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 endemic arboviruses—La Crosse encephalitis virus (LAC), West Nile virus (WNV), St. Louis encephalitis virus (SLE), and eastern equine encephalitis virus (EEE)—and travel-associated diseases such as chikungunya, dengue, and malaria. 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. Travel-associated mosquito-borne disease cases are being increasingly reported in the state

Most people who become infected endemic with arboviral infections have no clinical symptoms; however, encephalitis (inflammation of the brain) is 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. Mosquito surveillance is conducted in selected counties across the state from late spring through early fall. Dead birds reported to local health departments can also 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. Additionally, horses are also commonly infected with arboviruses and can become ill. Mosquitoes, dead birds and horses have all been used to help identify WNV and other arboviral disease activity in WV.

This surveillance report summarizes human cases of mosquito-borne disease and environmental surveillance—mosquito, dead bird, and horse surveillance—for arbovirus in WV in 2015.

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); only confirmed and probable cases were included for analysis. For dengue fever cases, the 2010 case definition was used to ascertain case status. For malaria and arboviral disease cases, the 2014 case definitions were used to ascertain case status. 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 2015 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 2015. 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 2015, testing of human specimens occurred through hospital laboratories, the West Virginia Office of Laboratory Services (WVOLS) for WNV, SLE, and EEE, the Virginia Department of Health Division of Consolidated Laboratory Services and CDC for LAC.

Equine Surveillance
Veterinarians suspecting arboviral infection in horse patients were asked to submit serum specimens to WVOLS that would be forwarded to the National Veterinary Services Laboratory in Ames, Iowa for IgM capture enzyme-linked immunosorbent assay (ELISA) testing for WNV and EEE. A report is submitted to CDC through ArboNet for any equine serum specimens testing positive for an arboviral infection

Dead Bird Surveillance
Local health department personnel submitted oral swabs from dead birds to WVOLS for testing of WNV, SLE, and EEE 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
Regular weekly mosquito trapping at three counties with historically low human cases of LAC (Kanawha, Wood, and Jackson) was conducted 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 Monongalia, Harrison, Wetzel, Putnam, Mercer, Greenbrier, and Monongalia counties. Daily mosquito samples were returned to WVOLS in the nets of the mosquito traps and placed in a -80°C freezer. Additional samples were received from Cabell, Wayne, Jefferson, Berkeley, Morgan, and Hancock counties. All mosquito specimens were identified to species.

For arboviral testing, mosquitoes collected from the same locality and on the same date were pooled together by mosquito 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 LAC 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, SLE, LAC, and EEE. Test results were reported to CDC through ArboNet. Pooled infection rates were examined for each mosquito genus each week. The minimum infection rate (MIR) for *Culex* spp. 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 2011-2015. During 2015, 7 cases of mosquito-borne diseases were reported in WV: 4 LAC cases (3 probable and 1 confirmed case), 2 confirmed travel-associated malaria cases, 1 probable travel-associated dengue fever case, and one confirmed travel-associated dengue case.

Table 1. Human cases of mosquito-borne disease in West Virginia from 2011 to 2015[*].

	# (%) of Cases[†] (2011)	# (%) of Cases[†] (2012)	# (%) of Cases[†] (2013)	# (%) of Cases[†] (2014)	# (%) of Cases[†] (2015)
LAC	26 (74)	14 (56)	11 (69)	2(28.6)	4 (57.1)
WNV	2[*] (6)	9[*] (36)	1 (6)	0(0)	0 (0)
Malaria	7 (20)	2 (8)	2 (12.5)	2(28.6)	2 (28.6)
Dengue	0 (0)	0 (0)	2 (12.5)	1(14.3)	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)	2(28.6)	0 (0)
Total	35 (100)	25 (100)	16 (100)	7(100)	7 (100)

**Does not include positive viremic blood donors*
†Includes only cases classified as confirmed or probable

WNV

No WNV cases were reported in 2015; no positive viremic donors were reported.

LAC

Four probable cases of LAC were reported in 2015; three were neuroinvasive cases. All were female, and the median age was 10.5 years (mean= 9 years; range= 4-11 years). Illness onset began in June (n=1), July (n=1), and August (n=2). The cases were reported in Greenbrier, Lincoln, and Raleigh counties. All four cases were hospitalized as a result of illness.

Dengue fever

One dengue fever case was reported in 2015. The case was a male from Monongalia County who traveled to India.

Malaria

Both travel-associated malaria cases were female; one was from Raleigh County and the other was from Mineral County. One case reported travel to Pakistan and the other reported travel to Malawi.

Equine Surveillance

No equine serum specimens were submitted to WVOLS for arboviral disease testing in 2015.

Dead Bird Surveillance

One dead bird was submitted to WVOLS for arboviral disease testing in 2015. The bird was negative for arboviral infection.

Mosquito surveillance

Active adult mosquito sampling was conducted from May 20, 2015 – September 28, 2015. A total of 24,126 adult female mosquitoes were collected during mosquito surveillance season, of which 600 mosquito pools were tested for arbovirus. Table 2 shows the total number of mosquitoes collected by species. The right column shows diseases known to be transmitted by that species.

Table 2. Mosquito species collected and identified in 2015.

Mosquito Species	Number of Mosquitoes Collected (%)	Major Vectors in Endemic Disease Transmission Cycle
Culex pipiens/restuans	14,380 (59.60)	WNV, SLE, EEE
Culex erraticus	3,880 (16.08)	
Aedes albopictus	1,943 (8.05)	LAC
Aedes japonicus	1,070 (4.44)	LAC
Aedes triseriatus	129 (0.53)	LAC
Coquillettidia perturbans	88 (0.36)	EEE
Other	2,636 (10.9)	
Total	24,126 (100)	

Figure 1 shows a map of counties where adult mosquito surveillance occurred in the state. Positive WNV pools were found in five of the 18 counties where mosquito samples were tested. Thirty-seven (6.2%) of the 600 total mosquito pools were infected with WNV. Most of the WNV-infected mosquitoes were active along the western edge of West Virginia (39 (78.4%) were collected from Cabell County, 3 (8.1%) from Kanawha County, 3 (8.1%) from Wetzel County, and 1 (2.7%) from Hancock County). A single mosquito pool from Jefferson County, in West Virginia's eastern panhandle, was WNV positive. The first WNV-positive pool was *Culex pipiens/restuans* active in Cabell County on July 13, 2015. The last WNV-positive mosquito pools were *Culex pipiens*/*restuans* and *Aedes albopictus*/*Aedes triseriatus* collected from Cabell County on August 26, 2015 and *Culex pipiens*/*restuans* collected from Jefferson County on August 25, 2015. In *Culex* mosquitoes, WNV activity was high in late July and early August (Fig. 2). LAC, EEE, and SLE were not detected in any mosquito pools in 2015. Samples from Putnam County were insufficient for arboviral testing.

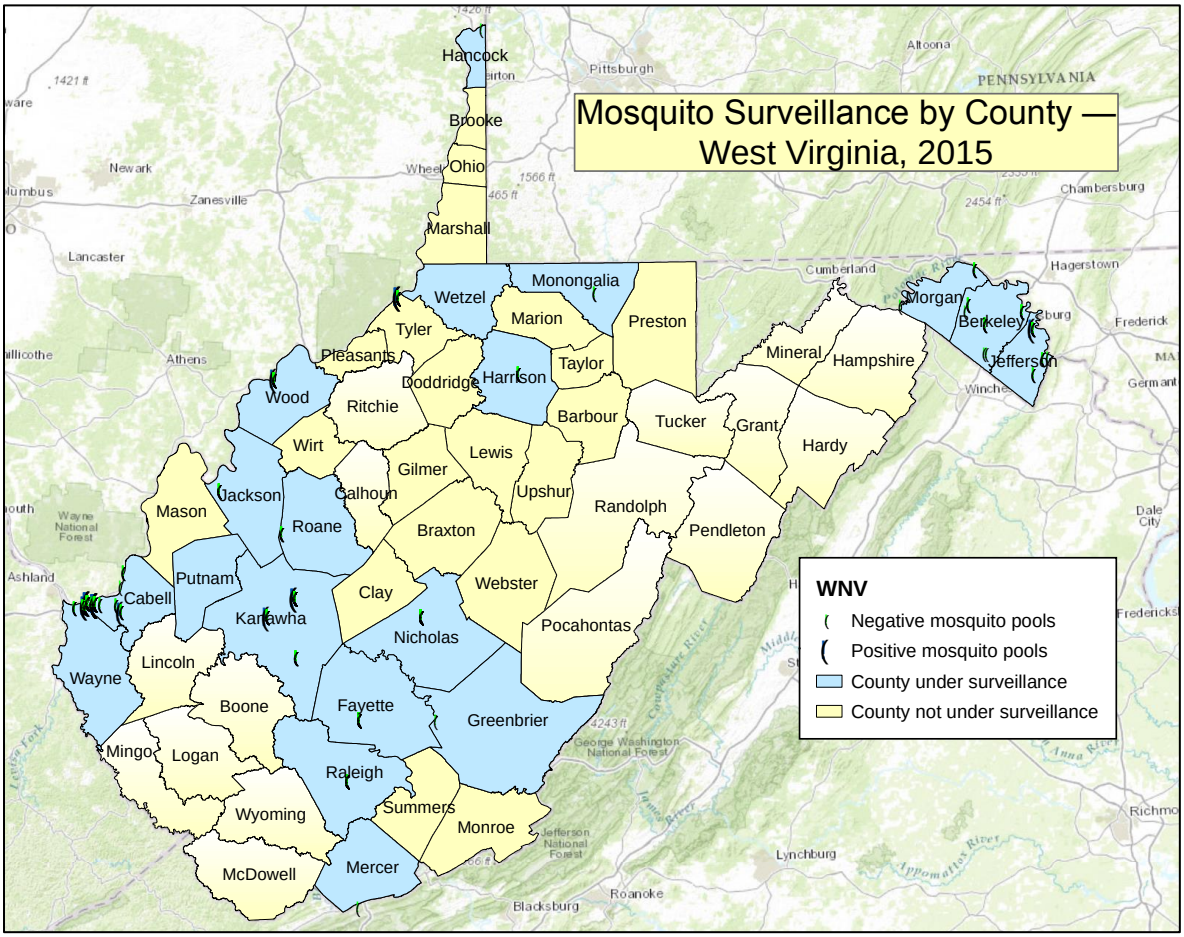


Figure 1. Counties in West Virginia where mosquito surveillance was conducted. Nineteen counties were under surveillance in 2015. Five counties had mosquito pools positive for WNV.

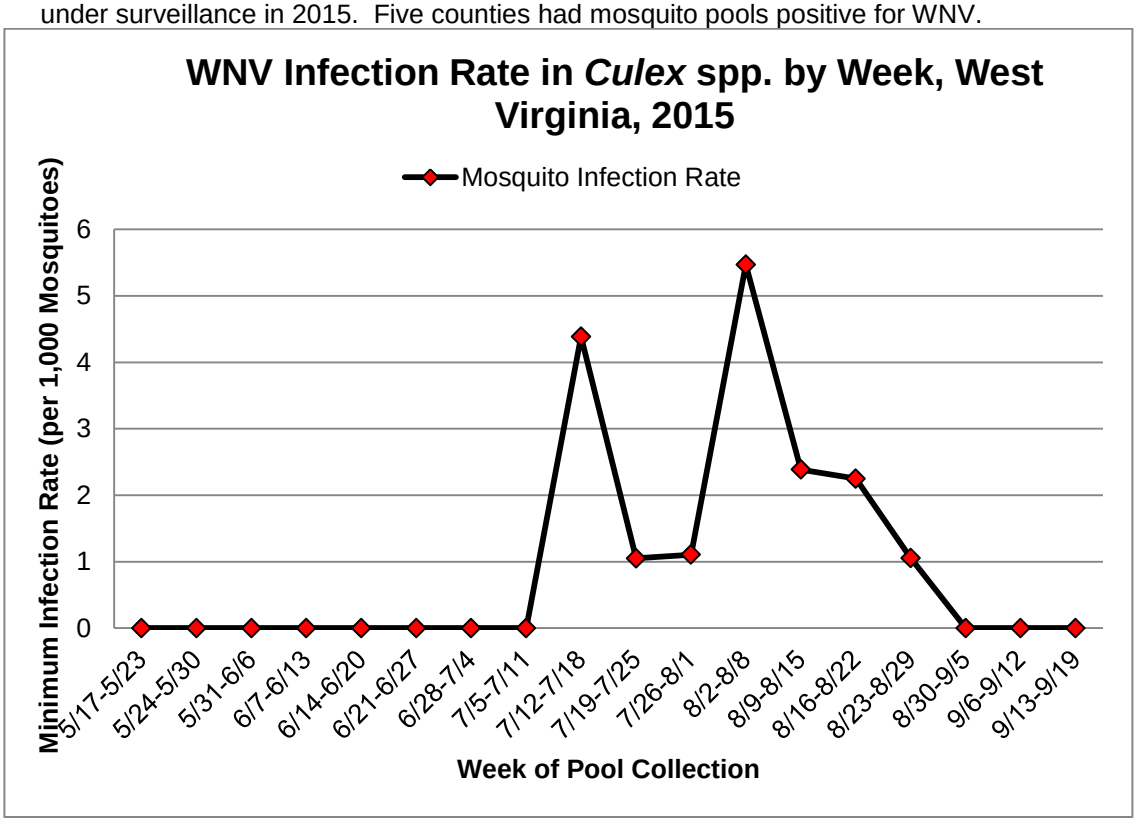


Figure 2. WNV infection rate in *Culex* spp. by week in West Virginia, 2015.

Discussion

The incidence of local mosquito-borne disease infections was very low in West Virginia in 2015 with only 4 LAC cases reported (0.2 per 100,000 people) and no WNV cases reported. The four LAC cases followed epidemiologic trends previously seen in WV (children under 15 years of age and in the southern region).

Three imported mosquito-borne disease cases occurred in 2015, accounting for 42.9% of all mosquito-borne cases reported. It is important that residents from West Virginia who travel internationally be mindful of mosquito-borne diseases endemic in their destinations, especially with the recent emergence of Zika virus in the Western Hemisphere. CDC's website for travelers' health is a good resource for this information: http://wwwnc.cdc.gov/travel/.

Equine serum and dead bird submissions 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.

The low arboviral activity in mosquitoes and the limited geographic distribution of infected mosquitoes resulted in few human arboviral cases in 2014. According to the WNV minimum infection rate in *Culex* mosquitoes, there was only a 'moderate' human risk of West Nile encephalitis in 2015, as defined in the '2015 West Virginia Mosquito Surveillance Plan' (http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Documents/Mosquito-Surveillance-Plan.pdf). WNV infection rates in *Culex* spp. during the 2015 mosquito surveillance season were similar to the low rates from other years when human incidence of West Nile encephalitis was low (2008-2011, 2013-2014). The low LAC, SLE, and EEE infection rate in the mosquito population meant comparatively few human LAC cases and no SLE and EEE human cases in 2015.

The Zoonotic Disease Group in the Division of Infectious Disease Epidemiology (DIDE) plans to increase outreach efforts related to mosquito-borne diseases across the state in 2016. Concerns about Zika virus disease and the health complications associated with infection should improve surveillance for other travel-associated diseases such as dengue fever and chikungunya. Additionally, surveillance for *Aedes* spp. mosquitoes will also be increased in 2016 with use of special traps that are more likely to catch *Aedes aegypti* and *Aedes albopictus* mosquitoes.

Links to CDC pages as well as public health literature on mosquito-borne disease can found on the Division of Infectious Disease Epidemiology Mosquito-borne Disease Webpage: http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Pages/default.aspx.

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. The LAC-transmitting mosquitoes are active 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.

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 2015.

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 (2015 MMWR Year), 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
Surveillance data about confirmed and cases of each TBD for MMWR Year 2015 were exported from WVEDSS to an Excel database for analyses. County- and state-level census estimates for 2015 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. Tick surveys were conducted at sixteen sites: eight sites in five northern counties and eight sites in five southern counties.

Veterinary Tick Submission Project
2015 marked the three 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 16 official game checking stations in central and southeastern West Virginia from November 24-26, 2014. 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, weight, antler characteristics, county where deer was collected, UTM coordinates where deer was collected, check station locality, submission date, and presence/absence of arthropod ectoparasites (ex. ticks, lice, louseflies) were provided for each ectoparasite submission. The ectoparasites were delivered to the state public health entomologist for tick species identification.

Tick Pathogen Testing
West Virginia University conducted real-time PCT pathogen testing for *Borrelia burgdorferi* on ticks collected through the Zoonotic Disease Program's various tick surveillance activities.

Results

In 2015, 304 confirmed and probable TBD cases were reported from 40 counties in WV (Figure 1). Conditions reported included anaplasmosis, ehrlichiosis, Lyme disease, and spotted fever

group rickettsioses (SFGRs). No cases of babesiosis or Powassan virus were reported during this period. Table 2 summarizes TBD from 2013 to 2015.

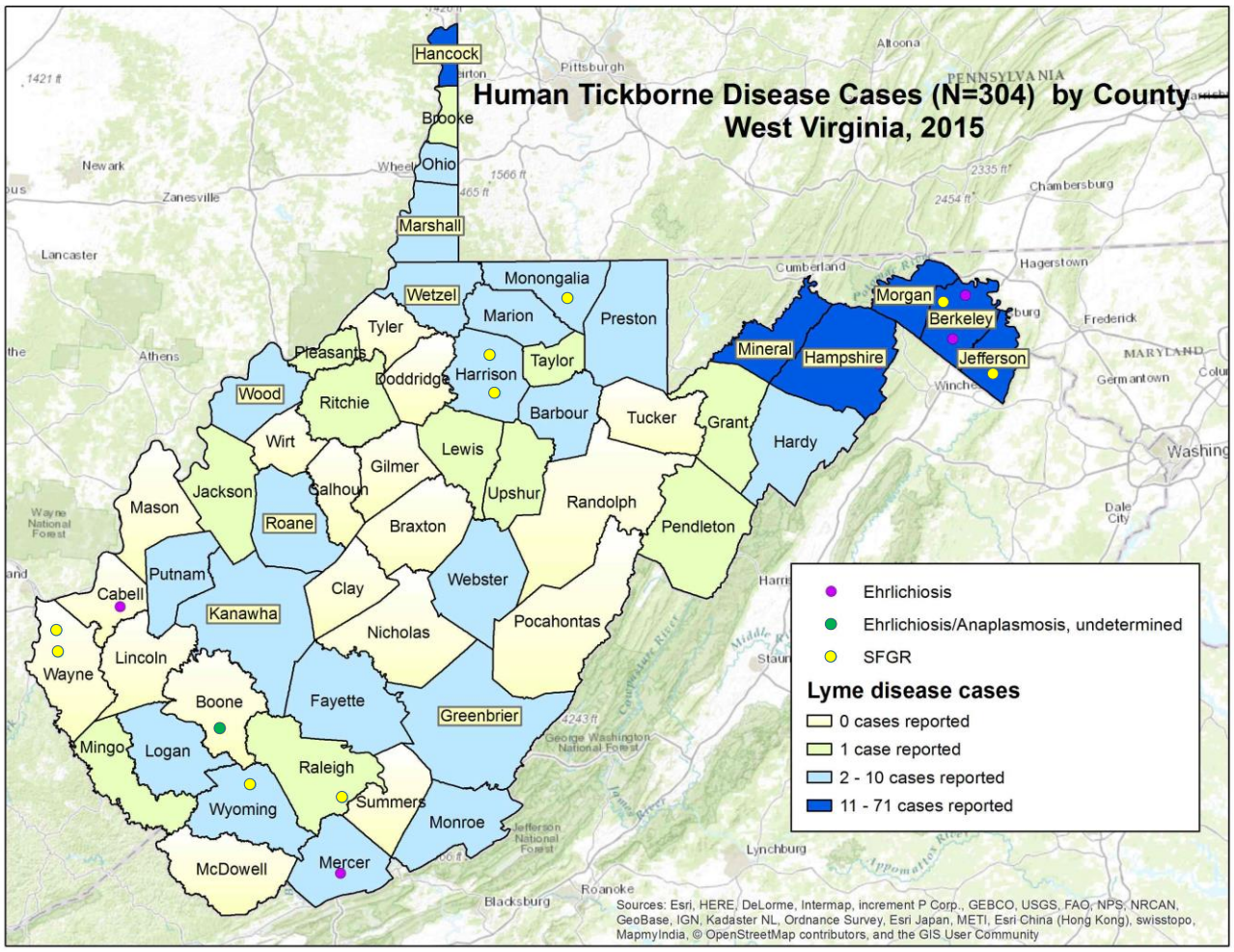


Figure 1. Counties in West Virginia that reported at least tickborne disease. Thirty-eight (69.1%) counties reported in at least one TBD in 2015.

Table 2. Summary of reporting statistics for TBDs reported in West Virginia from 2013 to 2015.

Disease Name	# of cases reported in 2013	# of cases reported in 2014	# of cases reported in 2015	# of counties with cases (2015)	Incidence per 100,000 (2015)
Anaplasmosis	3	2	2	0	0
Ehrlichiosis	4	2	5	4	0.2
Anaplasmosis/ Ehrlichiosis undetermined	2	0	1	1	0.1
RMSF/SGFR	7	5	9	7	0.48
Lyme disease	143	136	289	37	15.6
TOTAL	**159**	**145**	**304**	**38**	**16.5**

Ehrlichiosis and Anaplasmosis/Ehrlichiosis Undetermined

Five cases of ehrlichiosis (one confirmed and four probable) were reported during the MWWR Year 2015. Cases were reported from Berkeley, Cabell, Hampshire, and Mercer counties. Three

cases were male and two were female. Their ages ranged from 50 to 72 years of age. One case was hospitalized, and no deaths were reported.

One anaplasmosis/ehrlichiosis undetermined case was reported during MMWR Year 2015. The case was a male from Boone County. The case was hospitalized but no death was reported.

SFGR

Nine probable SFGR cases were reported during the MWWR Year 2015. Cases were reported in Berkeley, Harrison, Jefferson, Monongalia, Raleigh, Wayne, and Wyoming counties. Seven cases were male and two were female. Their ages ranged from 5 to 69 years of age. Four cases were hospitalized, and no deaths were reported.

Lyme disease

There were 289 confirmed (n=243) and probable (n=46) Lyme disease cases reported in West Virginia during MMWR Year 2015 accounting for 95.1% (289/304) of all TBD cases reported during this period. Cases of Lyme disease were reported from 37 counties across the state (Figure 1). Lyme disease endemic counties in the Eastern Panhandle (Berkeley, Hampshire, Jefferson, Mineral, and Morgan counties) accounted for 64.0% (n=185 cases). Nine counties 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.

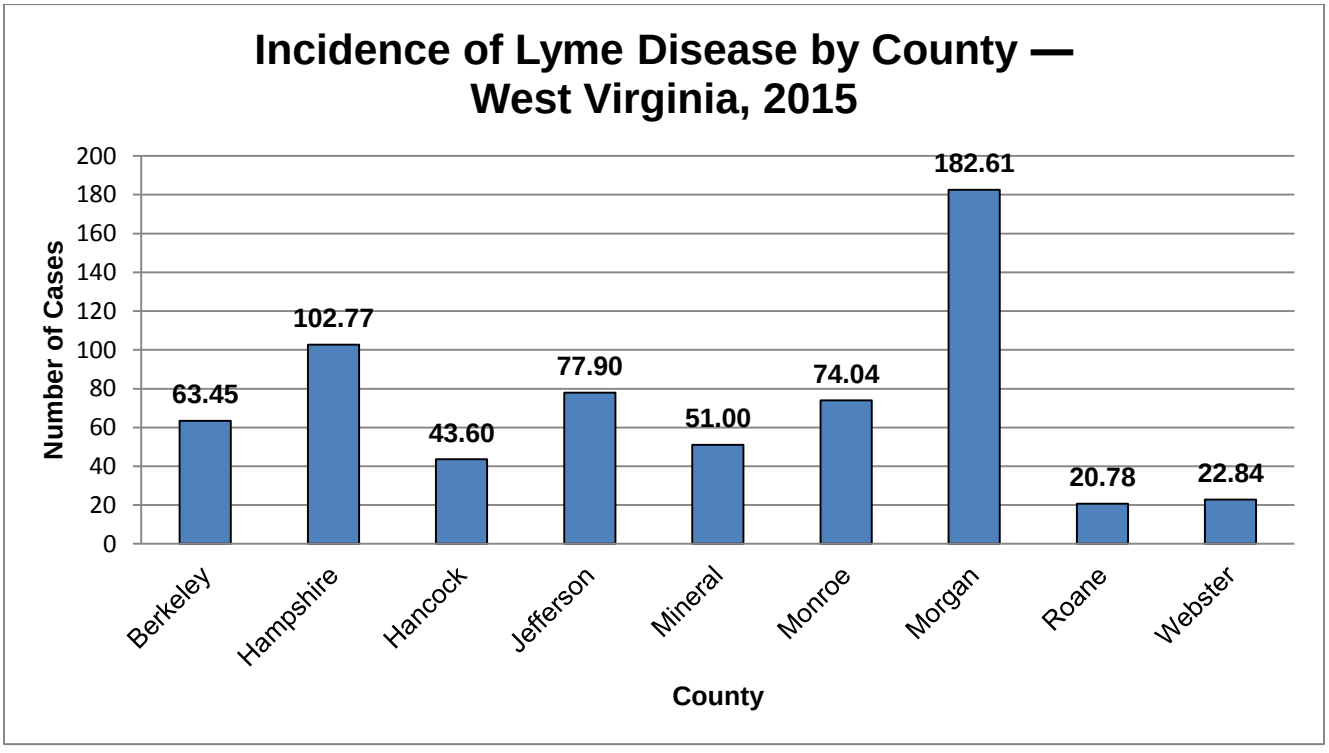


Table 3. Incidence of Lyme disease cases by county. Estimates are based on 2015 census data for each county. Only counties with incidence rates above 20.0 people per 100,000 are shown.

Confirmed and probable Lyme disease cases ranged in age from 1 to 86 years of age. The highest proportion of cases in the 61-70 age group (Figure 4). No deaths were reported as a result of illness.

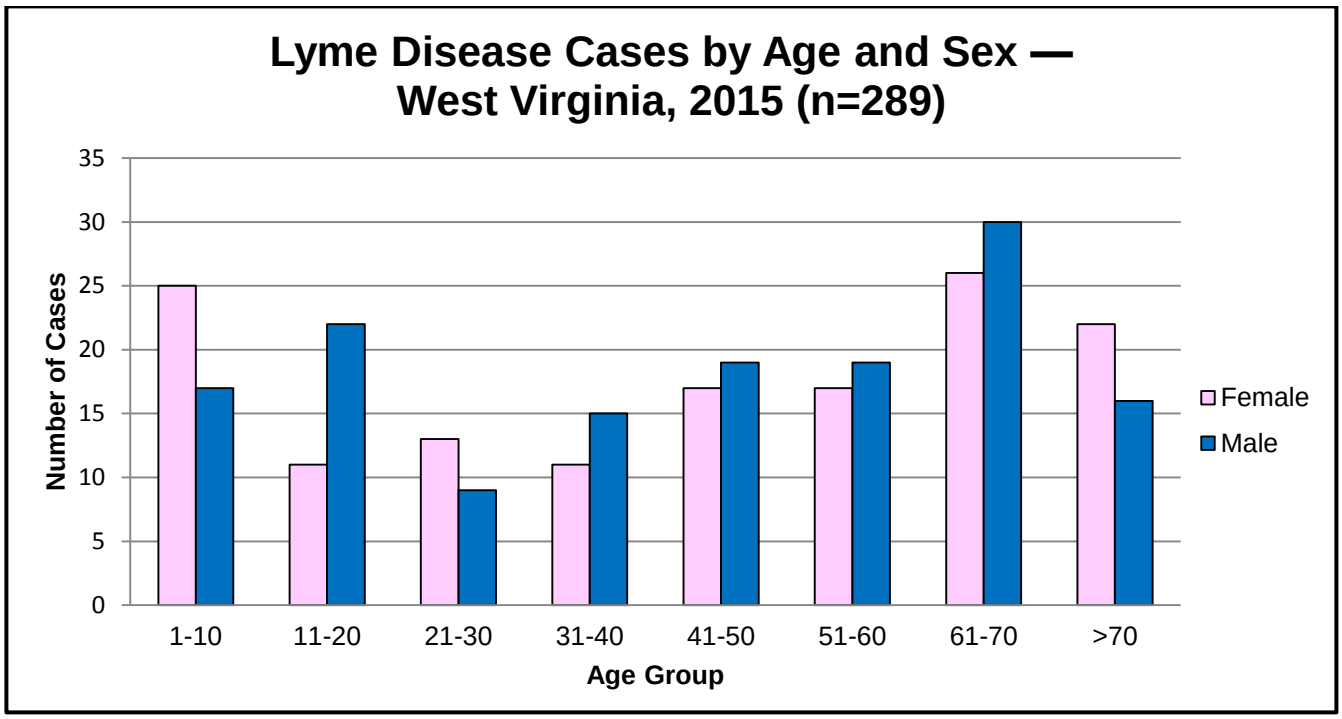


Figure 4. Incidence of Lyme disease by age group and sex during MMWR Year 2015.

Active Tick Surveillance

Active surveillance across the state began on May 8, 2015 at eleven sites in West Virginia. Sites were selected based on 2014 human Lyme disease surveillance data and 2014 West Virginia Veterinary Tick Submission Program (WVVTSP) data (home zip codes of animal hosts on which ticks were found). *Ixodes scapularis* was collected in four of 16 sites: Charleston residential area (n=65) (Figure 5), Tygart Lake State Park (n=14), 4-H Camp Muffly (n=1), and WVU Core Arboretum (n=1) (Figure 6).

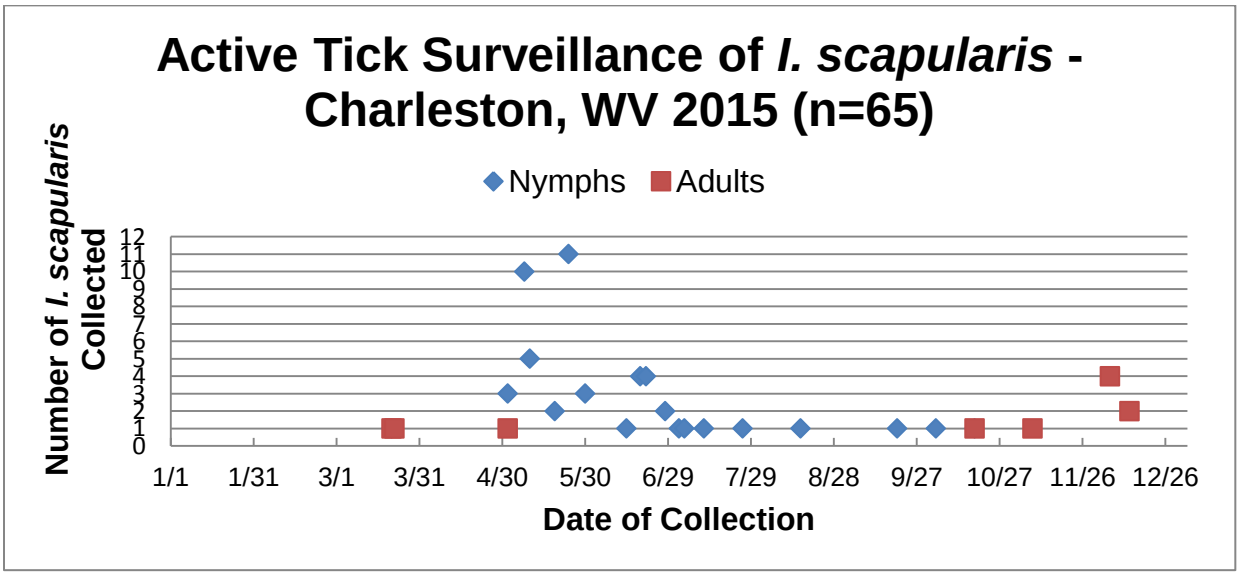


Figure 5. Active tick surveillance for *I. scapularis* at a location in Charleston, WV (25311).

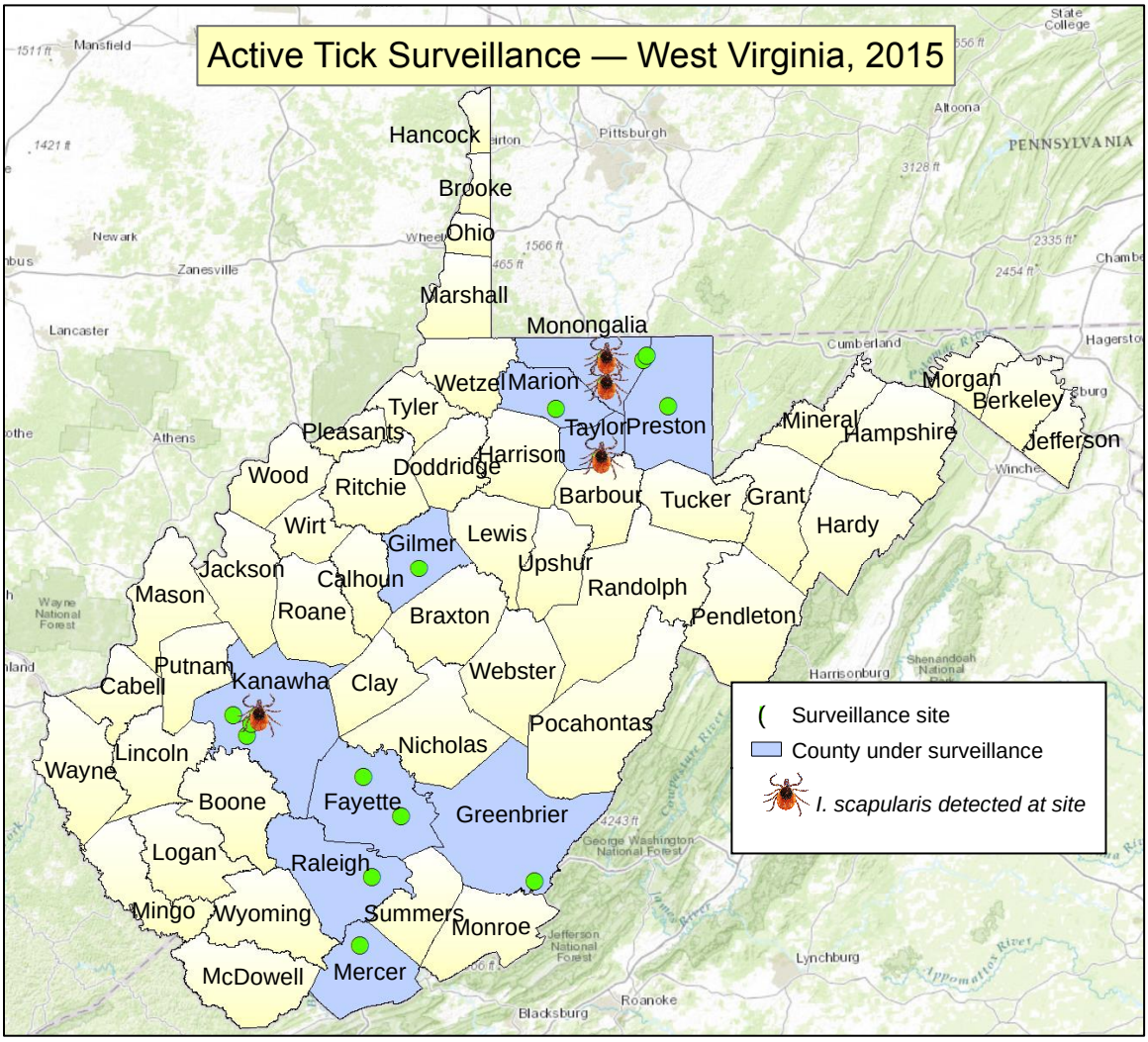


Figure 6. Counties under active tick surveillance in 2015.

Veterinary Tick Surveillance

Veterinarians from 51 veterinary clinics in West Virginia submitted 1,345 ticks from animal patients. Six tick species were identified: *Amblyomma americanum, Dermacentor variabilis, Ixodes cookei, Ixodes scapularis,* and *Rhipicephalus sanguineus* (Table 3). Fifty-seven counties were represented including 11 counties in Maryland, Ohio, Pennsylvania, and Virginia based on the home county of the animal host (Figure 7). Animal hosts included a bull, cats, a chipmunk, dogs, a horse, and humans.

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	677	Feline, Canine, Human	43
I. scapularis	410	Bovine, Feline, Canine, Rodent	35
I. cookei	86	Feline, Canine	12
A. americanum	85	Feline, Canine, Equine	12
Ixodes spp.	86	Feline, Canine	24
Ambloymma spp.	1	Canine	1
Total	**1,345**	**6**	**57**

[1]Based on home county of the animal; includes counties in states bordering West Virginia.

Deer Ectoparasite Surveillance

A total of 642 ticks were collected through the deer ectoparasite survey conducted in 2014. One hundred fifty *I. scapularis* ticks (24 adult females, 126 males) were collected from white-tailed deer. Although more winter tick (*Dermacentor albipictus*) specimens were collected (485 total with 106 adult females, 235 adult males, 143 nymphs, and 1 larva), *Dermacentor albipictus* is not of human public health interest. Seven indeterminate *Ixodes* adult females were also collected. Counties with high prevalence of *I. scapularis* were in northern and western West Virginia (Figure 8).

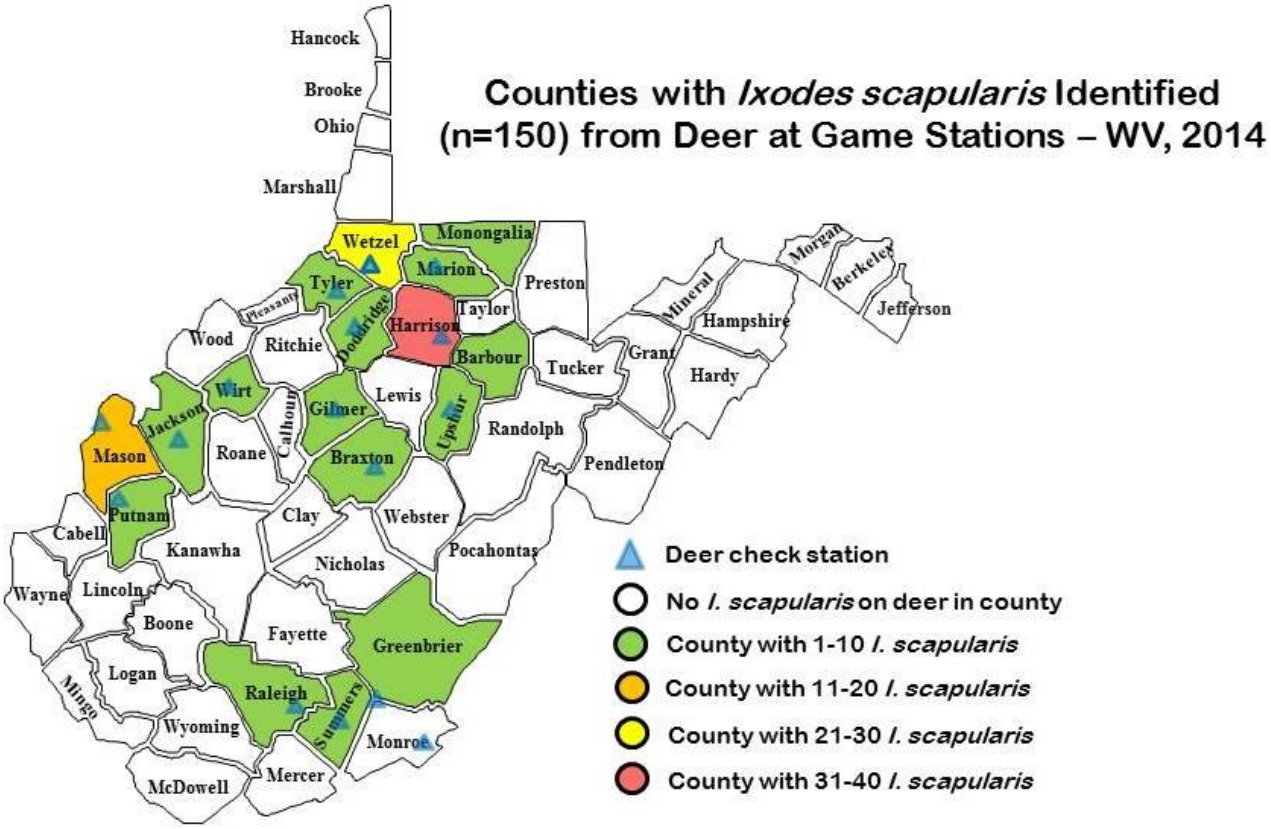


Figure 8. Distribution and number of *I. scapularis* collected from deer at game check stations in West Virginia in 2014. In comparison with other West Virginia counties, large numbers of *I. scapularis* were collected from deer in Harrison, Wetzel, and Mason counties.

Discussion

Four human TBDs were reported in West Virginia during 2015: anaplasmosis/ehrlichiosis undetermined, ehrlichiosis, Lyme disease, and 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 more than double what was for previous reporting year and was the most number of TBDs ever reported in a single year in the state (Table 2); the number of counties that reported at least one TBD went up from 27 counties in 2014 to 38 counties in 2015. *I. scapularis* and *I. cookei* ticks were collected by veterinarians and the public health entomologist from January to December indicating that ticks were active even in cold weather.

2015 was the first year that *R. sanguineus* was identified through WVVTSP from Berkeley and Kanawha counties.

Six cases with tickborne rickettsial diseases (anaplasmosis, ehrlichiosis, and RMSF) were hospitalized (40.0%). These diseases can lead to serious illness (such as bleeding disorders) or death if left untreated. Patients who are treated with antibiotics early may recover quickly making early diagnosis of these diseases very important.

Five counties were added as Lyme endemic counties in 2015: Greenbrier, Kanawha, Marshall, Roane, and Wetzel counties. At least two human cases reported erythema migrans (EM) and exposure within the home county, and had appropriate confirmatory laboratory criteria. West Virginia now has 12 Lyme disease endemic counties including Berkeley, Hampshire, Hancock, Jefferson, Mineral, Morgan, and Wood counties that were previously classified as endemic (Appendix A). A historical map of Lyme disease cases from 2000 to 2015 can be found in Appendix B.

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.

When compared to active tick surveillance, sentinel tick surveillance has proven to be more successful in identifying and collecting tick species. This is likely due to the fact that WV's passive surveillance activities mostly involves collecting ticks from animal hosts either through veterinary submissions or from other veterinary public health partners. These "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 continued to increase over previous years (604 ticks in 2013 1,220 in 2014, and 1,345 in 2015). Zip code data collected through WVVTSP will influence 2016 tick surveillance activities.

West Virginia expanded its tick surveillance capacity in 2015 with three new tick interns in addition to the existing tick surveillance intern. Tick surveillance started late in the season, likely attributing to the low number of ticks collected.

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 2015, there were 48 "suspected" cases of Lyme disease and one suspected SFGR case 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.

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:

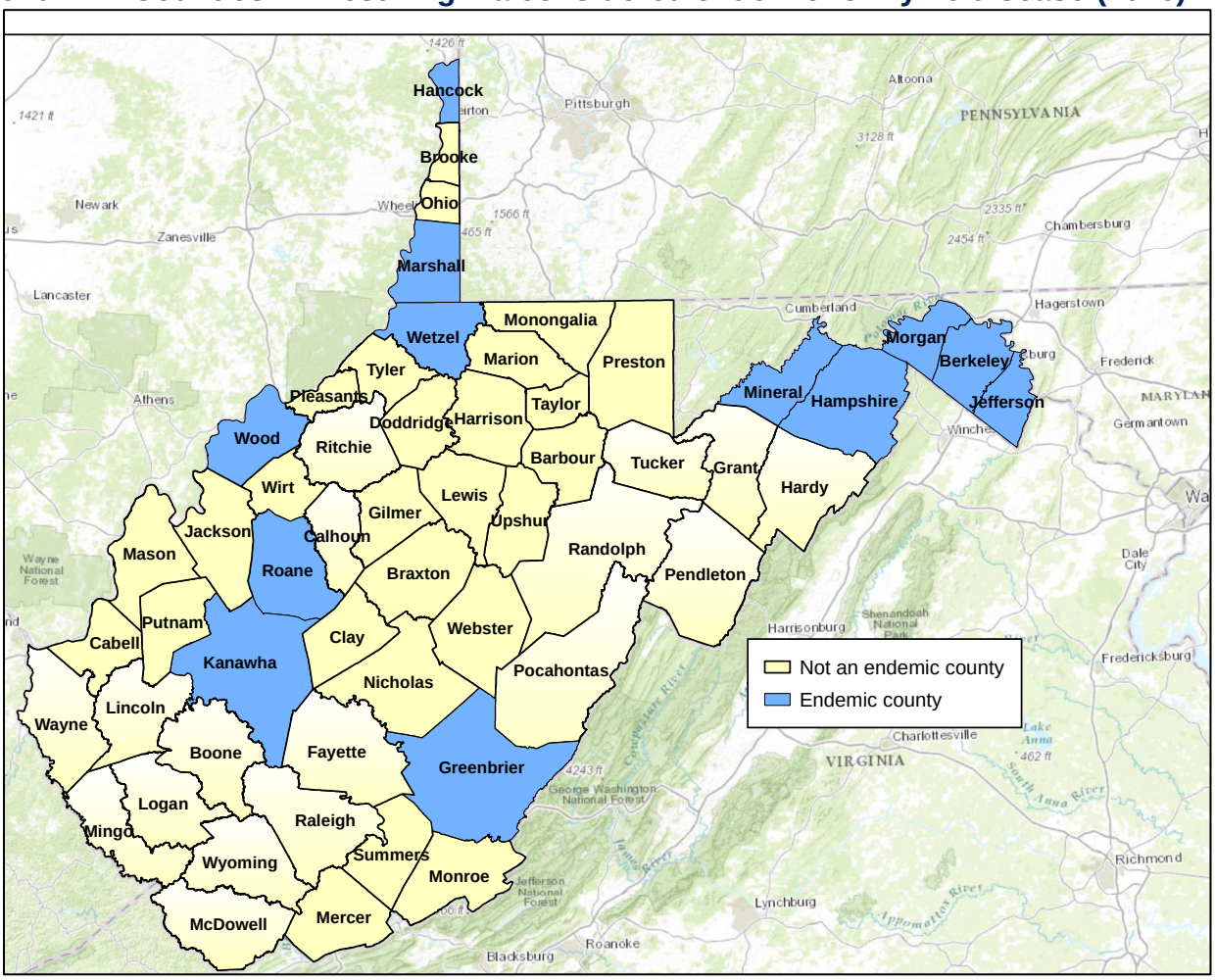
http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Tick/Documents/Tick%20Bite%20Prevention%20Checklist.pdf. In addition, CDC provides recommendation for the prevention of TBDs, adapted in Box 1. Because ticks are more active in warmer months, it is also important to make the public aware of the risk of becoming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

Below are CDC recommended steps for tick bite prevention

- 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.
- Use repellents that contain 20 to 30% DEET (N, N-diethyl-m-toluamide) on exposed skin and clothing for protection that lasts up to several hours. Always follow product instructions. Parents should apply this product to their children, avoiding hands, eyes, and mouth.
- Use products that contain permethrin on clothing. Treat clothing and gear, such as boots, pants, socks and tents with products containing 0.5% permethrin. It remains protective through several washings. Pre-treated clothing is available and may be protective longer.
- 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.
- Bathe or shower as soon as possible after coming indoors (preferably within two hours) to wash off and more easily find ticks that are 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 return 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 the legs, around the waist, and especially in their hair.
- Examine gear and pets. Ticks can ride into the home on clothing and pets, then attach to a person later, so carefully examine pets, coats, and day packs.
- Tumble clothes in a dryer on high heat for an hour to kill remaining ticks. (Some research suggests that shorter drying times may also be effective, particularly if the clothing is not wet.

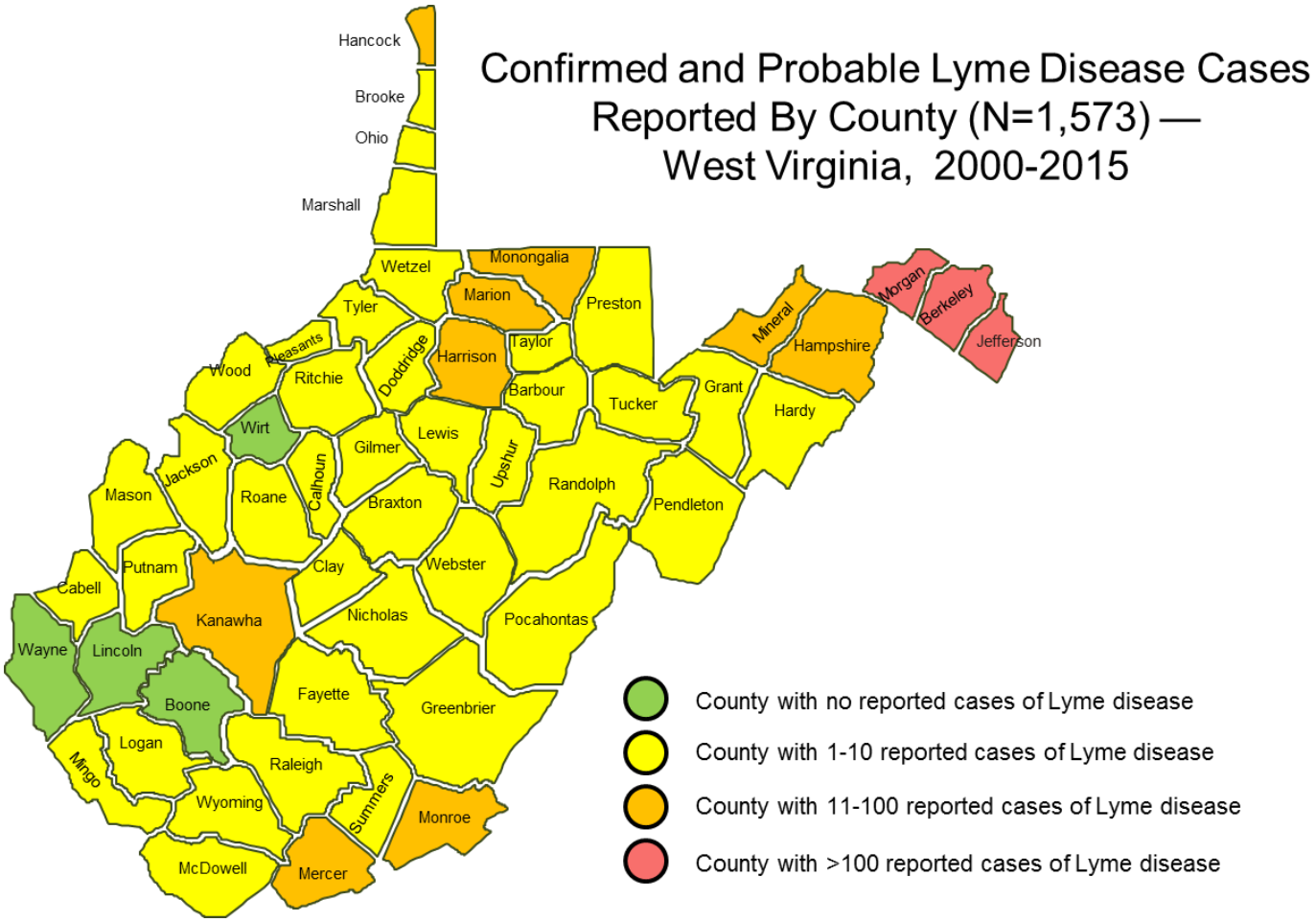
The Zoonotic Disease Program sincerely thanks the many public health partners who contributed to tickborne disease surveillance across the state. Your efforts have provided us with important information presented in this report.

Appendix A: Counties in West Virginia considered endemic for Lyme disease (2016).



An endemic county is one in which 1) two or more confirmed cases with EM, exposure within the county, and confirmatory two-tier laboratory testing have been reported or 2) established populations of *Borrelia burgdorferi* infected *Ixodes scapularis* ticks have been identified.

Appendix B. Historical Distribution of Lyme Disease Cases – West Virginia 2000-2015.



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.

Table 1. Lists of diseases, the associated pathogen(s), and host species.

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	
SARS	SARS coronavirus	Bats (likely)
Tularemia	*Francisella tularenis*	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]WVBPH has an annual rabies report that can be accessed at: http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Rabies/documents/surveillance/rabies-surveillance-2015.pdf

Methods

Human Surveillance

During the study period (MMWR Year 2015), passive surveillance was conducted for reportable zoonotic diseases 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

Q fever
Two probable Q fever cases were reported during MMWR year 2015 from Hampshire and Preston counties. One case was female and one was male. Neither were hospitalized, and no deaths were reported as a result of illness. One case reported exposure to birthing material from sheep.

Tularemia
One confirmed case of tularemia was reported during MMWR year 2015. The case was a male from Berkeley County. The case was hospitalized, but no death was reported due to illness.

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 with livestock 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.

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