Nicholas County, any man-made or artificial collection of standing water in which vector mosquitoes breed or where mosquito larvae are found, unless such collection of water is treated or managed so as to effectively prevent such breeding.

1. Necessary agricultural operations, such as livestock watering, are exempt from Section 2003.A unless it is determined by the Health Officer or designee that the operation may be contributing to disease spread or the operation is causing a vector nuisance for adjoining property owners.

2. The presence of any mosquito larvae in a tire or other container suitable for the breeding of vector mosquitoes is prima facie evidence of the existence of a condition endangering public health and is a direct violation of this regulation.

3. It shall be unlawful to keep tires that are capable of collecting and holding water for a period exceeding seven (7) days unless they are stored in a manner that prevents them from collecting water. Waste tires must be disposed of as stated in WV Code Chapter 17 Section 24 and WV Code Chapter 22 Section 15.

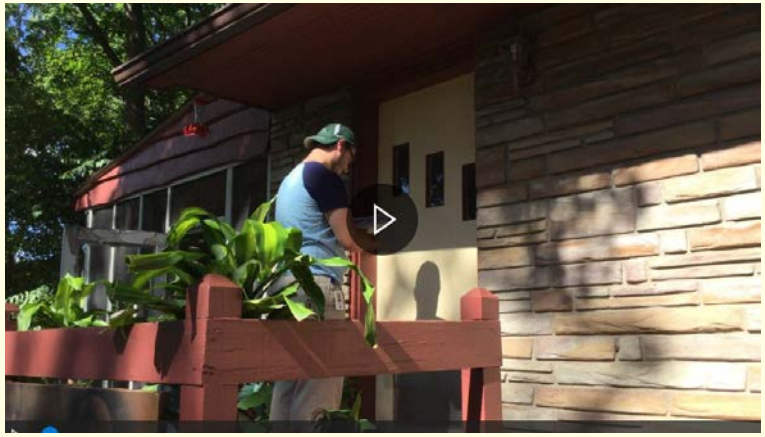
B. It shall be unlawful to have, keep, maintain, cause or permit, within Nicholas County, any accumulation of garbage or rubbish unless the waste is managed so as to effectively prevent access to vectors. All solid waste storage, collection and disposal must be done in a safe, clean and sanitary manner consistent with other local, state (WV Code Chapter 22 Section 15) and federal laws.

C. If an area is found to contain a rodent infestation as defined in this regulation or an infestation of any other vector species, all owners and occupants in the affected area must comply with the orders and recommendations issued by the Health Officer or his/her designee. Noncompliance with orders issued by the Health Officer or his/her designee is a violation of this regulation. Such orders and recommendations may include, but are not limited to:

1. Storing all pet and domestic animal feeds in vector-proof sealed containers or structures inaccessible to vectors.
2. Removing all vector food sources, such as fallen fruit and animal excrement.
3. Extermination of the vectors by an approved method.

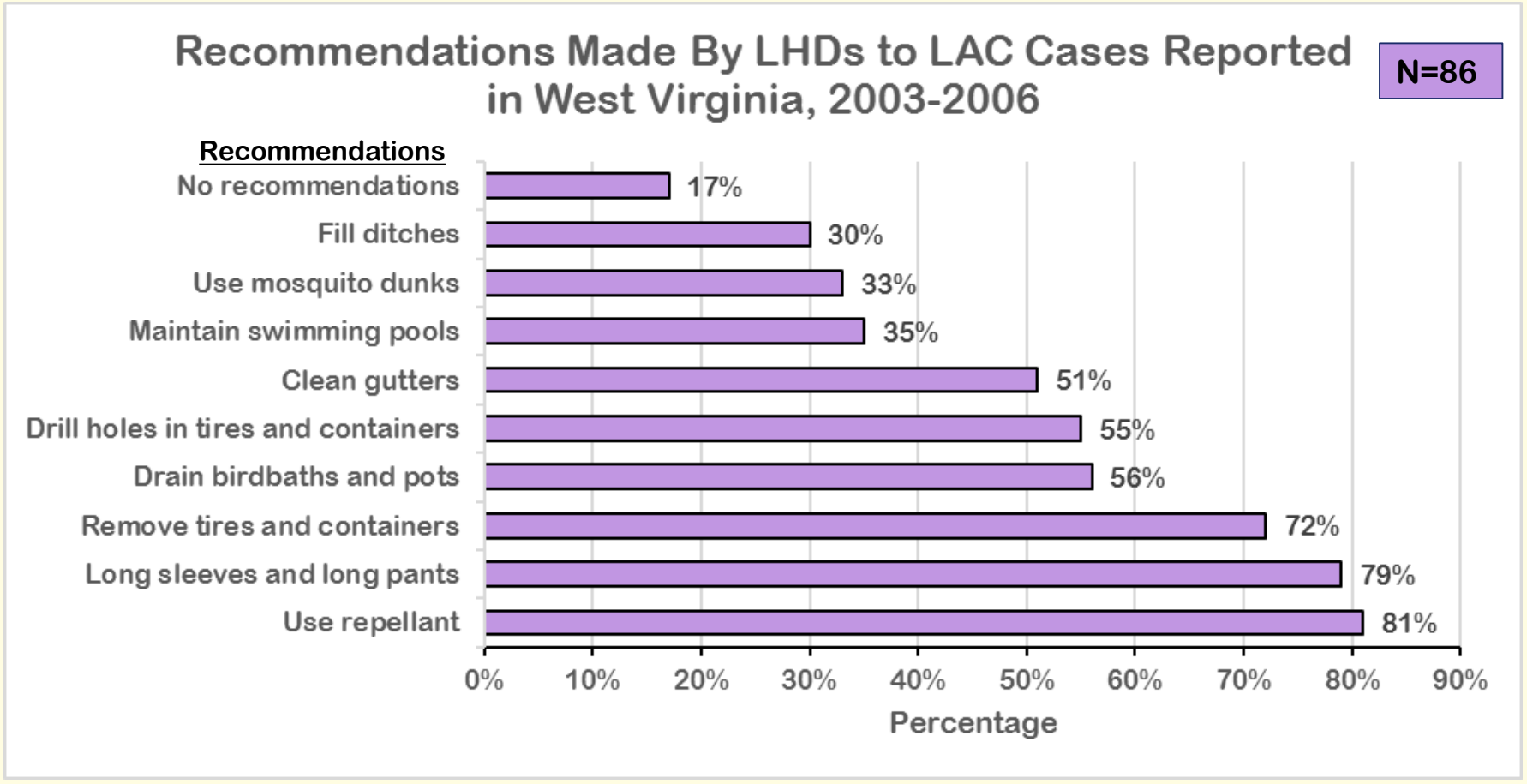
4

Mosquito Control Partners (cont.'d)

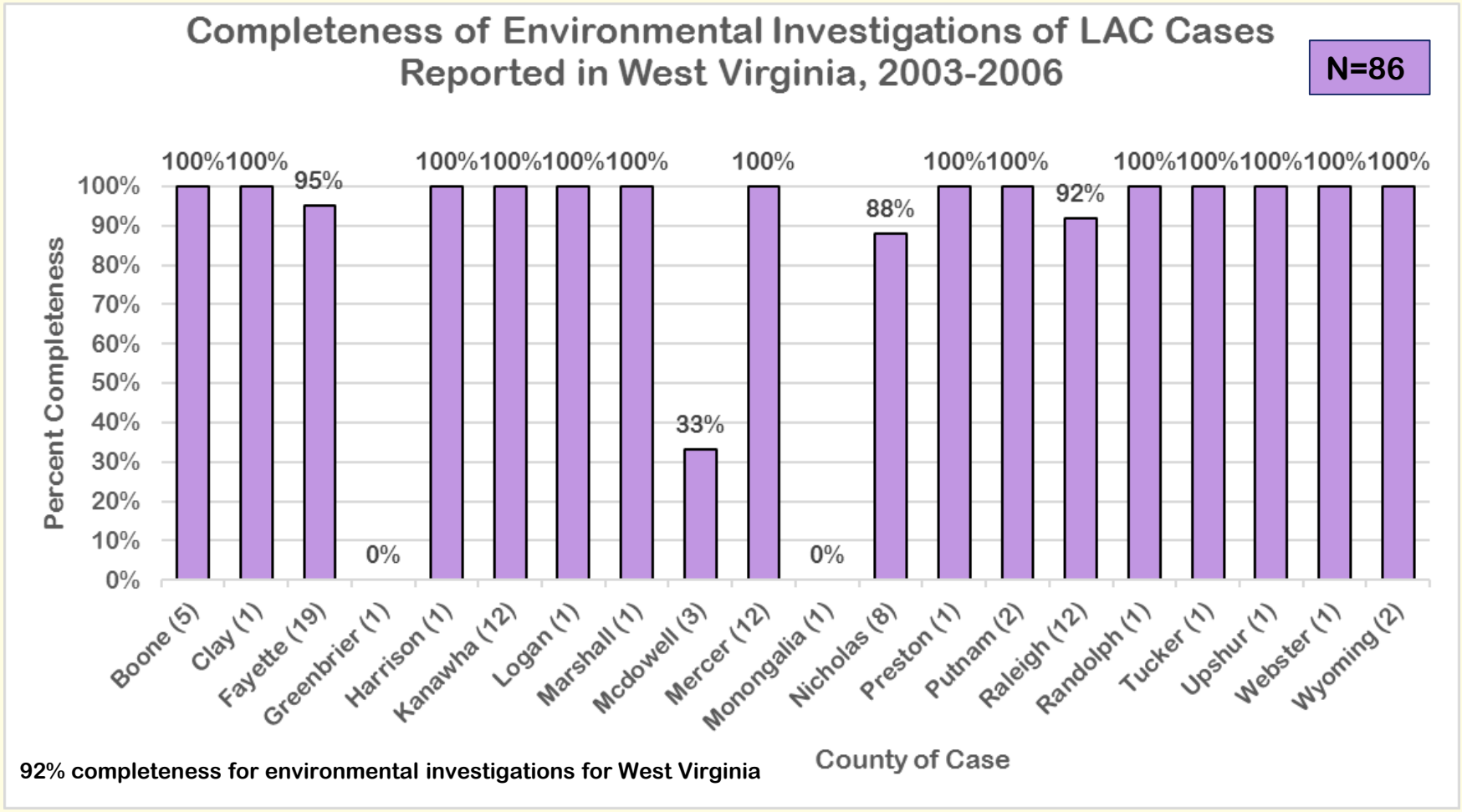


- Training LHDs about mosquito species identification, mosquito biology, and environmental assessment around case sites.
- Future pesticide certification training events are being planned with the West Virginia Department of Agriculture.

Mosquito Control Partners (cont.'d)



Mosquito Control Partners (cont.'d)



92% completeness for environmental investigations for West Virginia

Mosquito Control Partners (cont.'d)

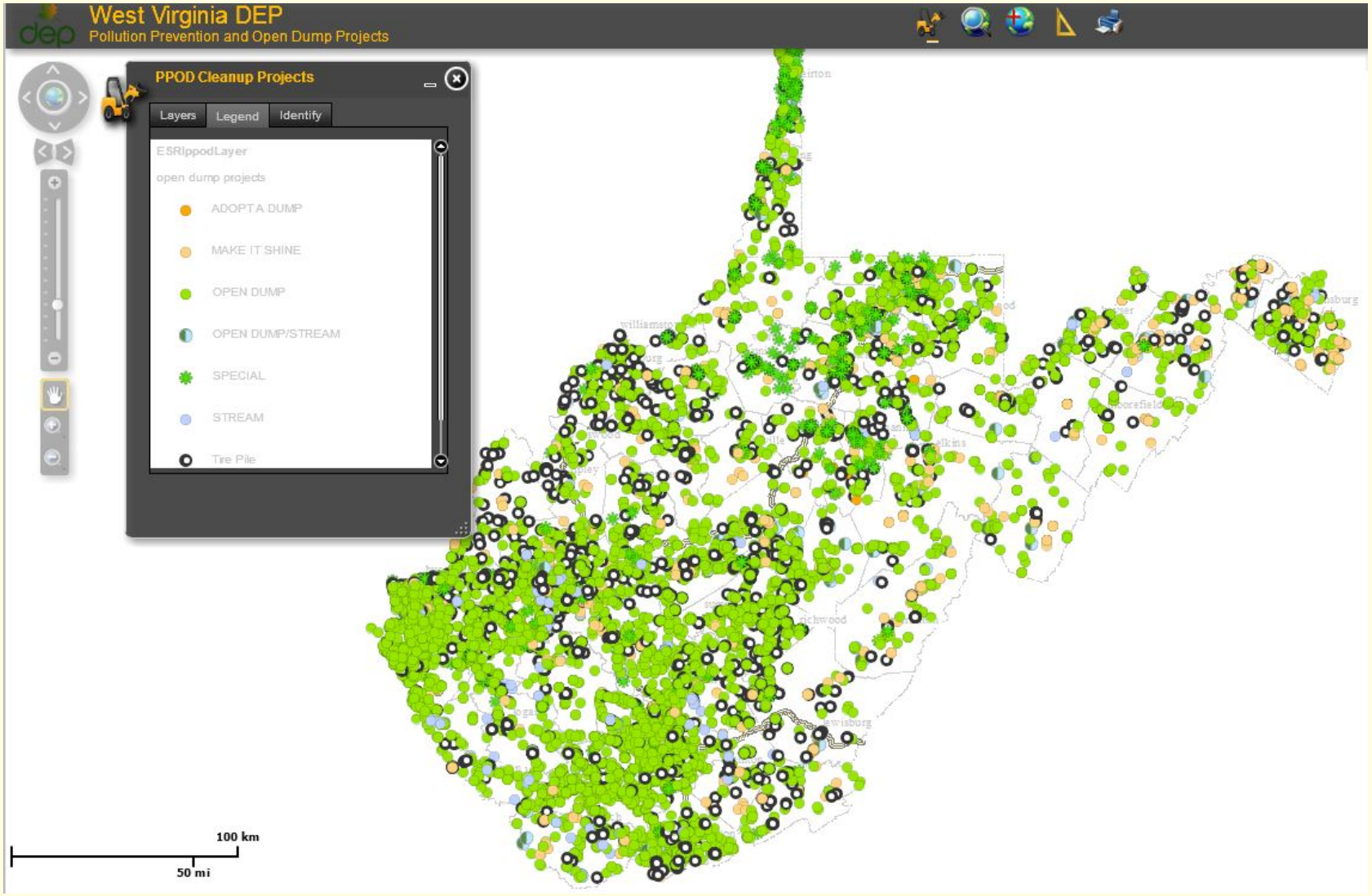
- West Virginia Department of Environmental Protection Rehabilitation Environmental Action Plan (REAP) Tire Collection Events
- Community Cleanup Activities

Mosquito Control Partners (cont.'d)

- **West Virginia Department of Environmental Protection REAP 'Pollution, Prevention, and Open Dump Program' works to reduce open dump sites in West Virginia.**

WVDEP PPOD

Mosquito Control Partners (cont.'d)



http://www.dep.wv.gov/dlr/oer/reap/ppod/Pages/ppod.html

Mosquito Control Partners (cont.'d)

- **Litter Control Officers have authority to control mosquito breeding sites on private and public land.**

Times West Virginian photo by Emily Gallagher
Division of Natural Resources officers Jeremiah Clark (left) and Randall Kocsis investigate an illegal dump site in Idamay.

- **West Virginia Division of Natural Resources has authority to investigate mosquito breeding sites in containers on private property.**

Mosquito Control Partners (cont.'d)

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."

Environmental Assessment

WEST VIRGINIA Department of Health & Human Resources BUREAU FOR PUBLIC HEALTH

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 preferable 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 (cont.'d)

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
☐House gutters with visible debris
☐Assessor encountered mosquitoes while on property
☐Screens on doors and windows in disrepair/missing
☐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 ache ☐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 Departure Date

ACTIONS OF PUBLIC HEALTH OFFICIAL

☐Mosquito traps were set on property
☐Drained water holding containers
☐Conduct treatment for mosquito larvae
☐Shared mosquito bite prevention literature
☐Disposed of litter/organic debris around home
☐Showed owner larval/pupae mosquito stages
☐Shared disease specific literature
☐Recommended that case remain confined indoors/covered up (for symptomatic cases)
☐Other: _____

Environmental Assessment (cont.'d)

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
- ☐ Shared mosquito bite prevention literature
- ☐ Drained water holding containers
- ☐ Disposed of litter/organic debris around home
- ☐ 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

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

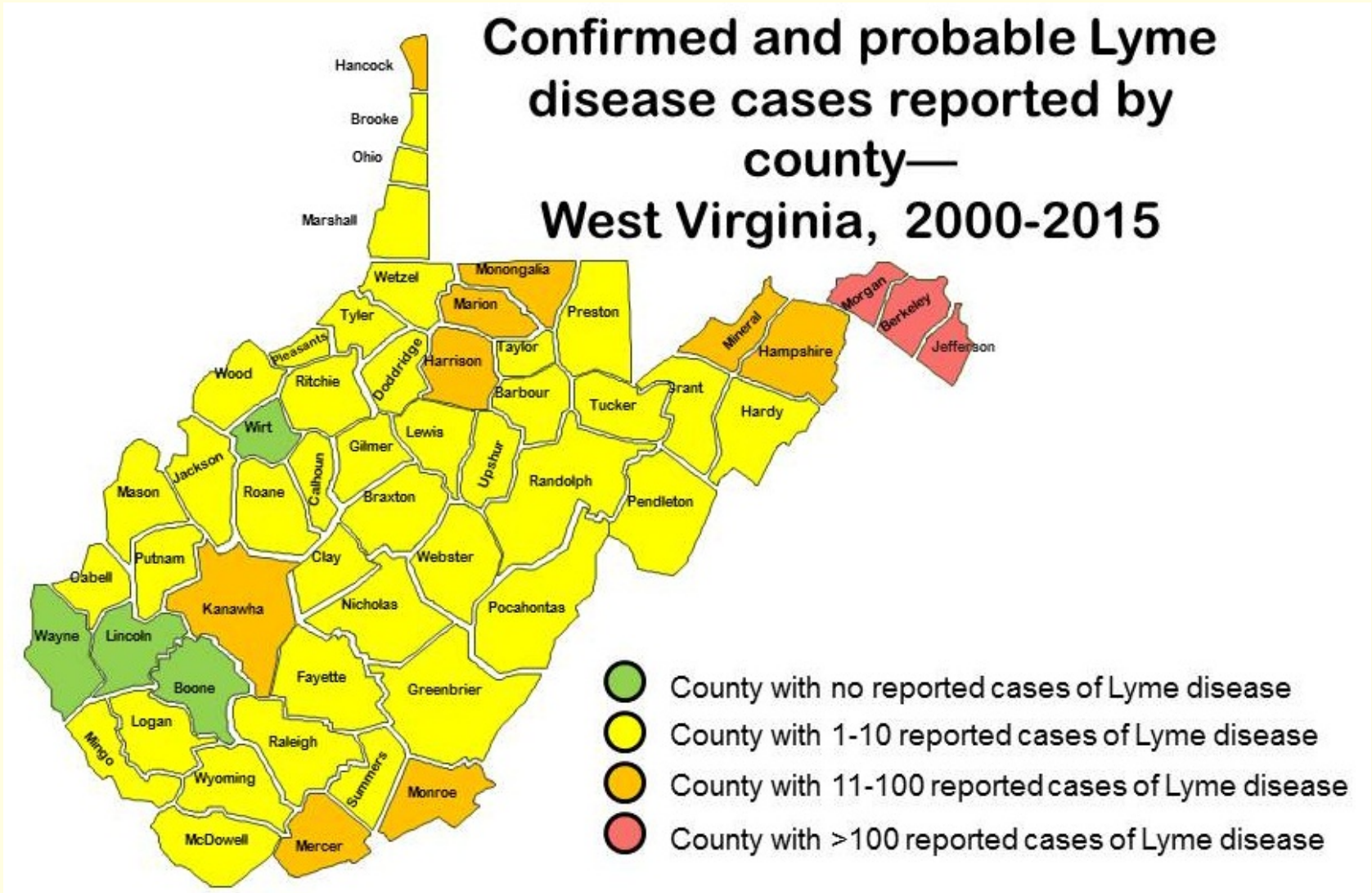
***This tick-borne disease has not been reported in West Virginia.**

Tick-borne Disease (cont.'d)

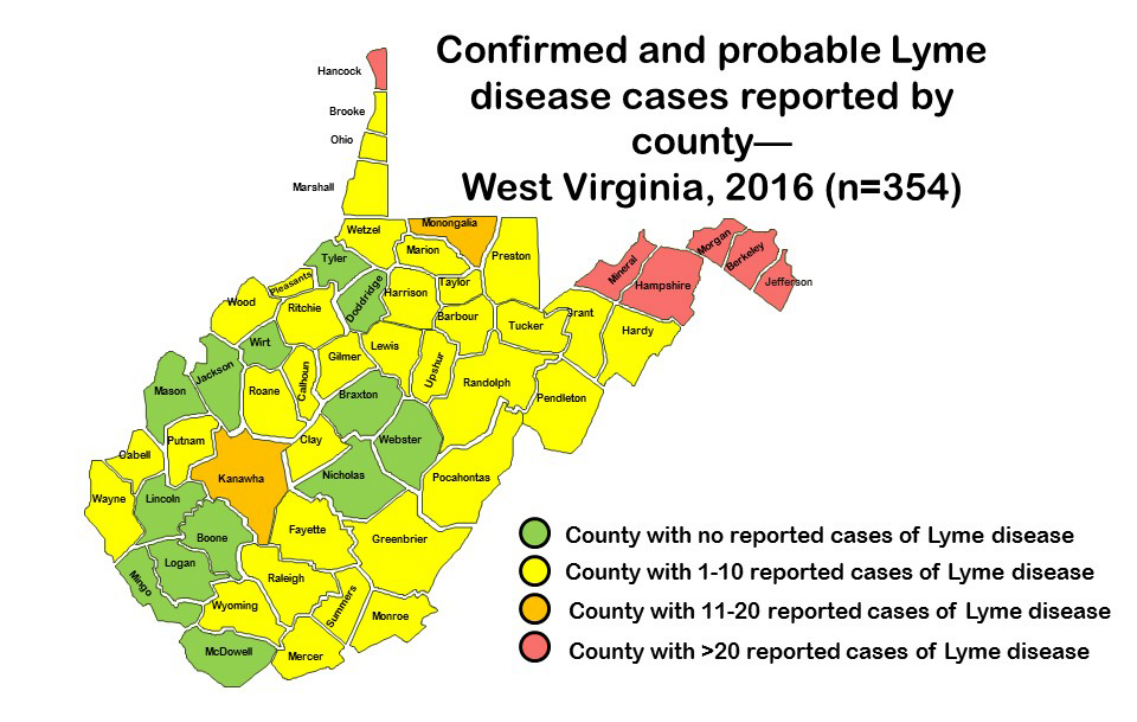
Summary of four tick-borne diseases reported in West Virginia 2000-2010

Disease Name	Total Cases Reported	Annual Range	Annual Mean	Annual Median	Standard Deviation	Cumulative Incidence per 100,000
Tularemia	2	0-1	0.2	0	0.4	0.01
Ehrlichiosis	8	0-3	0.7	0	1.1	0.04
Rocky Mountain spotted fever	49	0-10	4.5	4	3.2	0.25
Lyme disease	772	17-201	70.2	39	58.1	3.88

Tick-borne Disease (cont.'d)



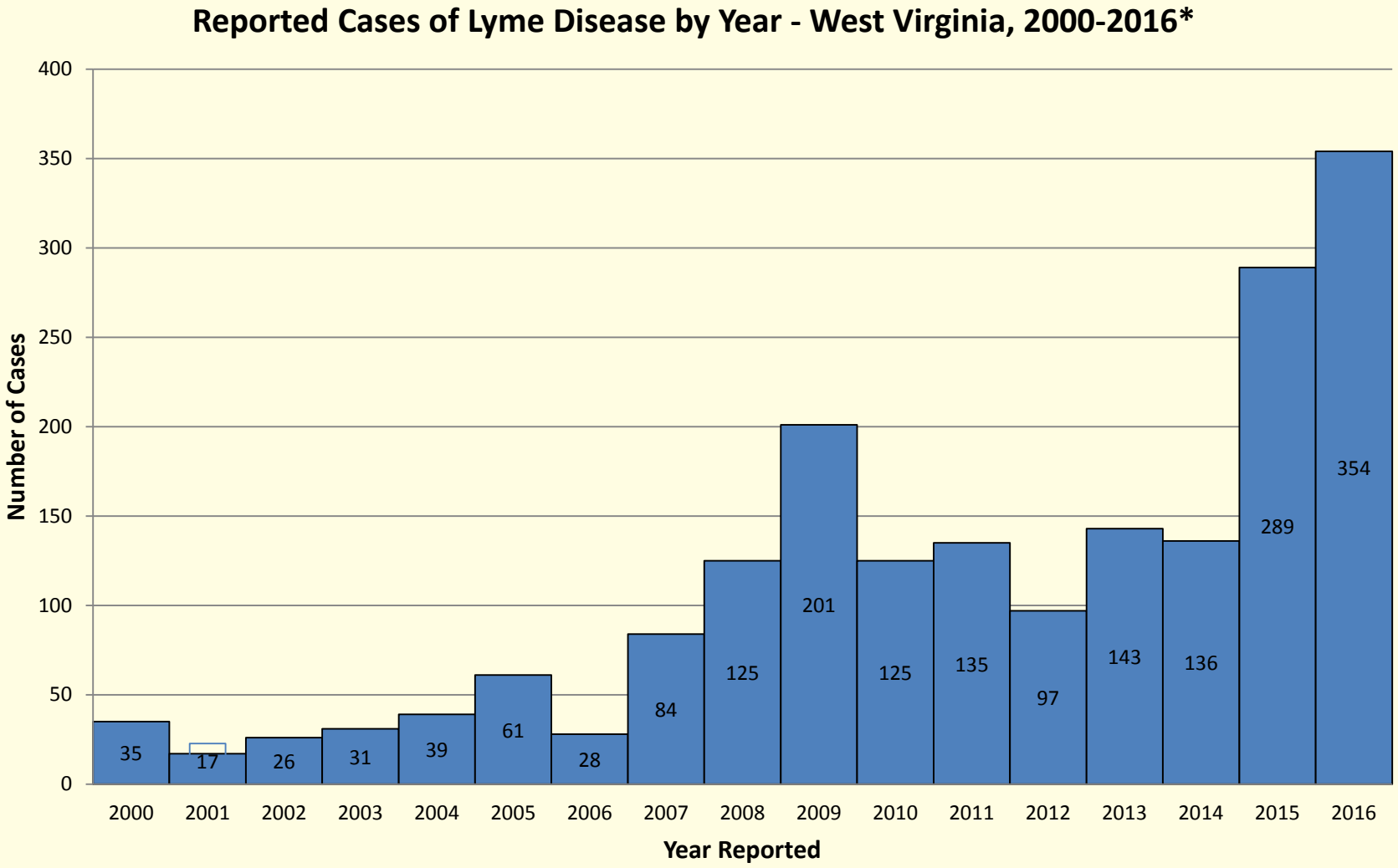
Tick-borne Disease (cont.'d)



Tickborne Disease[a]	# Confirmed or Probable Cases (2016) (as of January 9, 2017)
Ehrlichiosis	6
Lyme disease	354
Spotted fever group rickettsioses[b]	14
Q fever	1
TOTAL	375

[a]Table includes only confirmed or probable cases that have been reviewed and closed by Zoonotic Disease Epidemiologist.
[b]Includes Rocky Mountain spotted fever

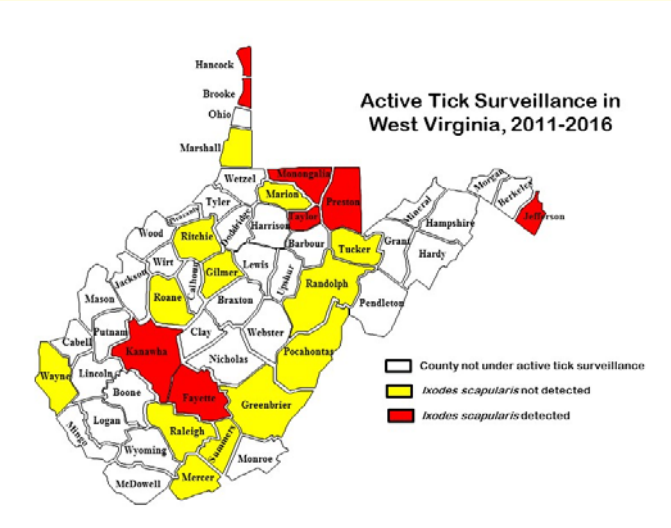
Lyme Disease



*Updated as of January 9, 2017

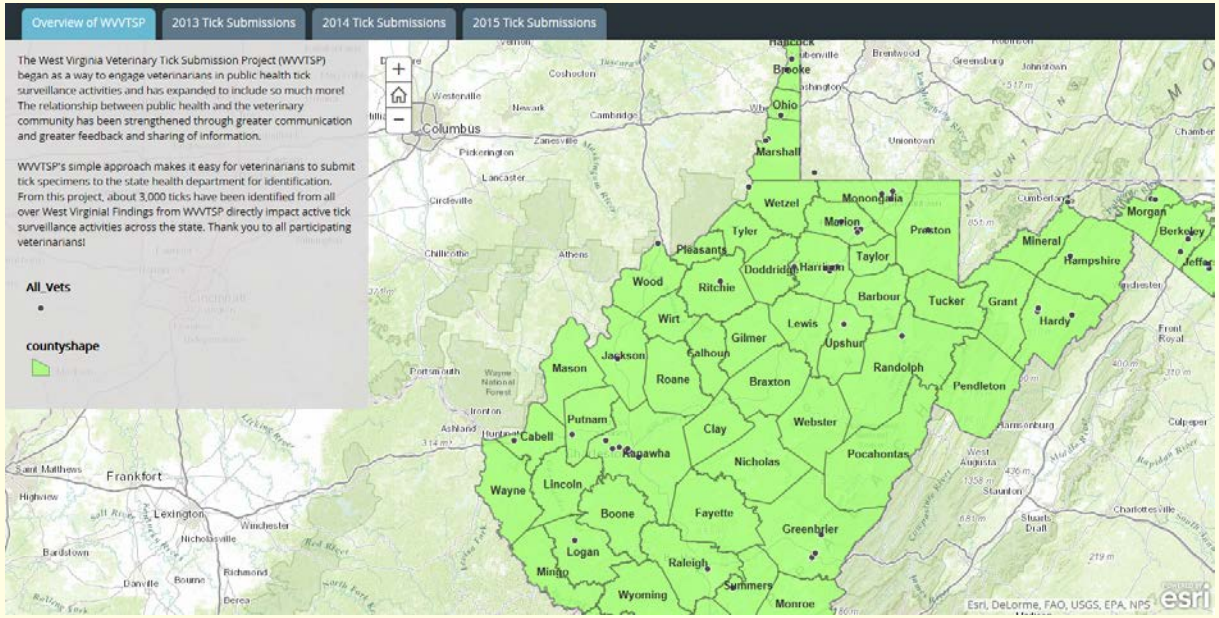
Active Tick Surveillance

- 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*.



West Virginia Veterinary Tick Submission Project

- **Since 2013, West Virginia veterinarians who participated in the West Virginia Veterinary Tick Submission Project (WVVTSP) 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 WVVTSP participating veterinary clinics.**



http://www.dhhr.wv.gov/oeps/zoonosis/tick/pages/wv-veterinary-tick-submission-project.aspx

West Virginia Veterinary Tick Submission Project (cont.'d)

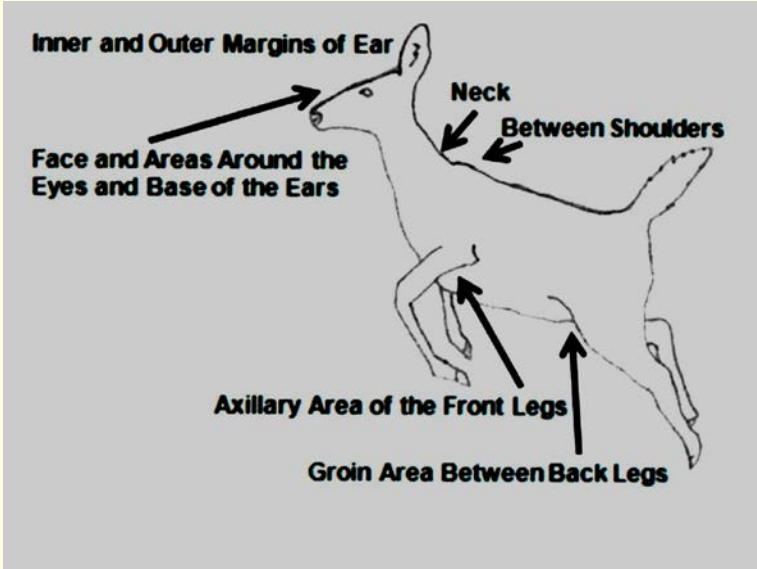
Tick Species	# of ticks submitted and identified (2013)	# of ticks submitted and identified (2014)	# of ticks submitted and identified (2015)	# of ticks submitted and identified (2016)
Dermacentor variabilis[1]	470	998	677	723
Amblyomma americanum[2]	5	16	85	109
Ixodes scapularis[3]	121	179	410	171
Ixodes cookei[4]	7	18	86	27
Haemaphysalis leporispalustris[5]	1	8	0	3
Amblyomma maculatum[6]	0	1	0	1
Rhipicephalus sanguineus[6]	0	0	4	119

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

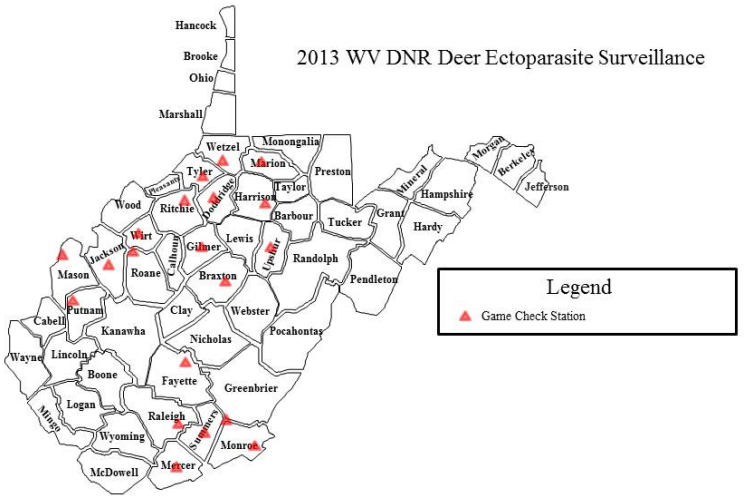
[1]Vector of tularemia and Rocky Mountain spotted fever
[2]Vector of ehrlichiosis, tularemia, STARI, and spotted fever rickettsioses
[3]Vector of Lyme disease, anaplasmosis, babesiosis, and Powassan encephalitis
[4]Vector of Powassan encephalitis
[5]Vector of tularemia in rabbits
[6]Vector of spotted fever rickettsioses

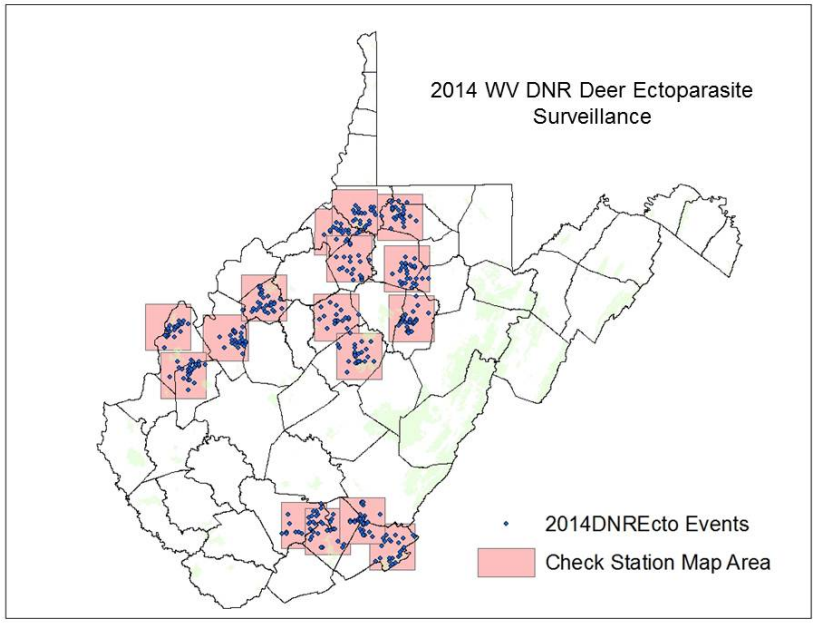
Deer Ectoparasite Study

- 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.

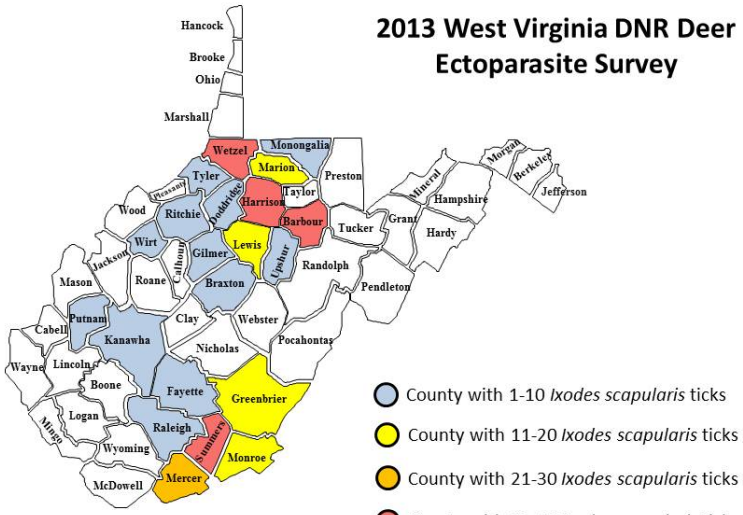


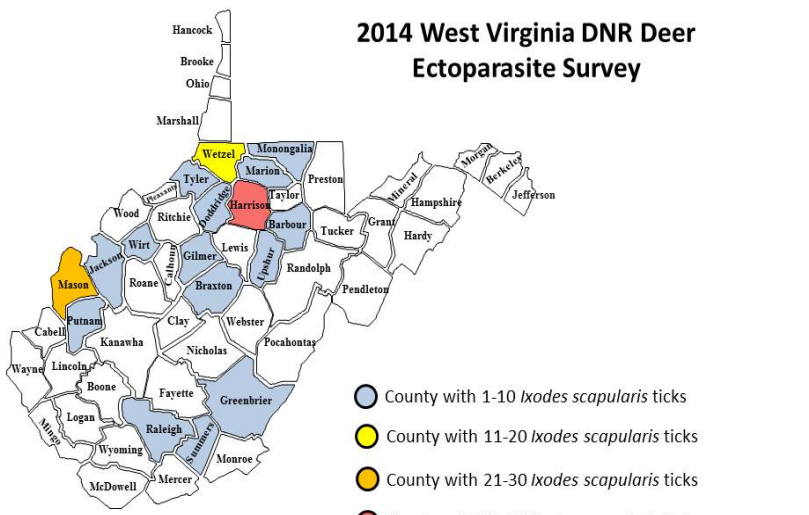
Deer Ectoparasite Study (cont.'d)





Deer Ectoparasite Study (cont.'d)

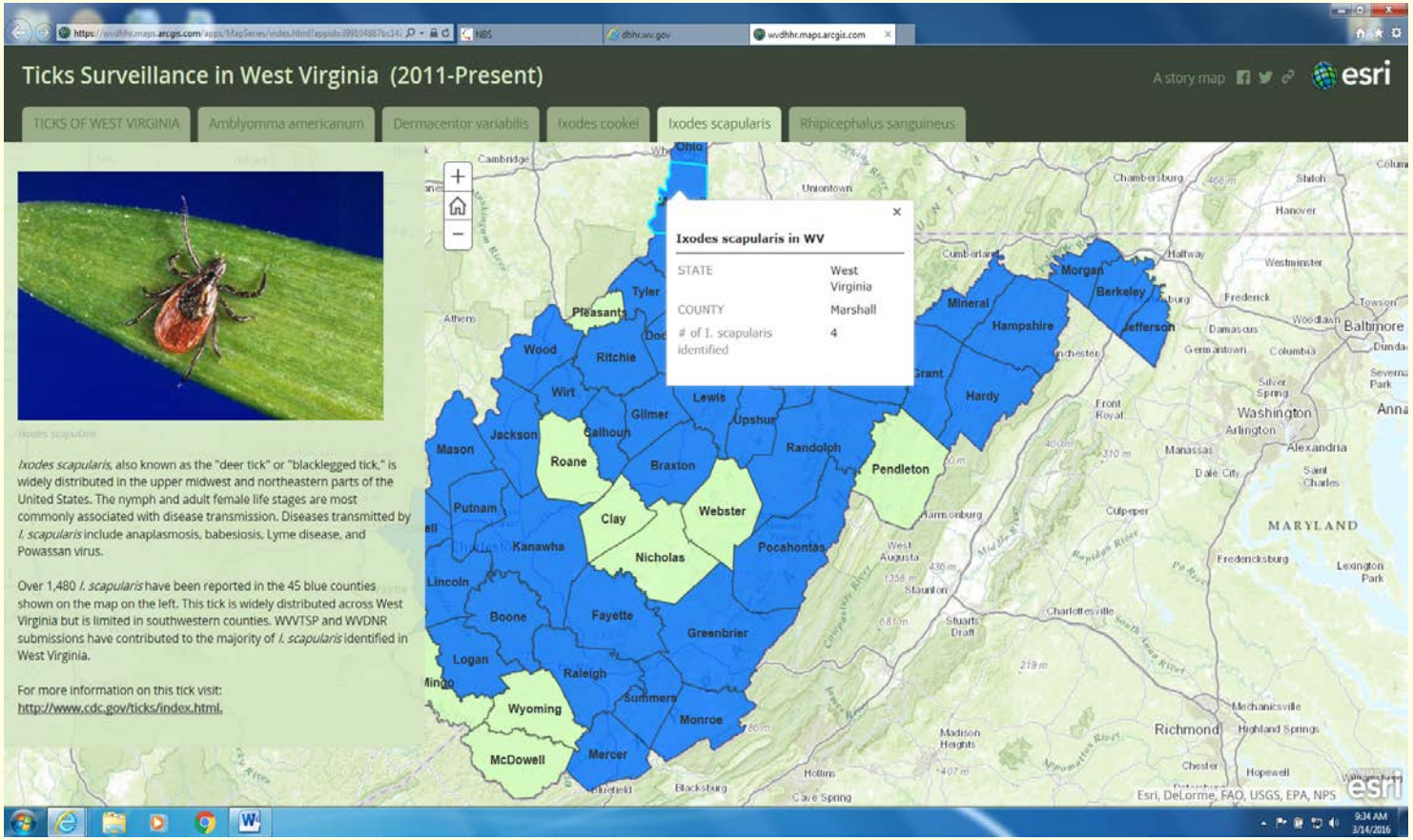




- 282 *Ixodes scapularis* from white-tailed deer in 2013
- 120 *Ixodes scapularis* from white-tailed deer in 2014

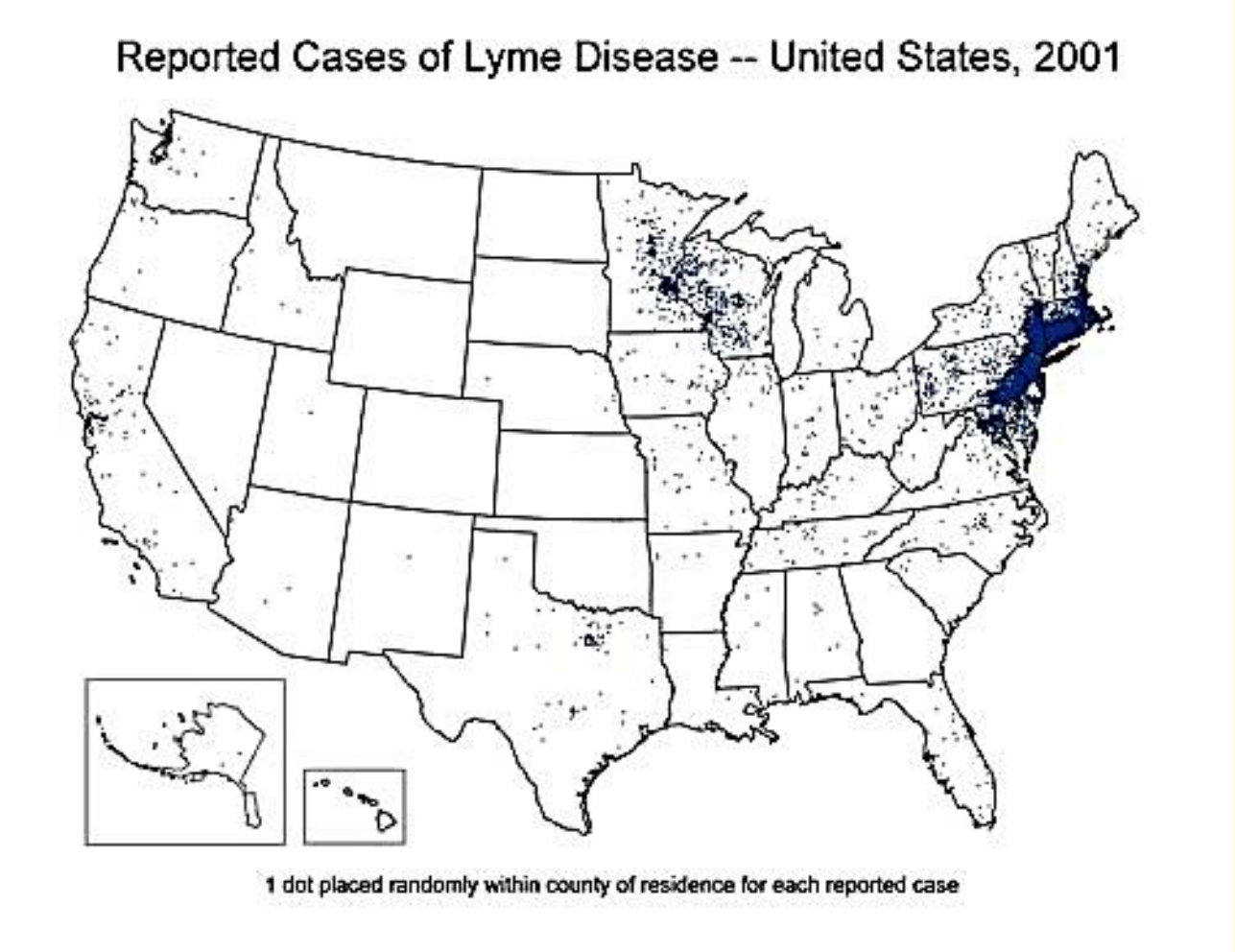
Tick Species Distribution in West Virginia

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



http://www.dhhr.wv.gov/oeps/disease/zoonosis/tick/pages/default.aspx

Lyme Disease Geographic Distribution

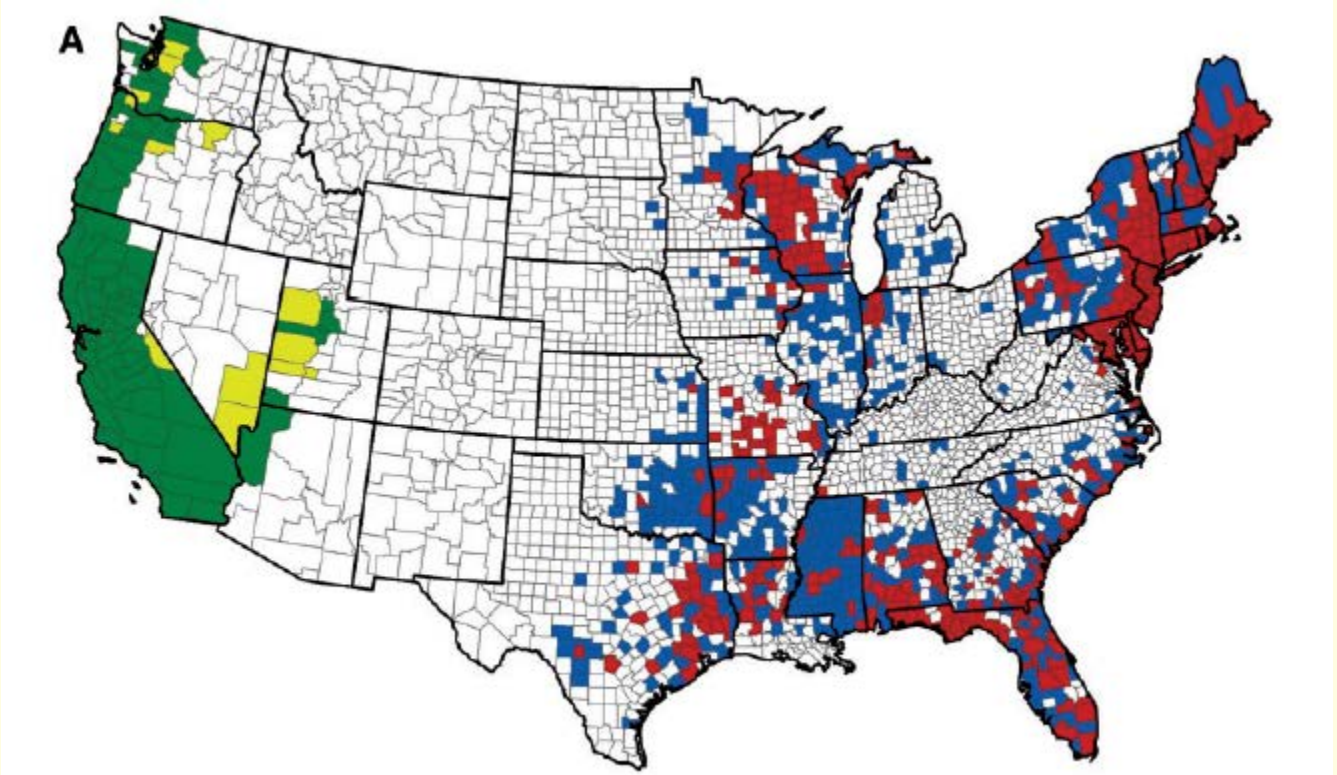


https://www.cdc.gov/lyme/stats/maps.html

Lyme Disease Vector Geographic Distribution

WEST VIRGINIA Department of Health & Human Resources BUREAU FOR PUBLIC HEALTH

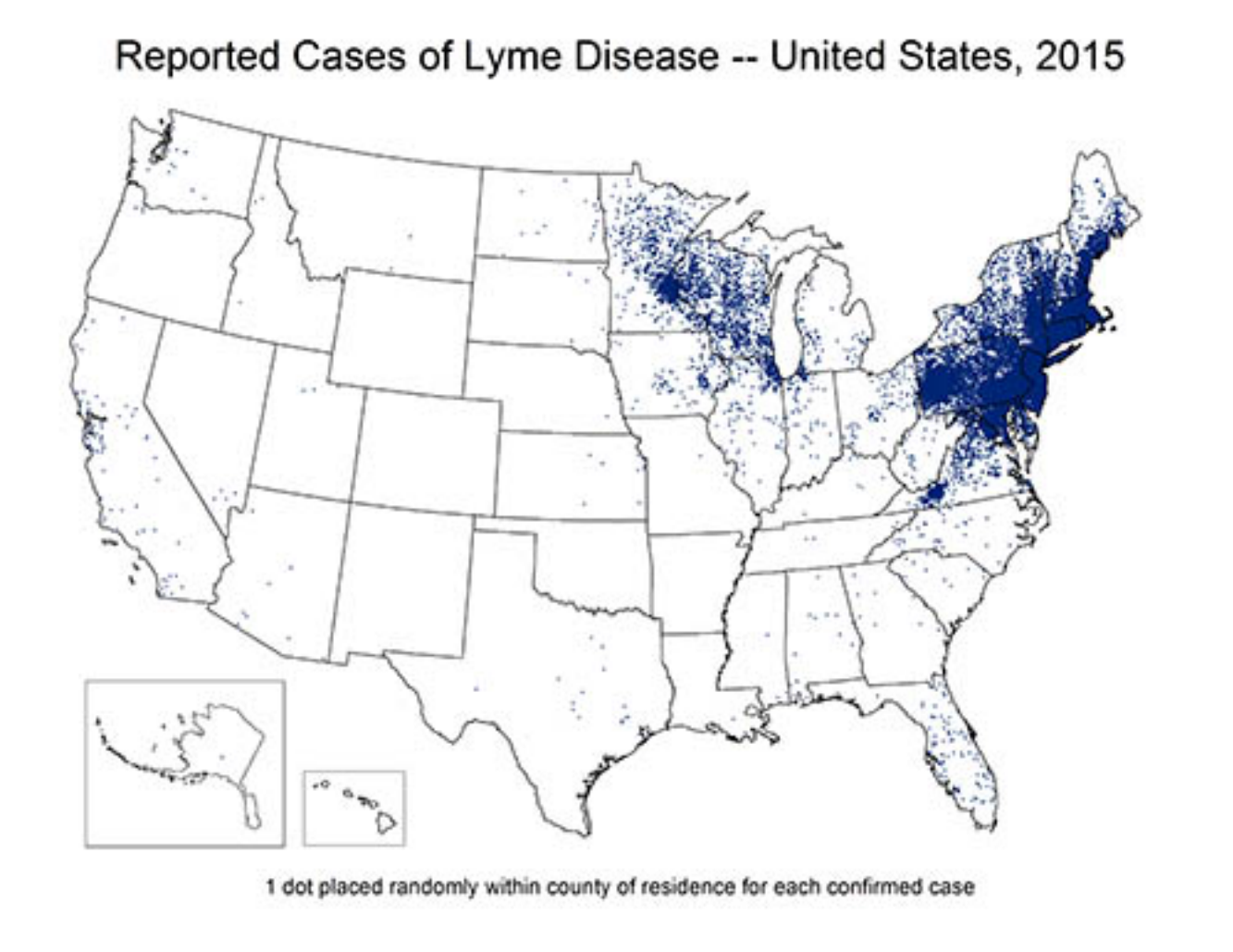
Lyme disease vector distribution 1907-1998



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

Dennis, D. T., T. S. Nekomoto, J. C. Victor, W. S. Paul & J. Piesman. 1998. Reported distribution of *Ixodes scapularis* and *Ixodes pacificus* (Acari: Ixodidae) in the United States. *Journal of Medical Entomology* **35** (**5**): 629-638.

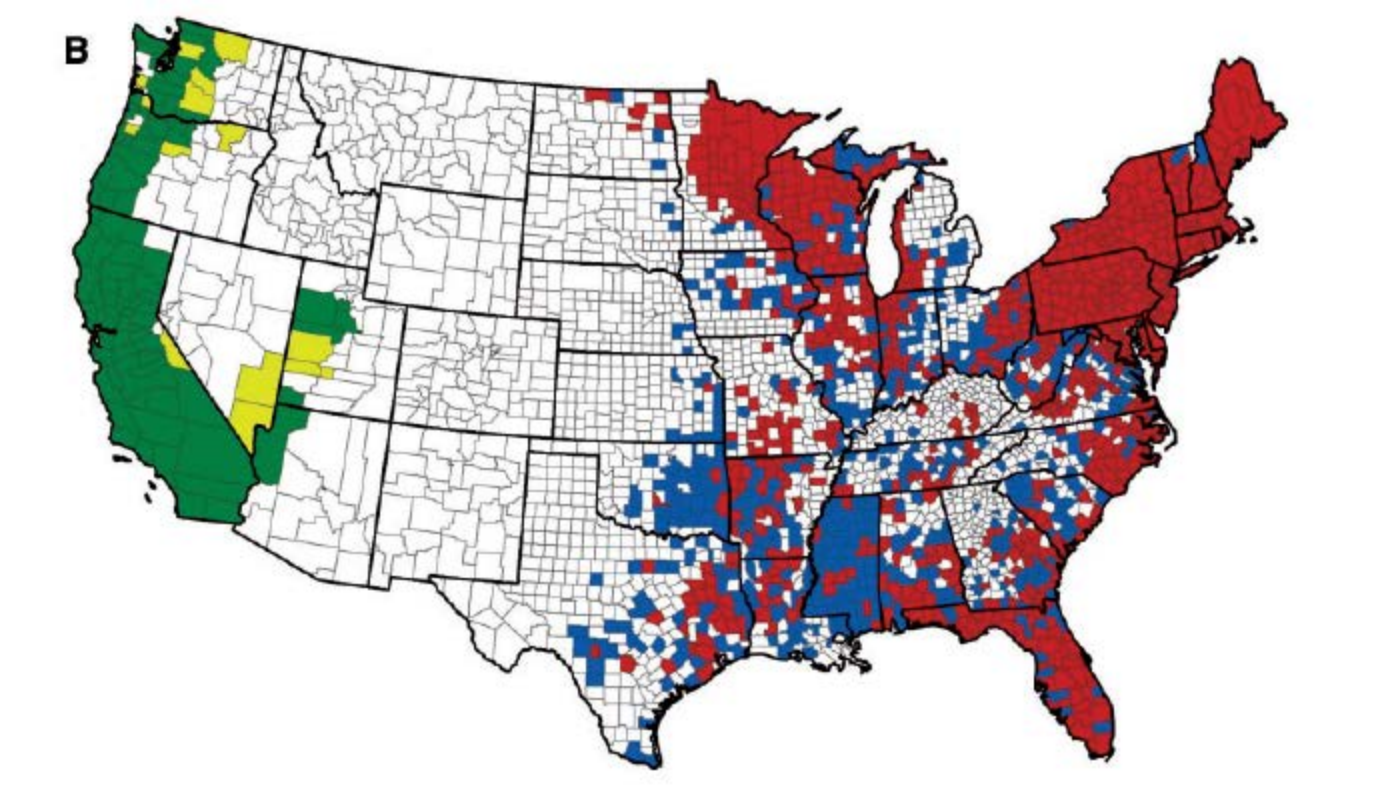
Lyme Disease Geographic Distribution



https://www.cdc.gov/lyme/stats/maps.html

Lyme Disease Vector Geographic Distribution

Lyme disease vector distribution 1907-2015



- *Ixodes scapularis* reported (blue) or established (red) in county
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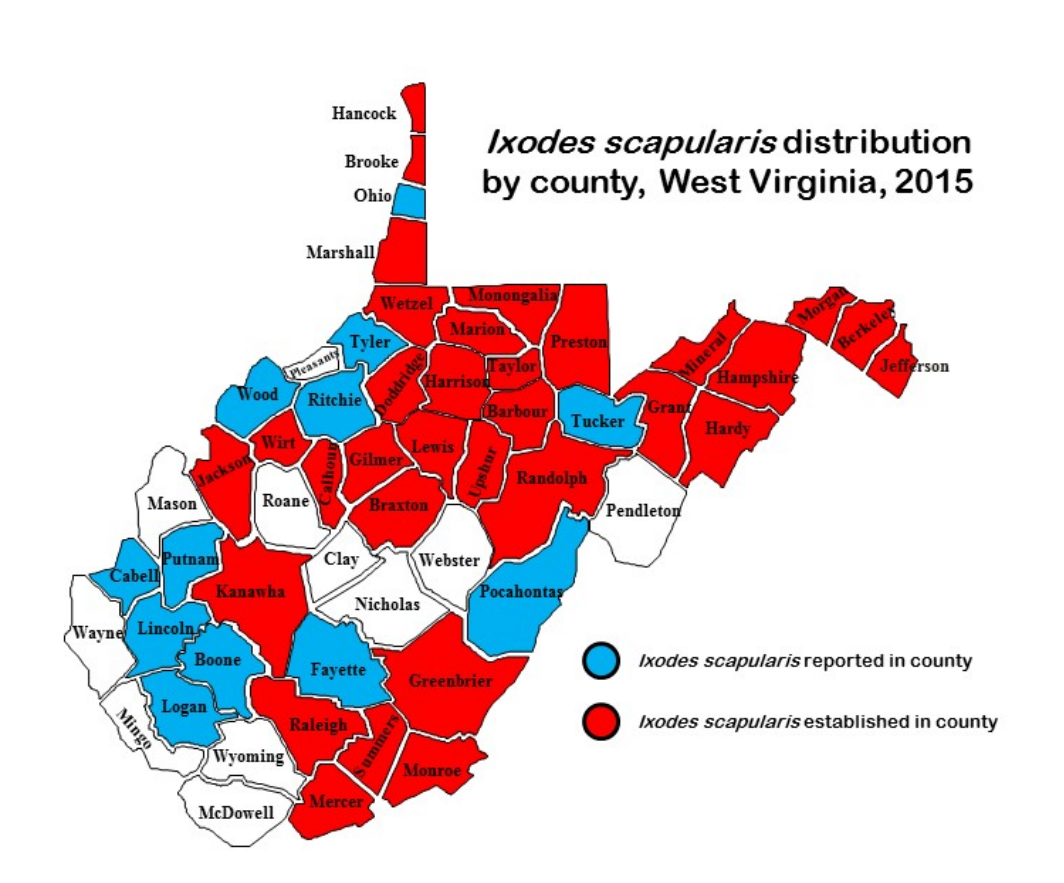
Eisen, R. J., L. Eisen & C. B. Beard. 2016. County-scale distribution of *Ixodes scapularis* and *Ixodes pacificus* (Acari: Ixodidae) in the continental United States. *Journal of Medical Entomology* **53** (**2**): 349-386.

Lyme Disease Vector Geographic Distribution



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

Eisen, R. J., L. Eisen & C. B. Beard. 2016. County-scale distribution of *Ixodes scapularis* and *Ixodes pacificus* (Acari: Ixodidae) in the continental United States. *Journal of Medical Entomology* **53** (**2**): 349-386.

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.

Contact

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