Introduction

Mosquito-borne diseases, the majority of which are viruses, are transmitted through the bite of infected mosquitoes. Surveillance for these diseases in West Virginia (WV) focuses on four arboviruses: La Crosse encephalitis virus (LACV), West Nile virus (WNV), St. Louis encephalitis virus (SLEV), and eastern equine encephalitis virus (EEEV). Historically, La Crosse encephalitis (LAC) has been the mosquito-borne disease of most concern in WV, with up to 40 human cases reported in previous years. Other mosquito-borne diseases, such as malaria and dengue fever, are not endemic to WV but a few travel-associated cases of these diseases have been reported. Chikungunya recently emerged in the Western Hemisphere in late 2013, and locally-acquired cases have occurred in Florida.

Most people who become infected with arboviral infections have no clinical symptoms; however, encephalitis (inflammation of the brain) is a common and potentially life-threatening complication that is often reported among infected persons who do develop symptoms. Symptoms generally begin 1 to 2 weeks after a mosquito bite and include fever, headache, myalgia, meningitis, and neurologic dysfunction. There is no specific treatment available for arboviral infections.

Environmental surveillance for arboviral diseases monitors local activity in non-human species. Mosquito surveillance is important to understanding the distribution of these vectors and the diseases that they may transmit to humans. The WV state public health entomologist conducts mosquito surveillance across the state from late spring through early fall. Reporting dead birds to local health departments (LHDs) is a great way to assist public health officials in arbovirus surveillance activities. Certain species of birds (e.g. crows and jays) are more likely to become infected with WNV than other bird species and can die from infections. Horses are also commonly infected with arboviruses and can become ill. Mosquitoes, dead birds and horses help identify WNV and other arboviruses in an area.

This surveillance report summarizes human cases of mosquito-borne disease and environmental surveillance—mosquito, dead bird, and horse surveillance—for arbovirus in WV in 2014.

Methods

Human Surveillance

Patients with a positive laboratory test result for a mosquito-borne disease were entered into the West Virginia Electronic Disease Surveillance System (WVEDSS) for additional follow-up by the local health department, including an environmental assessment of case sites. All reported human cases were classified according to the national case definition for each mosquito-borne disease (http://wwwn.cdc.gov/nndss/script/casedefDefault.aspx). For dengue fever cases, the 2010 case definition was used to ascertain the case statuses. For malaria and arboviral disease cases, the 2014 case definitions were used to ascertain case statuses. Confirmed and probable arbovirus cases were reported to Centers for Disease Control and Prevention (CDC) through ArboNet. Surveillance reports were shared with public health partners throughout active mosquito/mosquito-borne disease season from July-November 2014 to provide data on vectorborne disease activity around the state. To obtain case counts and basic descriptive

epidemiologic characteristics of cases, records were exported from WVEDSS for all mosquito-borne disease cases with a report date of MMWR Year 2014. Data were summarized using Microsoft Excel.

Enhanced passive surveillance methods were utilized to help detect human cases of mosquito-borne arbovirus infection. These methods included 1) statewide health alerts to physicians, 2) a hospital laboratory letter, 3) an email memo to local health departments with important arbovirus information, and 4) and dissemination of equine testing and dead bird surveillance information sheets to veterinarians. During 2014, testing of human specimens occurred through hospital laboratories, the West Virginia Office of Laboratory Services (WVOLS) for WNV, SLEV, and EEEV, the Virginia Department of Health Division of Consolidated Laboratory Services and CDC for LACV.

Equine Surveillance
Veterinarians suspecting arboviral infection in horse patients were asked to submit serum specimens to WVOLS for IgM capture enzyme-linked immunosorbent assay (ELISA) test for WNV and EEE at National Veterinary Services Laboratory in Ames, Iowa. Equine specimens that tested positive for arbovirus are reported to CDC through ArboNet.

Dead Bird Surveillance
Local health department personnel submitted oral swabs from dead birds to WVOLS for testing of WNV, SLEV, and EEEV at the Southeastern Cooperative Wildlife Disease Study (SCWDS) at the University of Georgia. A report was submitted to CDC through ArboNet for any dead bird specimens testing positive for an arboviral infection.

Mosquito Surveillance
The state public health entomologist and four summer mosquito surveillance interns conducted regular weekly mosquito trapping at three counties with historically low human case numbers of LAC (Kanawha, Wood, and Jackson) and three counties with historically high human case numbers of LAC (Raleigh, Fayette, and Nicholas) using CDC gravid traps and CO_2 dispersing light traps. Semi-regular sampling was conducted in Mercer, Greenbrier, Putnam, Harrison, Marion, Wetzel, and Monongalia counties. Daily mosquito samples were returned to WVOLS in the nets of the mosquito traps and placed in a -80°C freezer. Volunteers (sanitarians, public health nurses, local health department interns) around the state collected additional samples from Cabell, Wayne, Braxton, and Hancock counties. All mosquito specimens were identified to species at WVOLS by the state public health entomologist.

For arboviral testing, mosquitoes collected from the same locality and on the same date were pooled together by genus in an effort to conserve on laboratory resources. The invasive Asian bush mosquito, *Aedes japonicus*, was tested separately from its congeneric mosquito species in order to elucidate the role *Aedes japonicus* may play in the LACV transmission cycle. Pools consisting of between 10-50 adult female mosquitoes were tested for arboviruses. Real time RT-PCR was used for arboviral detection. Mosquito pools were screened for WNV, SLEV, LACV, and EEEV. Test results were reported to CDC through ArboNet. Pooled infection rates were examined for each genus each week. The minimum infection rate (MIR) was determined weekly, (MIR is the ratio of the virus positive mosquito pools to the total number of mosquitoes in the samples).

Results

Human Surveillance

Table 1 provides a comparison of human cases of mosquito-borne diseases reported in WV during 2010-2014. During 2014, 7 cases of mosquito-borne diseases were reported in WV: 2 LAC cases (1 probable and 1 confirmed case), 2 confirmed travel-associated malaria cases, 1 probable travel-associated dengue fever case, and two confirmed chikungunya case. There were also two positive WNV viremic blood donors. Figure 1 shows the geographic distribution of LAC cases and other human mosquito-borne disease cases in 2014.

LAC cases

The median age of LAC cases was 8 years (mean=8 years, range=5-11 years). One case was male and the other was female. Both cases reported illness onset in August. The cases were reported in Kanawha and Raleigh Counties. One case has neuro-invasive disease and the other had non-neuroinvasive disease.

Table 1. Human cases of mosquito-borne disease in West Virginia from 2010 to 2014[*].

Mosquito-borne Disease	# (%) of Cases[†] (2010)	# (%) of Cases[†] (2011)	# (%) of Cases[†] (2012)	# (%) of Cases[†] (2013)	# (%) of Cases[†] (2014)
LAC	8 (62)	26 (74)	14 (56)	11 (69)	2(28.6)
WNV	0 (0)	2[*] (6)	9[*] (36)	1 (6)	0(0)
Malaria	3 (23)	7 (20)	2 (8)	2 (12.5)	2(28.6)
Dengue	2 (15)	0 (0)	0 (0)	2 (12.5)	1(14.3)
EEE	0 (0)	0 (0)	0 (0)	0 (0)	0(0)
SLE	0 (0)	0 (0)	0 (0)	0 (0)	0(0)
Chikungunya	0(0)	0(0)	0(0)	0(0)	2(28.6)
Total	13 (100)	35 (100)	25 (100)	16 (100)	7(100)

**Does not include positive viremic blood donors*

†Includes only cases classified as confirmed or probable

WNV cases

No WNV cases were reported in 2014; however, two positive-viremic donors were reported by Jefferson and Mineral Counties.

Dengue fever case

One 64 year-old female from Tyler County traveled to Haiti in late October and returned in early November.

Malaria cases

Both travel-associated malaria cases were 21 year-old males; one was from Mercer County and the other was from Mineral County. One case reported travel to South Korea and the other reported travel to New Guinea.

Chikungunya cases

West Virginia reported its first two chikungunya cases in 2014. The cases were from Wayne and Gilmer Counties. They were both female, ages 24 and 65 years of age. The first WV case traveled to Haiti; the second case reported travel to Jamaica.

Equine Surveillance

No equine serum specimens were submitted to WVOLS for arboviral disease testing in 2014.

Dead Bird Surveillance

Six dead birds were submitted to WVOLS for arboviral disease testing in 2014. Specimens were submitted between May and October from three counties: Hancock, Kanawha, and Nicholas counties. Bird specimens submitted included a Northern Flicker, a Grey Catbird, a Woodpecker, an Eastern Bluebird, and a House Finch (species was unknown for one bird). All were forwarded to and tested by SCWDS. One specimen, a House Finch submitted in October from Kanawha County tested positive for WNV. All other specimens were negative for arboviral infection.

Mosquito surveillance

Active adult mosquito sampling was conducted from May 13, 2014 – September 25, 2014. A total of 32,532 adult female mosquitoes were collected during mosquito surveillance season, of which 761 mosquito pools were tested for arboviruses. Table 2 shows the total number of mosquitoes collected by species.

Table 2. Mosquito species collected and identified in 2014.

Mosquito Species	**Number of mosquitoes collected (%)**
Culex pipiens/restuans	22,616 (69.5)
Culex erraticus	4,017 (12.3)
Aedes albopictus	2,104 (6.5)
Aedes trivittatus	1,781 (5.5)
Aedes japonicus	562 (1.7)
Aedes vexans	468 (1.4)
Psorophora ferox	373 (1.1)
Aedes triseriatus	215 (0.7)
Coquillettidia perturbans	152 (0.5)
Anopheles punctipennis	114 (0.4)
Anopheles quadrimaculatus	50 (0.2)
Psorophora columbiae	27 (0.1)
Other (13 *Uranotaenia sappharina,* 11 *Orthopodomyia signifera,* 6 *Aedes spp.,* 5 *Psorophora ciliata,* 4 *Anopheles perplexens,* 3 *Aedes canadensis,* 3 *Anopheles barberi,* 3 *Psorophora spp.,* 2 *Anopheles spp.,* 1 *Aedes tormentor,* 1 *Psorophora horrida,* 1 *Toxorhynchites rutilus septentrionalis*)	53 (0.2)
Total	**32,532 (100)**

Figure 1 shows a map of counties where mosquito surveillance occurred in the state. Samples from Mercer County were insufficient for arboviral testing. Positive WNV pools were found in two of the 16 counties where mosquito samples were tested. Twenty-five (3.3%) of the 761 total mosquito pools were infected with WNV; 24 (96%) were collected from Cabell County and one (4%) was collected from Hancock County. Mosquitoes with WNV infection were limited to counties along the western border of the state. The first WNV-positive pools were *Culex pipiens/restuans* active in Cabell County on August 1, 2014. The last WNV-positive mosquito pools were *Culex pipiens/restuans* and *Aedes albopictus* from Cabell County on September 23,

2014. In the mosquitoes, WNV activity was high in August 2014 and higher in September 2014 (Fig. 2).

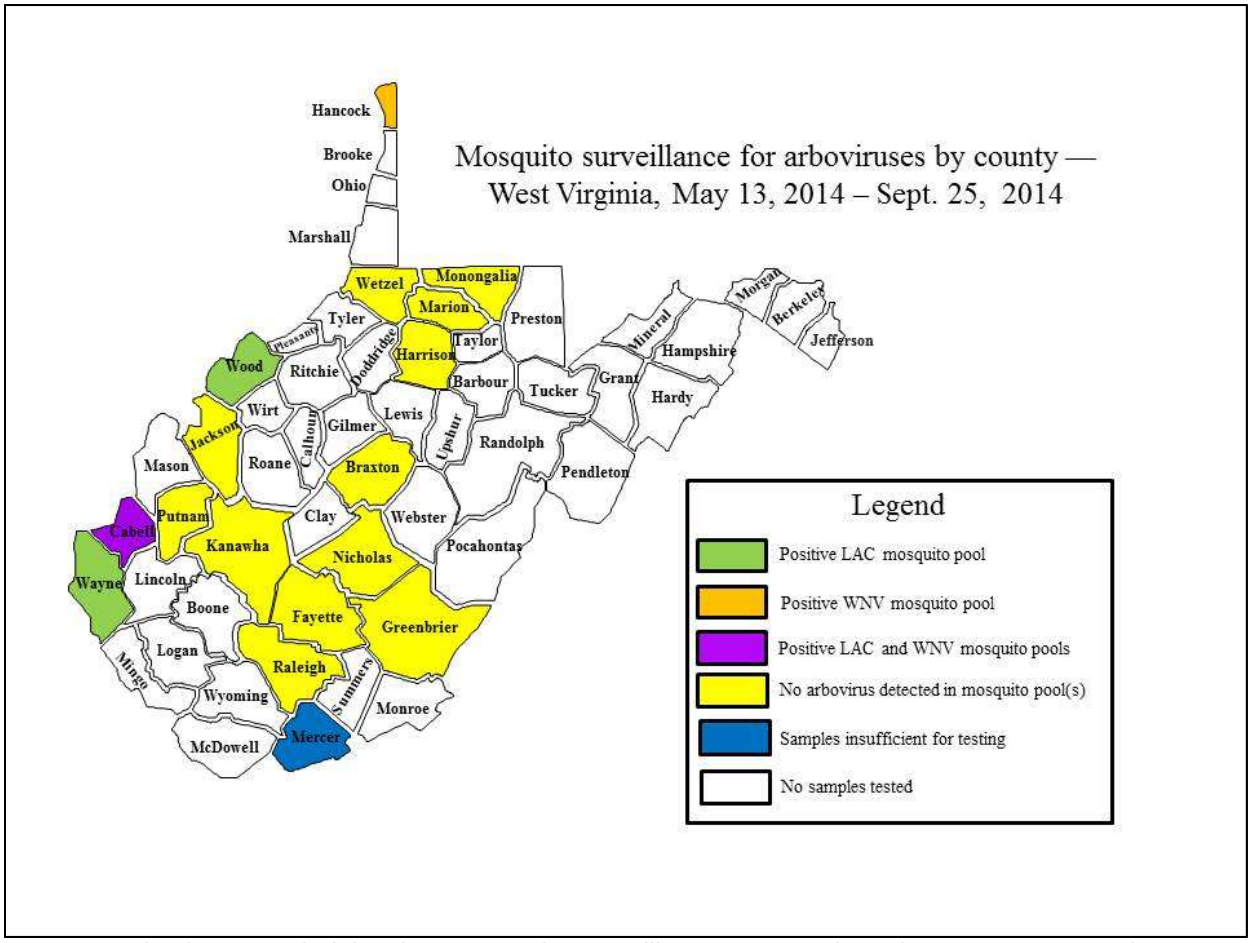


Figure 1. Counties in West Virginia where mosquito surveillance was conducted. Seventeen counties were under surveillance in 2014. Two counties had mosquito pools positive for WNV. Three counties had mosquito pools positive for LACV.

Mosquitoes infected with LACV were active in three of the 16 counties where mosquito samples were tested for arbovirus. Four of the 761 mosquito pools were infected with LACV; two were collected from Cabell County, one from Wayne County, and one from Wood County. Mosquitoes with LACV infection were limited to western border counties. This is the first record of LACV infected mosquitoes in Wood County. The first LAC virus-positive mosquitoes were *Culex pipiens/restuans* from Wayne County on June 13, 2014. The last LAC virus -positive mosquitoes were *Aedes triseriatus* from Cabell County on July 24, 2014.

There were new state records for three mosquito species in 2014. A single *Aedes tormentor* adult was collected in a CO_2 dispersing light trap in Fayette County on August 11-12. In Cabell County, a *Psorophora horrida* adult was collected in a CO_2 dispersing light trap on June 18-19. Mosquito gravid traps in three separate localities in Cabell County captured *Anopheles perplexens* adults on July 1-2, August 5-6, and September 4-5. And a CO_2 dispersing light trap in Kanawha County also collected an *Anopheles perplexens* adult on September 23-24.

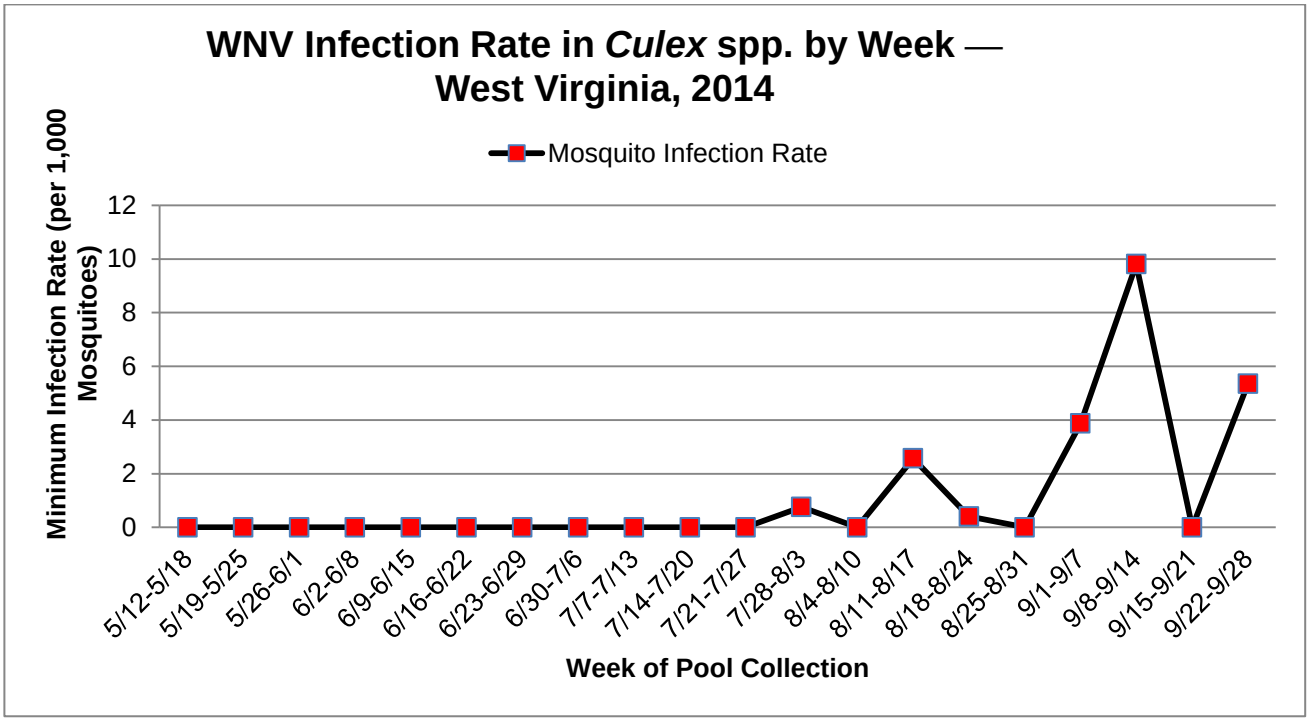


Figure 2. WNV infection rate in *Culex* spp. by week in West Virginia, 2014.

Discussion

The incidence of local mosquito-borne disease infections was very low in West Virginia in 2014 with only 2 LAC cases reported for the year and no WNV cases reported (two positive viremic blood donors were reported). LAC cases followed epidemiologic trends previously seen in WV (children under 15 years of age and in the southern region).

Interestingly, the number of imported mosquito-borne disease cases was higher than locally-acquired infections. Five imported mosquito-borne disease cases occurred in 2014, accounting for 71.4% of all cases. Chikungunya made its way to West Virginia in June 2014 and again in October 2014. Both cases reported travel to the Caribbean. It is important that residents from West Virginia who travel internationally be mindful of mosquito-borne diseases endemic in their destinations. CDC's website for travelers' health is a good resource for this information: http://wwwnc.cdc.gov/travel/.

Reducing the risk of mosquito-borne disease means reducing the risk of being bitten by mosquitoes:

- Be aware of the times of day when mosquitoes are most active. Many mosquitoes peak hours are dusk and dawn. For some LAC-transmitting mosquitoes, peak hours are during the day.
- Wear protective clothing such as long sleeves, pants, and socks. Use insect repellant that contains DEET, picardin, IR3535 or oil of lemon eucalyptus on exposed skin and clothing when outdoors.

- Ensure that window and door screens are intact to keep mosquitoes outside of homes. Remove breeding sites around the home (e.g. any containers that can accumulate water).
- Check with your healthcare provider when traveling abroad to learn about mosquito-borne diseases found in that area of the world.

Equine serum specimens have not contributed to environmental arboviral disease surveillance in recent years. Information sheets about submitting equine specimens for testing were sent to veterinarians before the start of active mosquito season. Other interventions may be necessary to promote participation. From dead bird surveillance, one WNV-positive house finch was reported late in the season. Increased environmental surveillance may provide valuable supplemental information related to arboviral activity in the state.

The low arboviral activity in mosquitoes and the limited geographic distribution of infected mosquitoes resulted in few human arboviral cases in 2014. WNV infection rates in *Culex* spp. during the 2014 mosquito surveillance season were similar to the low rates from other years when human incidence of West Nile encephalitis was low (2008-2011, 2013). In 2013, mosquitoes infected with WNV were broadly distributed throughout the state. As a result, a West Nile encephalitis human case occurred in Monongalia County in 2013. This year, no WNV infected mosquitoes were identified in the interior of West Virginia, and no human cases of West Nile encephalitis reported. In 2013, LACV was detected in 22 mosquito pools collected from six counties in southwestern West Virginia and one county in West Virginia's eastern panhandle. Eleven human cases of LAC were distributed across six West Virginia counties in 2013. Conversely, LACV was only detected in four mosquito pools collected from three counties along West Virginia's western border in 2014. With little to no LACV activity in the mosquitoes across most of West Virginia, only two LAC human cases in two neighboring counties, Kanawha and Raleigh Counties, occurred in 2014.

The Zoonotic Disease Group in the Division of Infectious Disease Epidemiology (DIDE) hopes to increase outreach efforts related to mosquito-borne diseases across the state in 2015. Several new pieces of public health literature have been created to share with public health partners and the general public. An updated LAC pamphlet was drafted in 2013 and is available for use (http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Documents/arbovirus/lacrosseencephalitis/La-Crosse-Encephalitis-Pamphlet.pdf). Arboviral disease information sheets and other important public health messages concerning mosquito-borne diseases can be found on the DIDE website at http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Pages/default.aspx.

The Zoonotic Disease Group sincerely thanks the many public health partners who contributed to mosquito-borne disease surveillance across the state. Your efforts have provided us with important information presented in this report.

Introduction \

Tickborne diseases (TBDs) are diseases transmitted by the bite from an infected tick vector. In West Virginia, tick vectors responsible for disease transmission have been identified for at least six TBDs (Table 1). Diagnosing TBDs can be challenging as some of these infections can initially produce similar, non-specific clinical symptoms (as with rickettsial diseases), while other TBDs produce highly variable symptoms (as in Lyme disease)[1,2]. Early recognition and treatment of TBDs by healthcare providers is important to prevent complications from these diseases and decrease morbidity and mortality. Most TBDs, including those listed in Table 1, are reportable to public health authorities in West Virginia from healthcare providers and laboratories. The purpose of this summary is to describe the epidemiology of TBDs reported in West Virginia in 2014.

Table 1. Possible tickborne diseases by causative agent based on vectors found in West Virginia.

Tickborne Disease[a]	Agent	Tick Vector(s) in West Virginia
Anaplasmosis	*Anaplasma phagocytophilum*	Blacklegged tick (*Ixodes scapularis*)[b]
Babesiosis	*Babesia microti* and other *Babesia* spp.	Blacklegged tick (*Ixodes scapularis*)
Ehrlichiosis	*Ehrlichia chaffeensis* and *Ehrlichia ewingii*	Lone star tick (*Amblyomma americanum)*
Lyme disease	*Borrelia burgdorferi*	Blacklegged tick (*Ixodes scapularis*)
Powassan encephalitis	Powassan virus	Groundhog tick (*Ixodes cookei*)[c] Blacklegged tick (*Ixodes scapularis*)
Rocky Mountain Spotted Fever and other spotted fever rickettsioses	*Rickettsia rickettsii* (and other spotted fever group *Rickettsia* spp.)	American dog tick (*Dermacentor variabilis*) Brown dog tick (*Rhipicephalus sanguineus)* Lone star tick (*Amblyomma americanum*) Gulf Coast tick (*Amblyomma maculatum*)
Tularemia[d]	*Francisella tularensis*	American Dog tick (*Dermacentor variabilis*) Lone star tick (*Amblyomma americanum*)

[a] Other tickborne diseases, including but not limited to Colorado tick fever, tickborne encephalitis, and Crimean-Congo hemorrhagic fever, may result from travel to regions where these illnesses are endemic.
[b] *I. scapularis* is also commonly referred to as the deer tick.
[c] *I. cookei* does not have an official common name. Names that have been used include the groundhog tick, woodchuck tick, and the American castor bean tick.
[d] Tularemia cases are included in the "Other ZD Surveillance Summary" since other animal species more commonly transmit tularemia to humans.

Methods

Surveillance and Case Ascertainment Methods

During the study period (MMWT Year 2014), passive surveillance was conducted for TBDs in West Virginia. West Virginia State Code 16-3-1 and 64CSR7 establishes infectious disease reporting requirements for healthcare providers and laboratories. Local health departments conducted initial case investigations after receiving a case report or positive laboratory results for a reportable TBD. Cases were reported from local health departments to the state health department electronically using the West Virginia Electronic Disease Surveillance System (WVEDSS).

Cases reported by local health departments during the study period were reviewed by the state health department before a final case classification status was assigned. All case classifications were determined using the most current case definition for each disease or condition. Once final case status was determined, cases were reported by the state health department to the Centers for Disease Control and Prevention (CDC) via the National Electronic Telecommunications System for Surveillance (NETSS).

Data Extraction and Analyses
Demographic and clinical information about suspect, probable, and confirmed cases of each TBD were exported from WVEDSS to an Excel database. For the purposes of this study, only probable and confirmed cases with report dates during MMWR Year 2014 were included in analyses. County- and state-level census estimates for 2014 were obtained through the United States Census Bureau at http://quickfacts.census.gov/qfd/states/54000.html.

Active Tick Surveillance
Tick drag surveys were done using the standard tick drag method to collect specimens. Ticks found on the drag cloth (or the surveyor) were removed, preserved in 70% ethanol and returned to the laboratory for species identification and sex determination. Surveys were conducted by the public health entomologist at Coopers Rock State Forest (Monongalia and Preston counties) in northern West Virginia and Little Beaver State Park (Raleigh County), Greenbrier State Forest (Greenbrier County), Bluestone Wildlife Management Area (Summers County), and Pipestem Resort State Park (Summers County) in southeastern West Virginia. Sporadic tick surveys were conducted throughout Kanawha County including Kanawha State Forest.

West Virginia added a tick surveillance intern to the zoonotic disease program in 2014 through funding from the CDC Epidemiology and Laboratory Cooperative Agreement. The intern conducted four tick drag surveys: three in Monongalia County (Coopers Rock State Forest) and one in Roane County (a woody residential area), in late October and early December 2014.

Veterinary Tick Submission Project
2014 marked the second year of the West Virginia Veterinary Tick Submission Project (WVVTSP). Veterinarians from clinics across the state (and one in Pennsylvania) were asked to mail ticks found on animal clients to the state public health entomologist. For each submission, a form that collected information about the animal host (e.g. species, home county) and date of collection was also enclosed.

Deer Ectoparasite Surveillance
West Virginia Division of Natural Resources (WVDNR) biologists examined 30 white-tailed deer (*Odocoileus virginianus*) for external parasites at each of 20 official game checking stations in central and southeastern West Virginia from November 25-27, 2013. Biologists collected a representative sample of all arthropod external parasites from places on the deer where ectoparasites congregate (i.e. inner and outer margins of ear, face and areas around the eyes and base of the ears, neck, between shoulders, axillary area of the front legs, and groin area between the back legs). Host data, such as identification number, sex, age, county where deer was collected, submission date, and check station locality, were collected for each ectoparasite submission. The ectoparasites were delivered to the state public health entomologist for species identification.

Tick Pathogen Testing

Cornell University Animal Health Diagnostic Center (CUAHDC) formed an agreement with WVBPH to conduct real-time PCR pathogen testing (for *Borrelia* spp., *Anaplasma/Ehrlichia* spp., and *Babesia* spp.) on ticks collected through various surveillance activities. *I. scapularis* collected through WVVTSP were tested for *Borrelia* spp., *Anaplasma/Ehrlichia* spp., and *Babesia* spp. *I. scapularis* deer in northern West Virginia (Monongalia, Marion, Barbour, Harrison, Lewis, Doddridge, Wetzel, and Tyler counties) and central West Virginia (Kanawha and Putnam counties) were tested for *Borrelia burgdorferi.*

Results

In 2014, there were 145 confirmed and probable TBD cases reported from 23 counties in WV (Figure 1). Conditions reported included anaplasmosis, ehrlichiosis, Rocky Mountain spotted fever (RMSF) and other spotted fever group rickettsioses, and Lyme disease. Table 2 summarizes the data for 2014. No cases of babesiosis or Powassan virus were reported during this period.

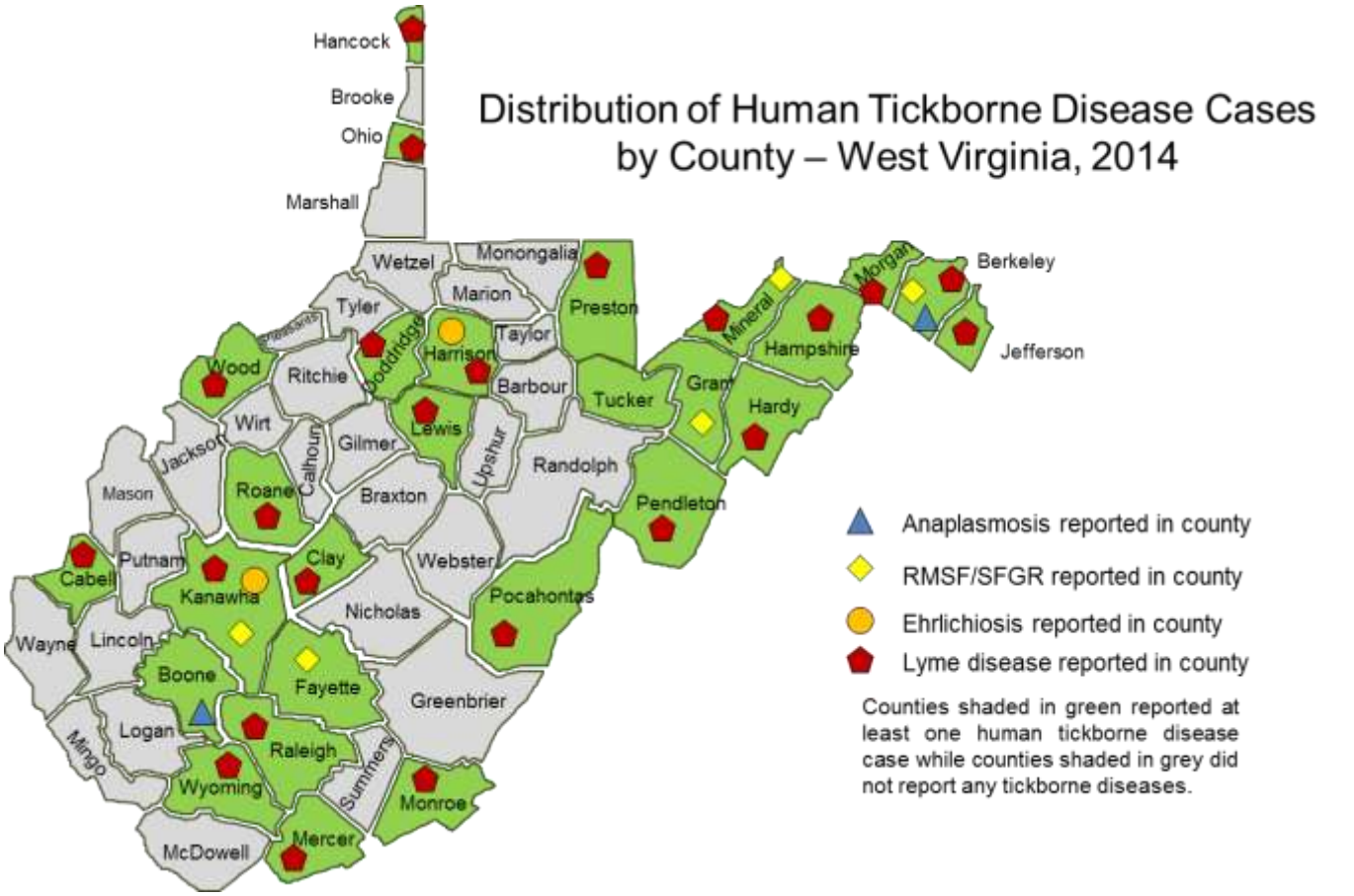


Figure 1. Counties in West Virginia that reported at least one TBD case. Twenty-seven (49.0%) counties reported at least one TBD case in 2014.

Table 2. Summary of reporting statistics for TBDs reported in West Virginia in 2014.

Disease Name	Total number of cases reported in 2013	Total number of cases reported in 2014	# of counties with cases (2014)	Incidence per 100,000 (2014)
Anaplasmosis	3	2	2	0.1
Ehrlichiosis	4	2	2	0.1
Anaplasmosis/ Ehrlichiosis undetermined	2	0	0	
RMSF/SGFR	7	5	5	0.3
Lyme disease	143	136	23	7.4
TOTAL	**159**	**145**	**27**	**7.8**

Anaplasmosis
Two probable cases of anaplasmosis were reported during the MWWR year 2014. Cases were reported from Berkeley and Boone Counties. One case was male and one was female. Their ages were 21 and 24. One was hospitalized, and no deaths were reported.

Ehrlichiosis
Two confirmed cases of ehrlichiosis were reported during the MWWR year 2014. Cases were reported from Harrison and Kanawha Counties. One case was male and one was female. Their ages were 60 and 67. Both were hospitalized, and no deaths were reported.

Rocky Mountain spotted fever and other SFGRs
Three probable cases of RMSF and two probable spotted fever group rickettsioses (SFGR) cases were reported during the MWWR year 2014. Cases were reported in Berkeley, Fayette, Grant, Kanawha, and Mineral Counties. Two cases were male and three were female. Their ages were 37, 40, 42, 49, and 80 years of age. Two cases were hospitalized, and no deaths were reported.

Lyme disease
There were 136 confirmed (n=112) and probable (n=24) Lyme disease cases reported in West Virginia during MMWR year 2014 accounting for 93.8% (136/145) of all TBD cases reported during this period. Cases of Lyme disease were reported from 23 counties across the state (Figure 1). Berkeley and Hampshire Counties, located in the Eastern Panhandle and endemic for Lyme disease, had the highest proportion of cases with 38 (27.9 %) and 26 (19.1%) cases, respectively. Berkeley, Hampshire, Jefferson, and Morgan Counties all had incidence rates greater than 20 per 100,000 people (based on population estimates for each county). All other counties with cases had incidence rates below 20.0 per 100,000 people.

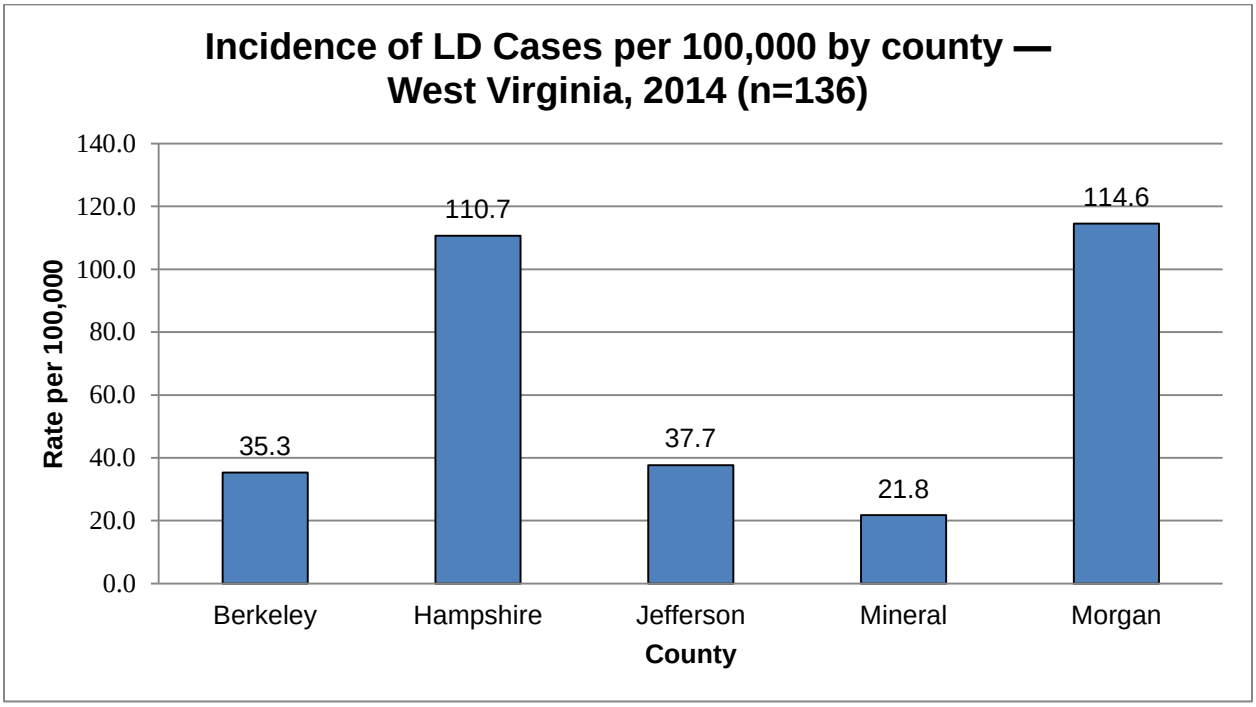


Figure 2. Incidence of Lyme disease cases by county. Estimates are based on 2012 census data for each county. Only counties with incidence rates above 10.0 people per 100,000 are shown.

The highest proportion of Lyme disease cases reported illness onset during the warm weather months (Figure 3); 81 (74.5%) cases reported illness onset dates from June to August. Among females, the highest incidence occurred in the 61-70 and 70+ age group; the highest incidence among males occurred in the 1-10 age group (Figure 4). Erythema migrans (EM) and arthritis with joint swelling were the most reported symptoms (44.9% and 42.6% of cases, respectively) (Fig. 5). No deaths were reported as a result of illness.

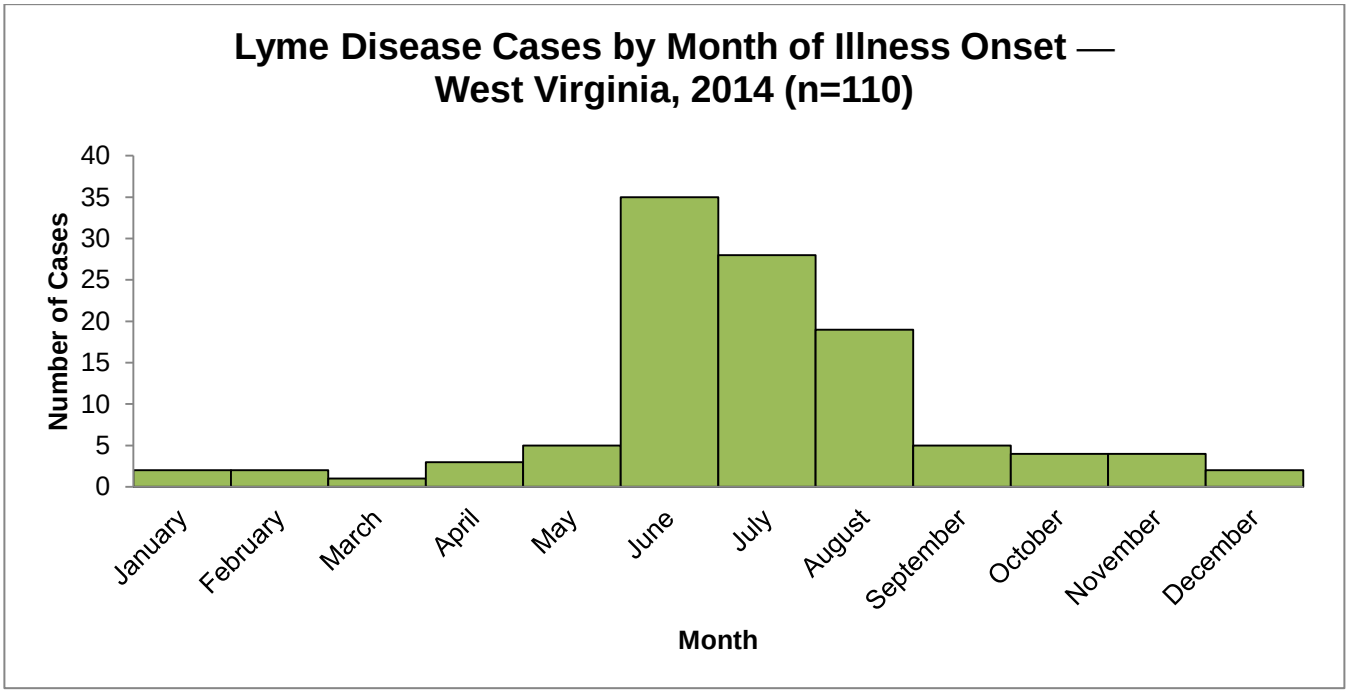


Figure 3. Month of illness onset for probable and confirmed cases of Lyme disease. Date of illness onset was missing for twenty-six cases.

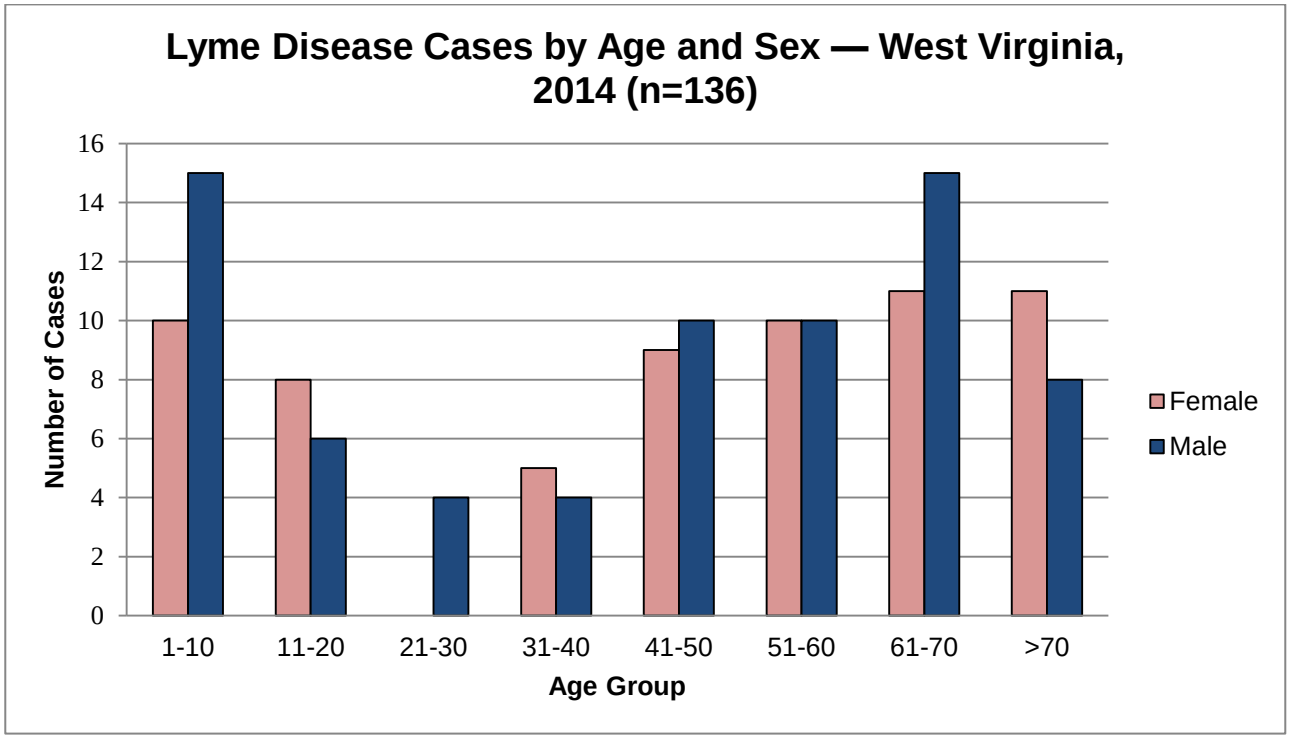


Figure 4. Incidence of Lyme disease by age group and sex.

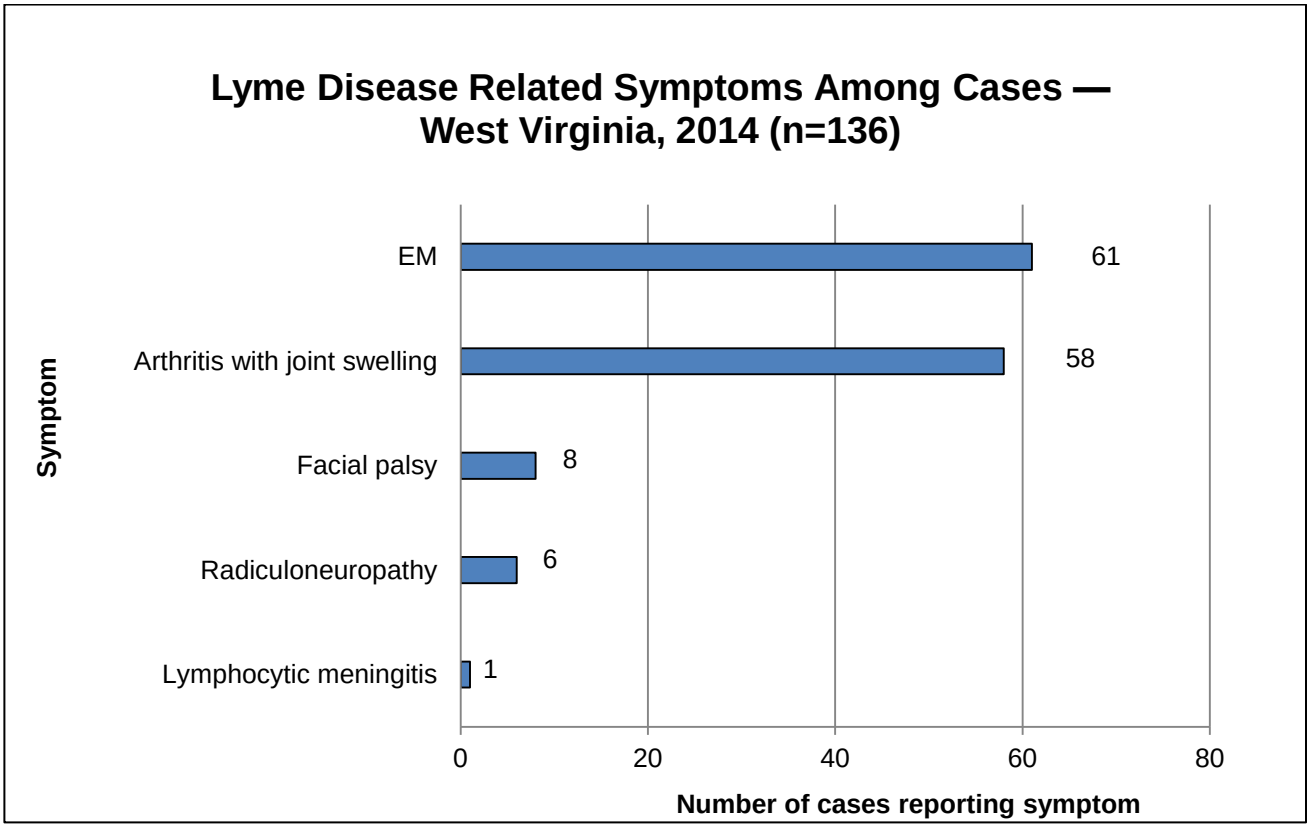


Figure 5. Symptoms reported by confirmed and probable Lyme disease cases in West Virginia. EM and arthritis with joint swelling were the most reported symptoms.

Active Tick Surveillance

A single adult female *I. scapularis* was collected from a human host at Seneca Rocks Discovery Center in Pendleton County, West Virginia on May 3, 2014. This specimen represents the first *I. scapularis* recovered from Pendleton County.

Through active tick surveillance, 129 *I. scapularis* were collected at a single collecting locality in Charleston, WV (25311) in 2014 (Figure 6). The site was characterized by extensive white-tailed deer (*Odocoileus virginianus*) activity and large accumulations of leaf litter. *Ixodes scapularis* were not recovered from any other locations in the state.

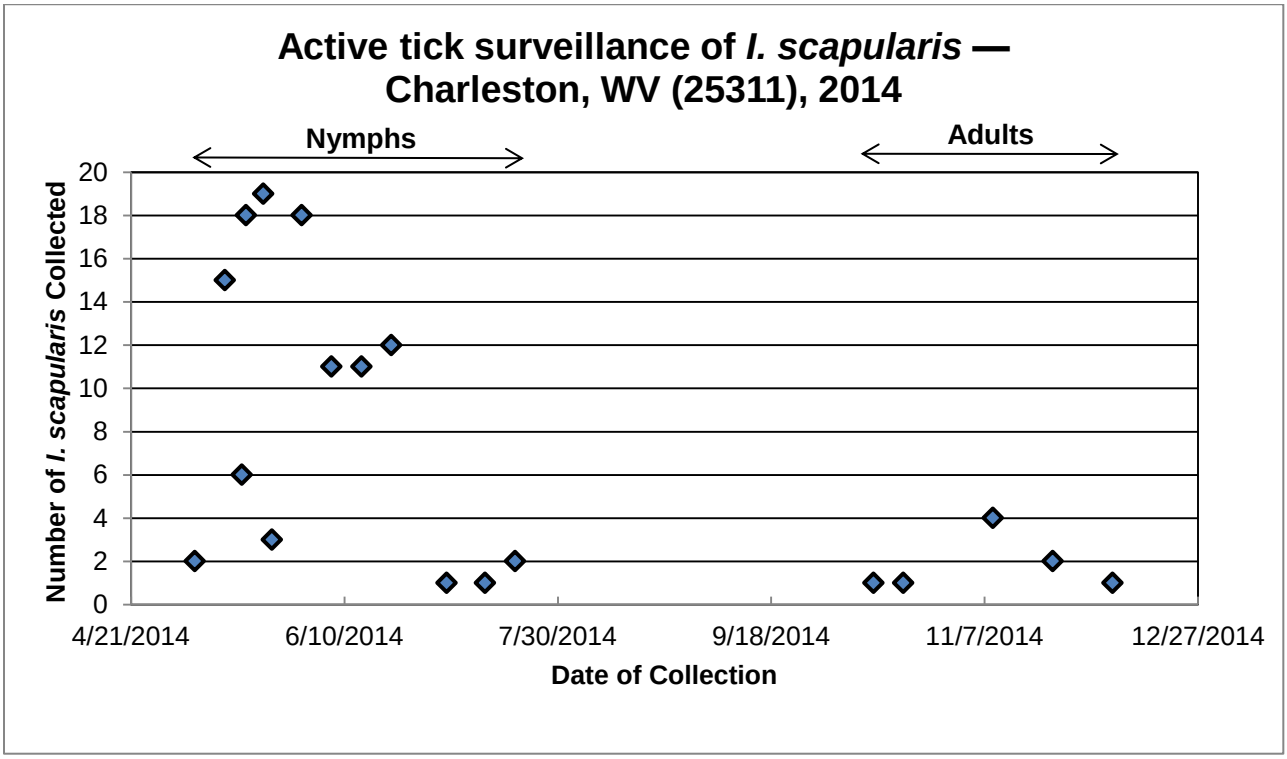


Figure 6. Active tick surveillance for *I scapularis* at a location in Charleston, WV (25311).

Veterinary Tick Surveillance

Veterinarians from 35 veterinary clinics in West Virginia submitted 1,220 ticks from animal clients. Six tick species were identified: *Amblyomma americanum, Amblyomma maculatum, Dermacentor variabilis, Ixodes cookei, Ixodes scapularis,* and *Haemaphysalis leporispalustris* (Table 4). Forty-seven counties were represented including 8 counties in Maryland, Ohio, Pennsylvania, and Virginia based on the home county of the animal host (Figure 7). Animal hosts included cats, a chipmunk, dogs, a fox, a horse, humans, and rabbits.

Table 3. West Virginia Veterinary Tick Surveillance Project (WVVTSP) data.

Species of Tick	# of ticks identified	Animal species from which tick was removed	# of counties with tick species[1]
D. variabilis	998	Cat, Dog Horse, Fox, Human	41
I. scapularis	179	Cat, Dog, Human, Rabbit	26
I. cookei	18	Cat, Chipmunk, Dog	7
A. americanum	16	Cat, Dog, Human	6
H. leporispalustris	8	Rabbit	1
A. maculatum	1	Dog	1
Total	**1,220**	**7**	**47**

[1]Based on home county of the animal.

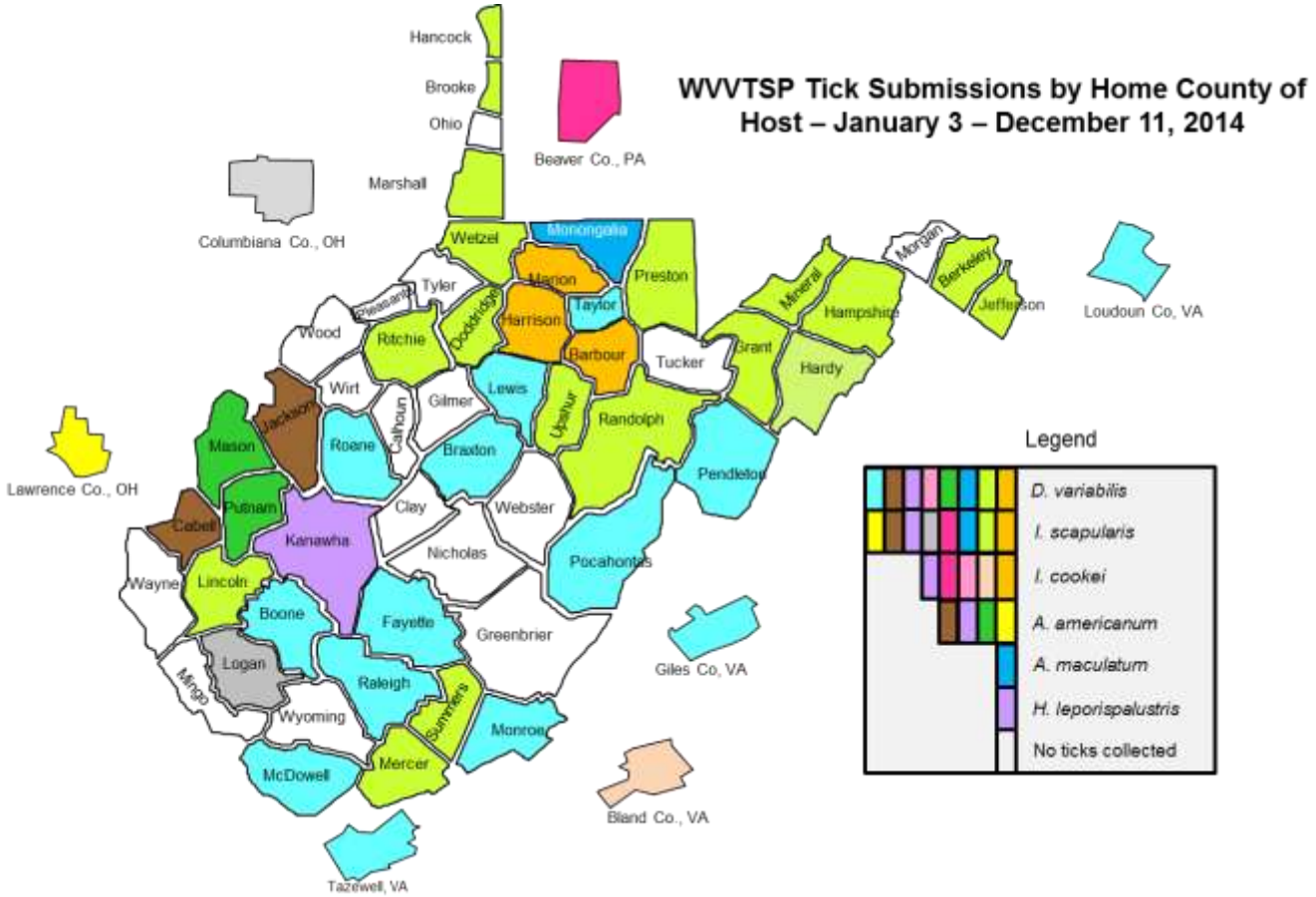


Figure 7. Map showing the distribution of ticks collected through veterinary submissions by home county of the animal on which the tick was found. 1,220 were collected from 47 counties.

Deer Ectoparasite Surveillance

A total of 904 ticks were collected through the deer ectoparasite survey conducted in 2013. Two hundred eighty two *I. scapularis* (101 adult females, 181 adult males) were collected from white-tailed deer. Although more winter tick (*Dermacentor albipictus*) specimens were collected (592 total with 134 adult females, 268 adult males, 185 nymphs, and 5 larvae), *Dermacentor albopictus* is not of public health interest. Thirty indeterminate *Ixodes* adult females were also collected. *I. scapularis* was more prevalent in counties in eastern West Virginia than in the

western half of the state (Figure 8). Out of 112 *I. scapularis* tested for *B. burgdorferi,* one adult female from a deer hunted in Marion County was infected with the Lyme disease pathogen.

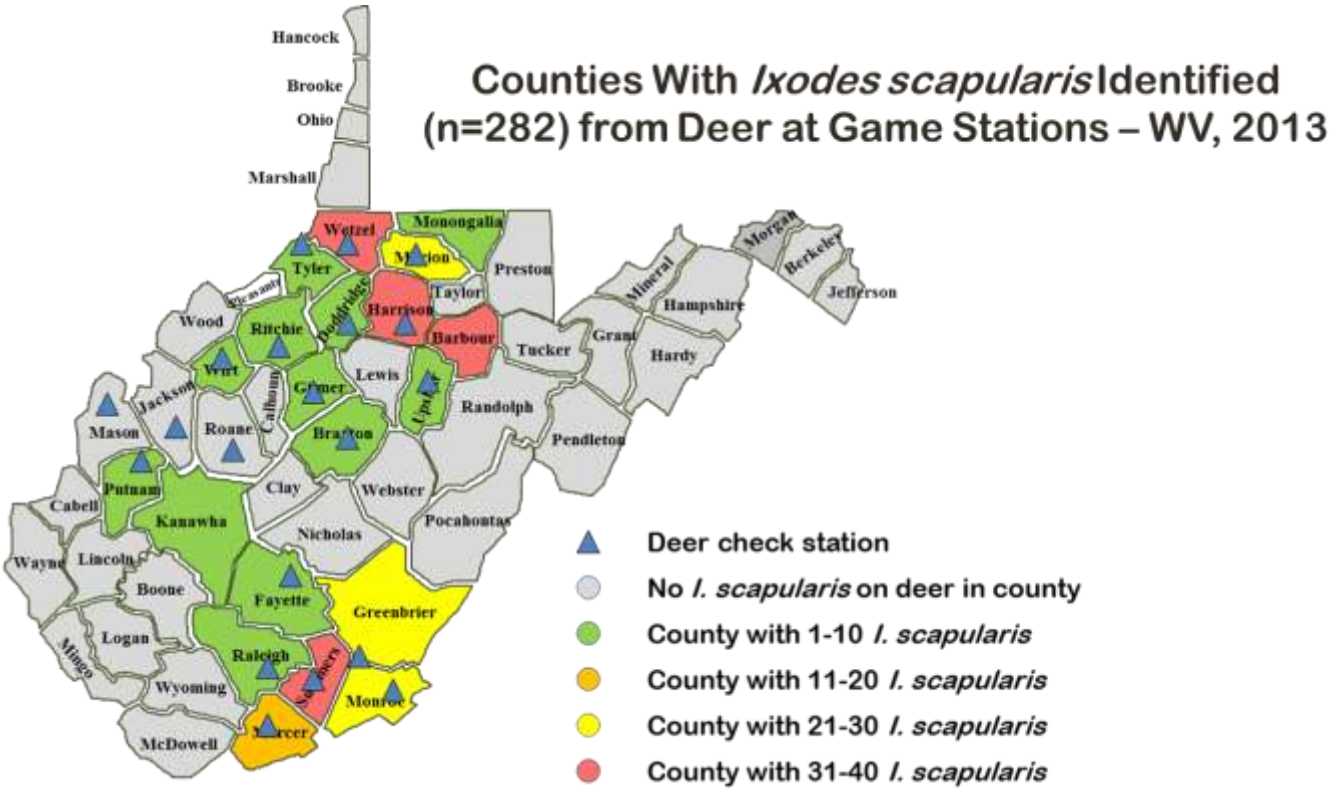


Figure 8. Distribution and number of *I. scapularis* collected from deer at game check stations in West Virginia in 2013. Barbour, Harrison, Summers, and Wetzel Counties were the counties from which the most number of *I. scapularis* were found on deer.

Discussion

Four human TBDs were reported in West Virginia during 2014: anaplasmosis, ehrlichiosis, Lyme disease, and Rocky Mountain spotted fever/spotted fever group rickettsioses. Lyme disease accounted for the majority of TBD cases (Table 2). Though the vectors of Powassan encephalitis (*I. cookei* and *I. scapularis*) have been identified in the state, there were no reports during the time period. Powassan virus has never been identified in humans in West Virginia.

The reported number of TBDs was less than for the previous reporting year (Table 2); the number of counties that reported at least one TBD went down by one from 24 counties in 2013 to 23 counties in 2014. While the majority of cases reported illness onset in warm months, there was at least one case that reported illness onset in each of the months. *I. scapularis* and *I. cookei* ticks were collected by veterinarians as early as January and late as December from animal clients, indicating that ticks were active even in cold weather.

The majority of cases with tickborne rickettsial diseases (anaplasmosis, ehrlichiosis, and RMSF) were hospitalized (71.4%). These diseases can lead to serious illness (such as bleeding disorders) or death if left untreated. Patients who are treated early may recover quickly making early diagnosis of these diseases very important.

West Virginia borders three states with high incidence of TBDs. Maryland, Pennsylvania, and Virginia rank in the top 13 states that account for about 95% of Lyme disease cases reported annually. Quality surveillance allows for monitoring of changes in the occurrence of TBDs and identification of emerging TBDs at the local, state, and national level. Therefore, it is important to obtain timely and accurate data, including travel history, during TBD case investigations.

Two counties were added as Lyme endemic counties in 2014: Hancock and Mineral counties. *B. burgdorferi* infected ticks were found in Hancock County, and Mineral County had at least two human cases with erythema migrans (EM) and appropriate confirmatory laboratory critieria with the disease acquired within the jurisdiction. With the addition of Wood County in 2015 (based on two confirmed cases from 2014), West Virginia now has seven Lyme disease endemic counties, including Berkeley, Hampshire, Jefferson, and Morgan counties that were previously classified as endemic (Appendix A). A historical map of Lyme disease cases from 2000 to 2014 can be found in Appendix B.

Unlike in many other states, active tick surveillance in West Virginia does not result in the collection of very many ticks. To this end, “One Health” collaborations have greatly expanded knowledge of the distribution of tick vectors across the state. The number of ticks submitted by veterinarians through WVVTSP more than doubled from the previous year (604 ticks in 2013 compared to 1,220 in 2014). Zip code data collected through WVVTSP will influence 2015 tick surveillance activities, meaning that targeted surveillance will occur in Marion, Mercer, Monongalia, Monroe, and Summers counties in 2015. *I. scapularis* was identified in 12 counties that reported human Lyme disease cases. Thanks to WVBPH’s partnership with WVDNR, new county records of *I. scapulars* were recorded in Braxton, Gilmer, Monroe, Putnam, Raleigh, Tyler, and Wirt counties.

WVBPH expanded its tick pathogen testing capabilities in 2014. In addition to CUAHDC, a pathogen testing partnership was forged between West Virginia University and WVBPH. *I. scapularis* collected from WVVTSP, WVDNR, and through active tick surveillance will be tested at WVU in 2015 while other ticks species identified through surveillance activities will be tested at CUADHC.

There are limitations to the current report. First, underreporting of TBDs in West Virginia is likely. Cases may not seek medical attention unless symptoms or clinical manifestations of disease become severe and cannot be resolved without treatment. Misdiagnosis of disease is possible due to inaccurate laboratory test results and/or provider diagnostic error. There is also the possibility of case misclassification. For example, case ascertainment for Lyme disease requires clinical, laboratory, and, sometimes, epidemiologic evidence. If information is missing, a true case may be classified as either “suspect,” or “not a case.” In 2014, there were 31 “suspected” cases of Lyme disease, one “suspected” case of anaplasmosis, one suspected ehrlichiosis, and one suspected SFGR cases that were not included in the analyses of this summary. This highlights the importance of obtaining quality laboratory, clinical, and epidemiologic information to ensure that appropriate surveillance is being conducted. Lastly, there is limited manpower to conduct tick surveillance in West Virginia. WVBPH will have two tick surveillance interns in 2015 to conduct tick drags in counties speculated to be endemic for Lyme disease (based on human surveillance data and presence of tick populations).

Prevention of tickborne illnesses focuses primarily on avoiding tick bites. A tickborne illness prevention checklist can be found on the Division of Infectious Disease Epidemiology website at:

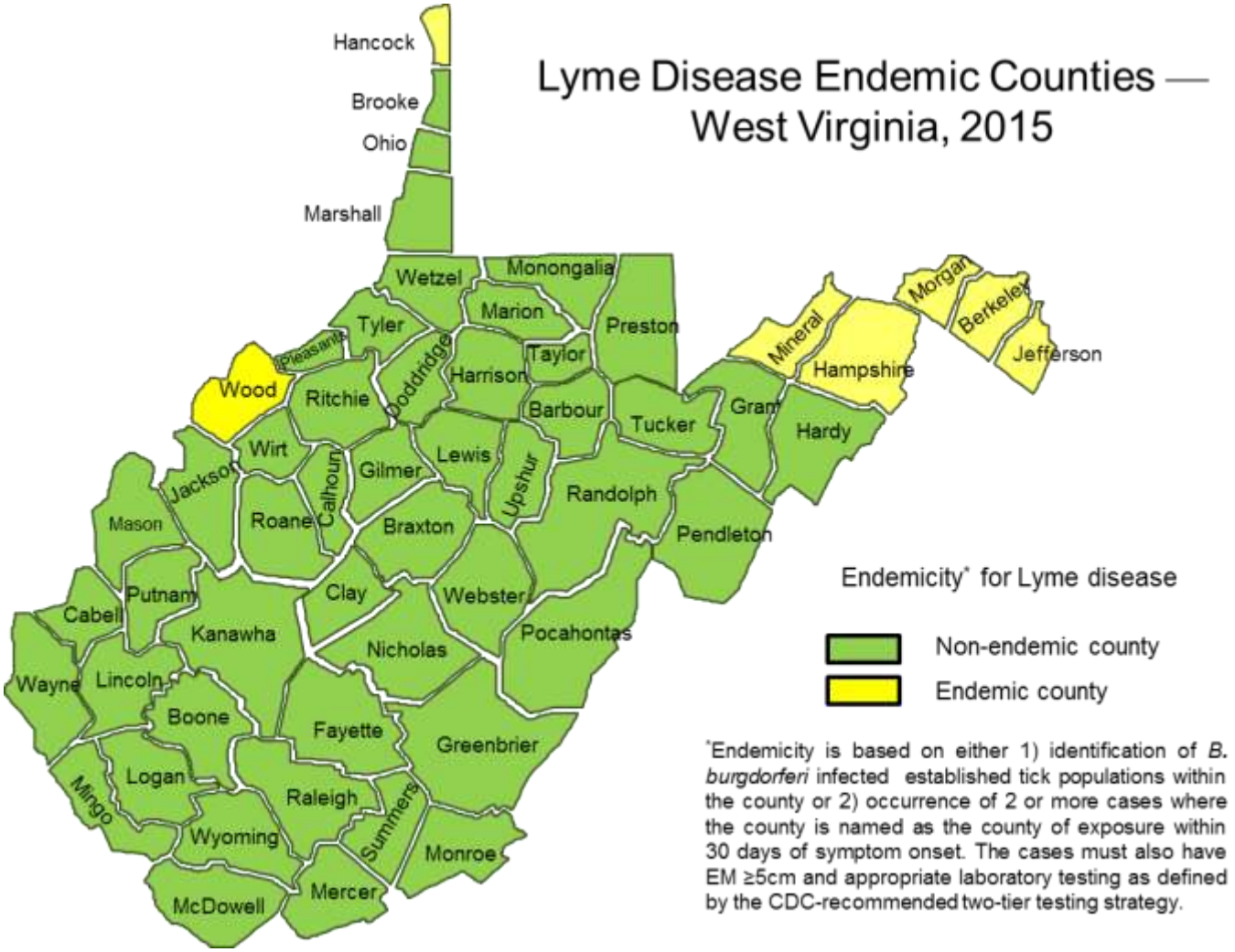
http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Tick/Documents/Tick%20Bite%20Prevention%20Checklist.pdf. In addition, CDC provides recommendation for the prevention of TBDs, adapted in Box 1. Because ticks are more active in warmer months, it is also important to make the public aware of the risk of becoming infected with any TBD from late-spring to early-fall.

Box 1. CDC recommended steps for tick bite prevention[3].

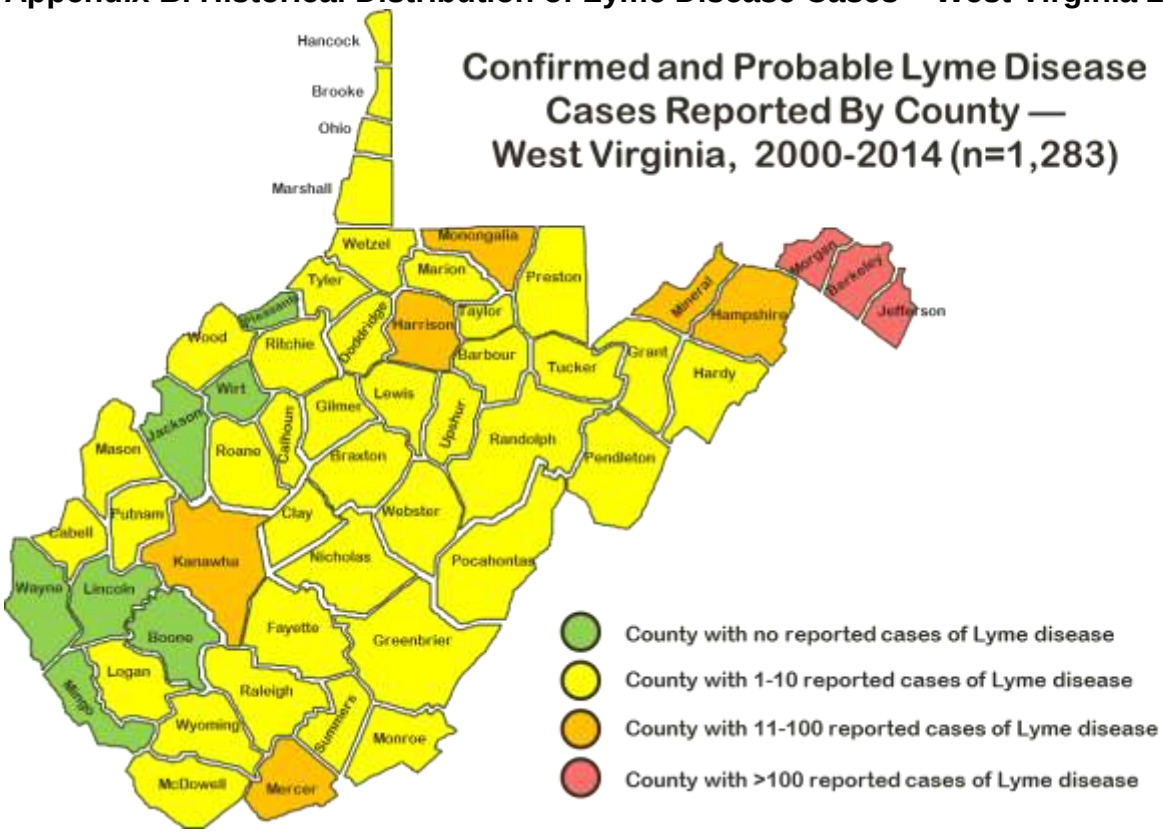
- Be extra vigilant in warmer months (April-September) when ticks are most active.
- Avoid wooded and bushy areas with high grass and leaf litter.
- Walk in the center of trails.
- Repel ticks with DEET or permethrin. Use repellents that contain 20% or more DEET on exposed skin for protection that will last several hours. Use products that contain permethrin on clothing. Treat clothing and gear, such as boots, pants, socks, and tents.
- Find and remove ticks from your body. Bathe or shower as soon as possible after coming indoors to easily find ticks that may be crawling on you.
- Conduct a full-body tick check using a hand-held or full-length mirror to view all parts of your body upon returning from tick-infested areas.
- Parents should check their children for ticks under the arms, in and around the ears, inside the belly button, behind the knees, between their legs, around the waist, and especially in their hair.
- Examine gear and pets. Ticks can ride into the home on clothing and pets. Tumble clothes in a dryer on high heat for an hour to kill ticks that may be attached.

The Zoonotic Disease Group sincerely thanks the many public health partners who contributed to tickborne disease surveillance across the state. Your efforts have provided us with important information presented in this report.

Appendix A: Counties in West Virginia considered endemic for Lyme disease (2015).



Appendix B. Historical Distribution of Lyme Disease Cases – West Virginia 2000-2014.



Introduction

While mosquito- and tickborne diseases account for the majority of zoonotic diseases reported in West Virginia, there are other diseases that can be transmitted from animals to humans without these vectors. Table 1 shows a list of diseases and conditions under surveillance in West Virginia that are transmitted by other animals. Q fever and tularemia can be transmitted by ticks, but are more commonly transmitted by other animals.

Disease	Pathogen	Host(s)
Anthrax	*Bacillus anthracis*	Cattle, sheep, and goats
Brucellosis	*Brucella* spp.	Sheep, goats, cattle, deer, elk, pigs, and dogs
Hantavirus pulmonary syndrome	Hantavirus	Wild rodents (deer mice)
Leptospirosis	*Leptospira interrogans*	Cattle, pigs, horses, dogs, rodents, and wild animals
MERS	MERS coronavirus	Camels, bats?
Monkeypox	Monkeypox virus	Rodents, prairie dogs, Gambian giant rat, rabbits
Plague	*Yersinia pestis*	Fleas and rodents
Psittacosis	*Chlamydophila psittaci*	Parrots, parakeets, macaws, turkeys, ducks
Q fever	*Coxiella burnetii*	Cattle, sheep, ticks and goats
Rabies[1]	Rabies lyssavirus	Mammals- bats, raccoons, skunks
SARS	SARS coronavirus	Bats?
Tularemia	*Francisella tularensis*	Hard ticks, rabbits, hares, and rodents
Viral hemorrhagic fever	Marburg virus, Lassa virus, Ebola virus, Crimean-Congo virus, Rift Valley Fever, Yellow Fever	Bats, primates, ticks, mosquitoes, rodents

[1]A separate report on rabies surveillance can be found at http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Rabies/documents/surveillance/rabies-surveillance-2014.pdf.

Methods

Human Surveillance

During the study period (MMWR Year 2014), passive surveillance was conducted for TBDs in West Virginia. West Virginia State Code 16-3-1 and 64CSR7 establishes infectious disease reporting requirements for healthcare providers and laboratories. Local health departments conducted initial case investigations after receiving a case report or positive laboratory results for a reportable zoonotic disease. Cases were reported by local health departments to the state health department electronically using the West Virginia Electronic Disease Surveillance System (WVEDSS).

Cases reported by local health departments during the study period were reviewed by the state health department before a final case classification status was assigned. All case classifications were determined using the most current case definition for each disease or condition. Once final case statuses were determined, cases were reported by the state health department to the Centers for Disease Control and Prevention (CDC) via the National Electronic Telecommunications System for Surveillance (NETSS).

Results

Brucellosis
One confirmed case was from Kanawha County, and two probable cases were from Hardy County. Their ages were 49, 60, and 62 years of age. Two were male and one was female. Two cases reported exposure to birthing products from cattle, goats, and a dog. One case had laboratory exposure to the *Brucella* organisms. One case was hospitalized; no deaths were reported.

Q fever
Three probable Q fever cases were reported from Jefferson, Pendleton, and Hampshire Counties. Two cases were female and one was male. Their ages were 30, 49, 57 years of age. One case reported exposure to sheep, and one case reported recent travel to Nigeria. One case was hospitalized as a result of infection. No deaths were reported as a result of illness.

Tularemia
One confirmed case of tularemia was reported from Hardy County. The case was a 66 year-old male who reported a tick bite and travel outside of West Virginia. The case was not hospitalized nor died as a result of infection.

Discussion

Zoonotic diseases in West Virginia can come from a variety of animals and are based on the type and location of exposure to pathogen zoonotic agents. Some zoonotic pathogens require travel to specific areas of the world for a person to become infected, while others required exposure to bodily fluids or a bite from a specific animal host.

In West Virginia, most of the non-mosquito-borne and non-tickborne infections come from contact with domestic animals such as livestock and dogs. West Virginia has a rich agricultural economy in the Eastern Panhandle, which may explain case reports from Hampshire, Hardy, Jefferson, and Pendleton Counties.

With increased human travel and factors that contribution greater expansion of animal hosts and vectors (e.g. climate change, deforestation), it is likely that the variety of diseases transmitted by animals, including mosquitoes and ticks, will increase in over the next few years.

For information about “other” zoonotic diseases reportable in West Virginia, visit: http://www.dhhr.wv.gov/oeps/disease/Zoonosis/other/Pages/default.aspx.

The Zoonotic Disease Group sincerely thanks the many public health partners who contributed to tickborne disease surveillance across the state. Your efforts have provided us with important information presented in this report.