

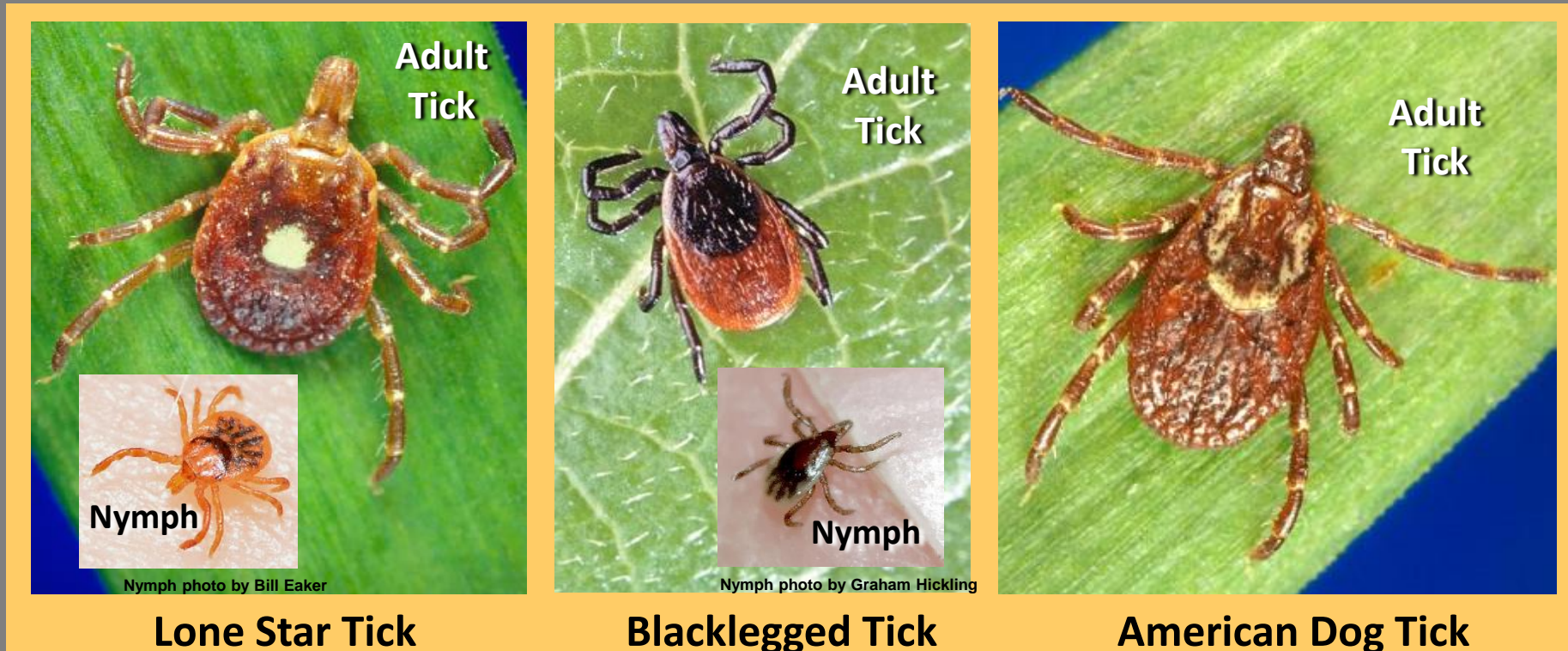
Ticks and Tick-Borne Diseases in Virginia

Dr. David N. Gaines
Public Health Entomologist
VDH-Office of Epidemiology



Important Tick Vectors of Disease in Virginia

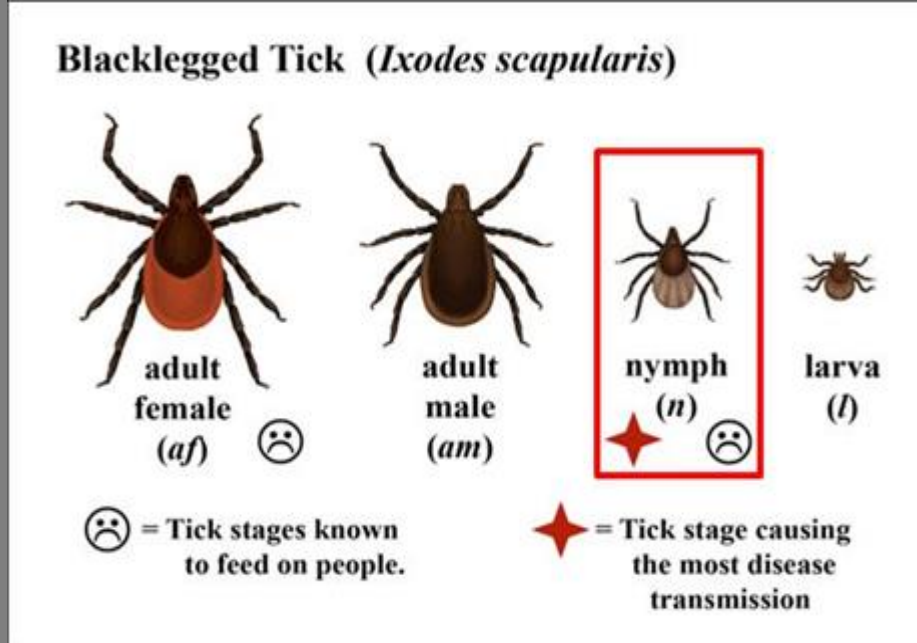
Among the 16 tick species native to Virginia, only **three species** will commonly bite people.



Among these three tick species, **Lone star ticks** and **Blacklegged ticks** are the most common cause of bites to people.

Tick Vector Species and Associated Diseases

Blacklegged Tick (a.k.a. deer tick)



Diseases are listed in order of prevalence in VA

† = Potentially fatal diseases

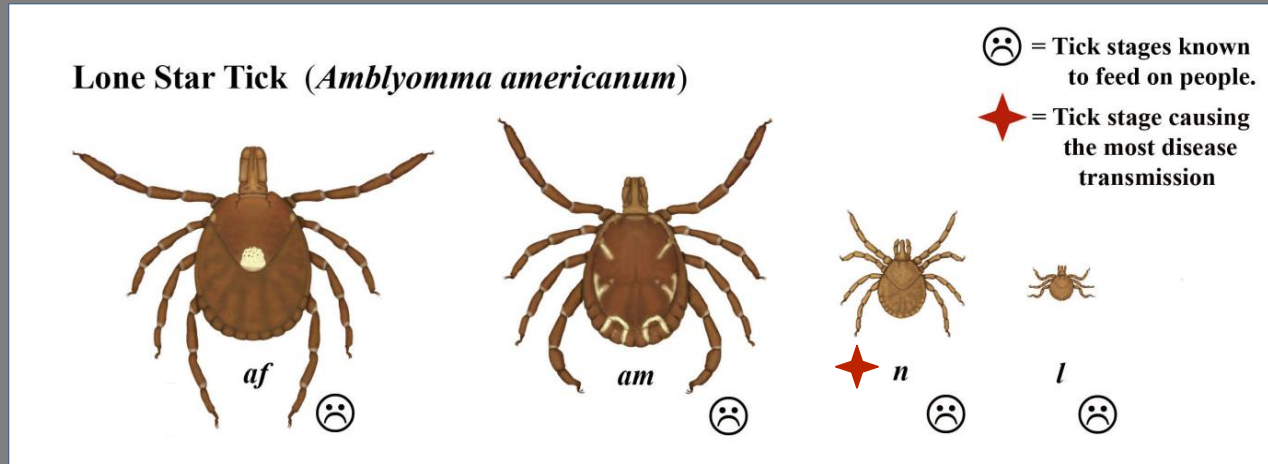
1. Lyme disease – *Borrelia burgdorferi*
2. Anaplasmosis – *Anaplasma phagocytophilum* †
3. Babesiosis – *Babesia microti* †
4. *Borrelia miyamotoi* disease – *Borrelia miyamotoi*
5. Tickborne encephalitis virus/Powassan virus – Flavivirus †

The main vectors of disease to people are nymph stage blacklegged ticks during late spring and summer (mainly May through mid-July)

Adult ticks bite people much less often, but generally have higher disease infection rates, and will bite people on warm days during the fall, winter, and spring (late September through April).

Tick Vector Species and Associated Diseases / Health Conditions

Lone Star Tick



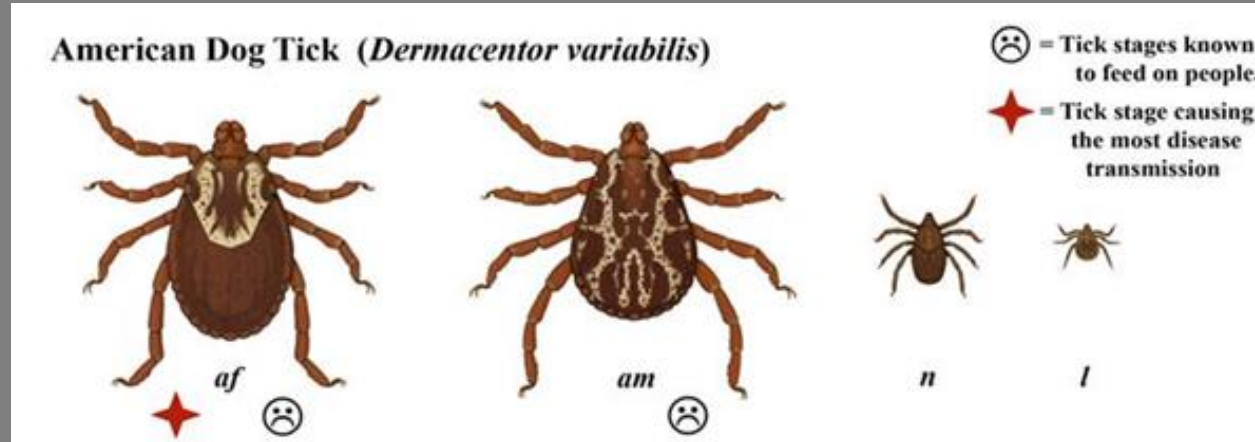
† = Potentially fatal disease/condition.

1. Ehrlichiosis – *Ehrlichia chaffeensis*† & *Ehrlichia ewingii* †
2. Acquired red meat allergy (Alpha-gal syndrome) – Caused by lone star tick saliva †
3. STARI (Southern Tick-Associated Rash Illness) – Caused by lone star tick saliva
4. Tularemia – *Francisella tularensis* †
5. *Rickettsia parkeri* spotted fever – *Rickettsia parkeri*
6. Rocky Mountain spotted fever – *Rickettsia rickettsii* †
7. Heartland Virus Disease – Phlebovirus (Bunyaviridae) †

Diseases are listed in order of prevalence in VA - from most to least prevalent

Tick Vector Species and Associated Diseases

American dog tick



Rocky Mountain spotted fever (RSMF) – *Rickettsia rickettsii* †

Tularemia – *Francisella tularensis* †

Rickettsia parkeri* spotted fever – *Rickettsia parkeri

† = Potentially fatal disease / condition.

The only disease vectors are adult female and male American dog ticks, during a period from spring to late summer.

American dog ticks mostly occur in overgrown fields (old fields with bushes and small trees), but may sometimes be found on leaf litter on the forest floor near overgrown fields.

The Most Important Tick Vectors of Disease in Virginia

As bites by, American dog ticks are the least common cause of disease transmission, so, the two most important vector tick species in Virginia are blacklegged ticks and lone star ticks.

Lone star ticks and blacklegged ticks are both found primarily in forest environments, and both of these tick species rely mainly on deer as a source of blood for egg production; Deer also serve as the primary location where adult male and female ticks meet to mate.

Deer population densities are generally greatest in suburban forests because deer hunting is forbidden in such environments. The higher the deer population density in a suburban forest, the greater the Lone star tick and/or blacklegged tick population density will be in that forest.

Thus, most people exposed to tick-borne disease agents are suburbanites.

Ten Tick-borne Diseases; their prevalence and number of cases counted in Virginia in a 10 year period from 2011 to 2020

	Total	Confirmed (%)	Probable
Lyme disease	12,216	8,481 (69.4 %)	3,735
Rocky Mntn. spotted fever (really RMSF ???*)	3,019	24 (0.9 %)	2,995
Ehrlichiosis (<i>E. chaffeensis</i>)	1,060	519 (48.9 %)	541
Anaplasmosis	154	34 (22.1 %)	120
Tularemia	26	17 (65.4 %)	9
Babesiosis	19	15 (78.9 %)	4
Ehrlichiosis (<i>E. ewingii</i>) **	13	13 (100 %)	0
<i>Borrelia miyamotoi</i> disease	2	2 (100 %)	0
Powassan virus (tick-borne encephalitis)	2	2 (100 %)	0
Spotted Fever Rickettsiosis (<i>R. parkeri</i>)	2	2 (100 %)	0

* It is likely that the vast majority of patients testing RMSF positive by serology in VA had been infected with low/non-pathogenic *Rickettsia amblyommatis* sometime in the year or more before their positive test.

** Ehrlichiosis cases caused by *Ehrlichia ewingii* are significantly under-reported in Virginia because most doctors use the "multiplex PCR assay" offered by Lab Corp, which does not test for *Ehrlichia ewingii* .

Heartland virus, a new tick-borne disease was identified in a Virginia patient in 2021

Although the Table on the previous slide identified 10 different tick-borne disease/conditions seen in Virginia from 2011-2020, a new tick-borne disease known as the “**Heartland virus**” was identified in an older Virginia resident (>60 years of age) in 2021. This patient died of his infection in spite of intensive care by doctors at a highly respected hospital.

The **Heartland virus** is carried and transmitted by lone star ticks, and infections can produce an illness with symptoms that are similar to symptoms of **Ehrlichiosis**, but patients do not respond to antibiotic treatment. **Heartland virus** infections are more likely to cause a severe or fatal illness in patients over the age of 60.

Tick Species and Tick-borne Diseases in Virginia

As I do not have time to cover every tick-borne disease/condition associated with tick bites in Virginia, I will try to cover the most common of the 11 tick-borne pathogens transmitted to people in Virginia.

Although American dog ticks can play a role in the transmission of **Rocky Mountain spotted fever (RMSF)** and other **spotted fever group agents**, they account for a very small proportion of the people reporting tick bites.

Additionally, published **RMSF** infection rates for American dog ticks are quite low. Also, several published studies in the Southeastern U.S. indicate that lone star ticks may sometimes play a role in **RMSF** transmission, and as lone star ticks are a much more common cause of tick bites to people, our program focuses mostly on lone star ticks and blacklegged ticks as tickborne disease vectors.

Lone Star Ticks

Lone star ticks are the most common tick to bite people in areas of Virginia that are below 1,400 ft. (430 meters) elevation, including all areas East of the Blue Ridge.

The nymph stage ticks are the main cause of bites to people, and their bites and disease transmission occurs mostly during the period from spring through summer (May – early August),

Adult ticks also occasionally bite and transmit diseases to people in the period from late winter to early summer (March through June).

Larval-stage ticks will bite people in the late summer and fall and can transmit the **Heartland virus***, but they cannot transmit **ehrlichiosis**.

Lone star ticks are mostly found in leaf litter on the shaded forest floor, on partly shaded grass or brushy habitats, but can sometimes be found in open grassy fields. Lone star tick bites almost always itch!

Lone Star Tick Associated Diseases

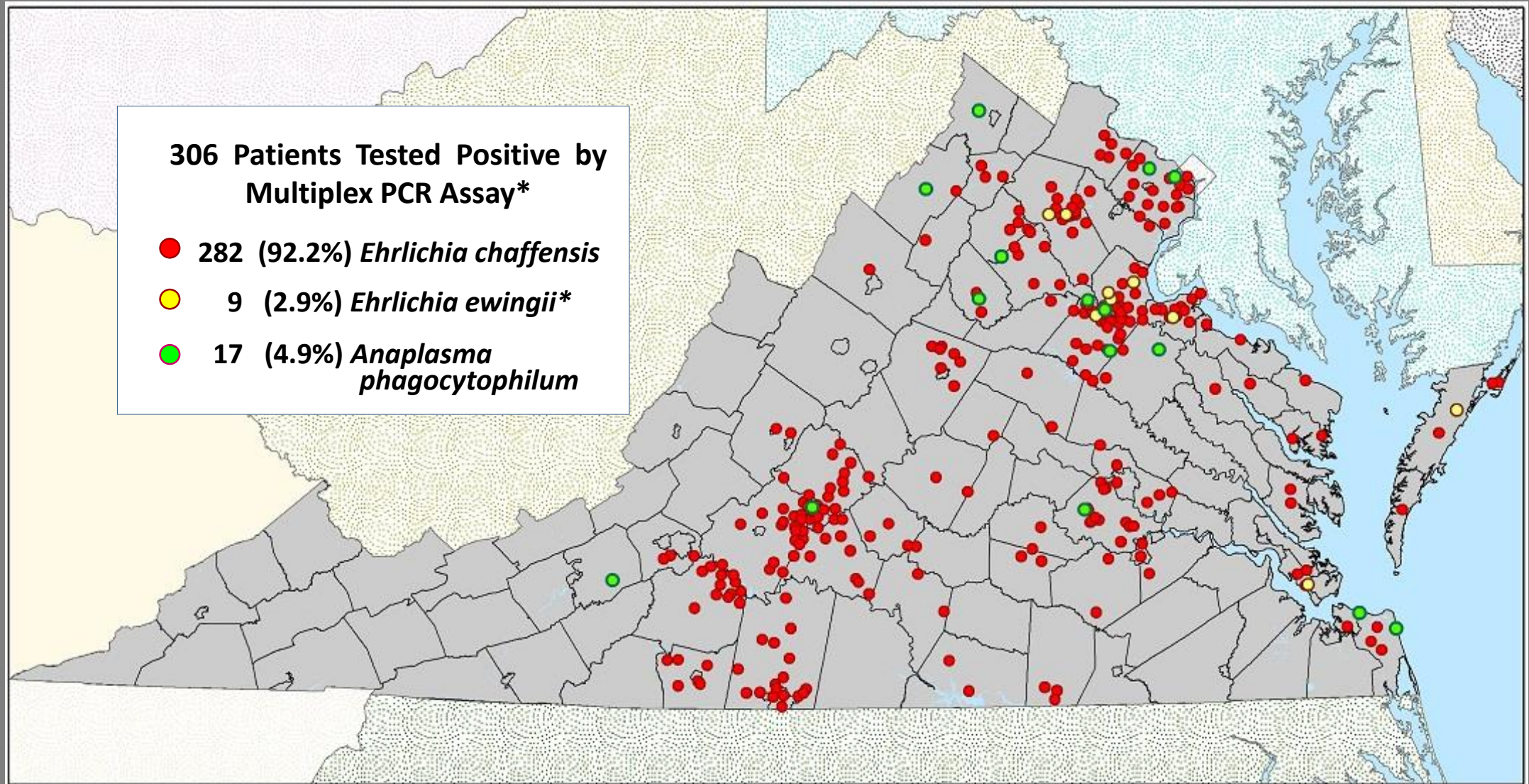
Ehrlichiosis

By far, the most common disease associated with lone star ticks in Virginia is **ehrlichiosis**.

Although **Lyme disease** is the most common tick-borne disease reported in Virginia, **ehrlichiosis** is the second most common tick borne disease in VA , and unlike **Lyme disease**, **ehrlichiosis** (caused by either *Ehrlichia chaffeensis* or *Ehrlichia ewingii*) often hospitalizes patients and sometimes causes patient fatalities.

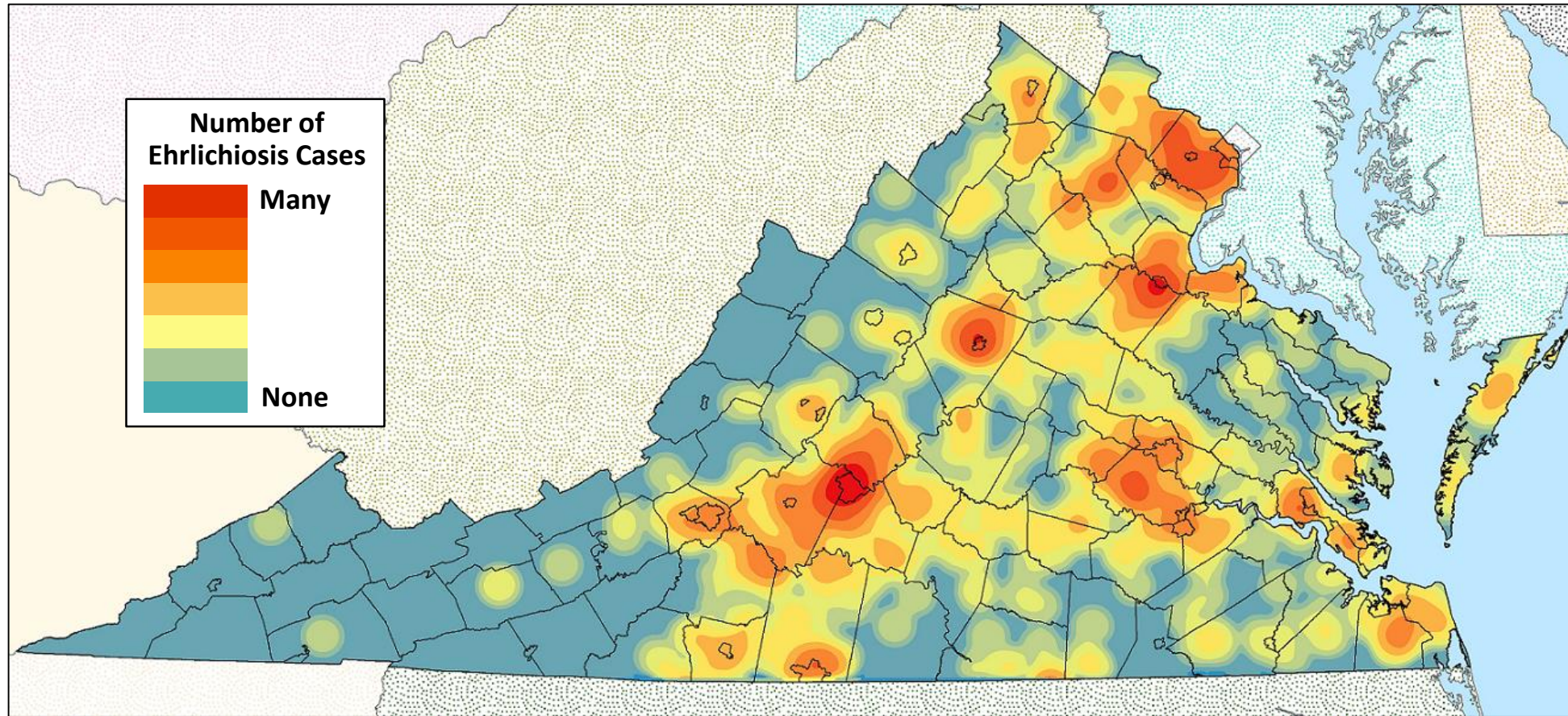
Other diseases that can be carried by lone star ticks and that can hospitalize patients and cause patient fatalities include: **tularemia**, **Heartland virus disease** and **Rocky Mountain spotted fever**, .

Ehrlichiosis and Anaplasmosis Cases Identified by Multiplex PCR Assays from 2006 through 2015



* *Ehrlichia ewingii* cases are only identified in patients tested by the Mayo Clinic Lab; The Lab Corp Multiplex Assay does not test for *E. ewingii*, and unfortunately, most hospitals and doctors in VA use Lab Corp as their primary diagnostic lab.

Geographic distribution of Ehrlichiosis cases in Virginia from 2008 to 2019
(based on the patient residential address, and number of cases per unit area*)



Ehrlichiosis case data compiled from 2008 to 2019 are based on 1,111 cases.

Lone Star Tick Associated Diseases Rocky Mountain spotted fever

Cases of Rocky Mountain spotted fever (RMSF) are frequently reported by doctors in Virginia, but Confirmed RMSF cases (caused by *Rickettsia rickettsii*) are fairly rare.

From 2011 through 2020, the Virginia Dept. of Health (VDH) only identified 24 Confirmed RMSF cases among the 3,019 RMSF cases reported to VDH.

Most of the RMSF cases that were classified as “probable cases” were probably diagnosed because the patient had been exposed to a common non-pathogenic “spotted fever agent” that is carried by most lone star ticks called *Rickettsia amblyommatus*.

Lone Star Tick Associated Diseases

Heartland virus

In 2021, a viral disease known as Heartland virus that is associated with lone star tick bites was identified in a Virginia patient. The Heartland virus was first discovered by the CDC in Kansas in 2009, and it has since been identified in multiple states across the Southeastern U.S. where lone star ticks are present. Cases have been identified in most of Virginia's neighboring states including Kentucky, Tennessee & North Carolina.

Virginia's first diagnosed Heartland virus case, was seen in November of 2021, and caused a severe illness in a 68+ year old man that was initially thought to be ehrlichiosis, but did not respond to antibiotic therapy. In spite of hospitalization and intensive medical care for 10 days in a highly-respected hospital, this patient died.

Blacklegged Tick (a.k.a. deer tick) – Associated Diseases



Blacklegged ticks occur predominantly on forest leaf litter or low vegetation on the shaded forest floor. They do not tolerate dry hot environments and are rarely found in open fields, or on grass unless it is at least partially shaded by trees. The majority of people bitten by blacklegged ticks are bitten by the tiny **nymph-stage tick**.

Nymph-stage blacklegged ticks are very small, and they move so slowly that they are easily mistaken for a tiny black speck of dirt, by the persons they are crawling on (a magnification lens may be needed to tell if it is a speck of dirt, or a tick).

The bites of **nymph-stage blacklegged ticks** are not felt, and rarely itch, so most of the people they bite do not know they have been bitten until they come down with **Lyme disease** or some **other associated disease**.

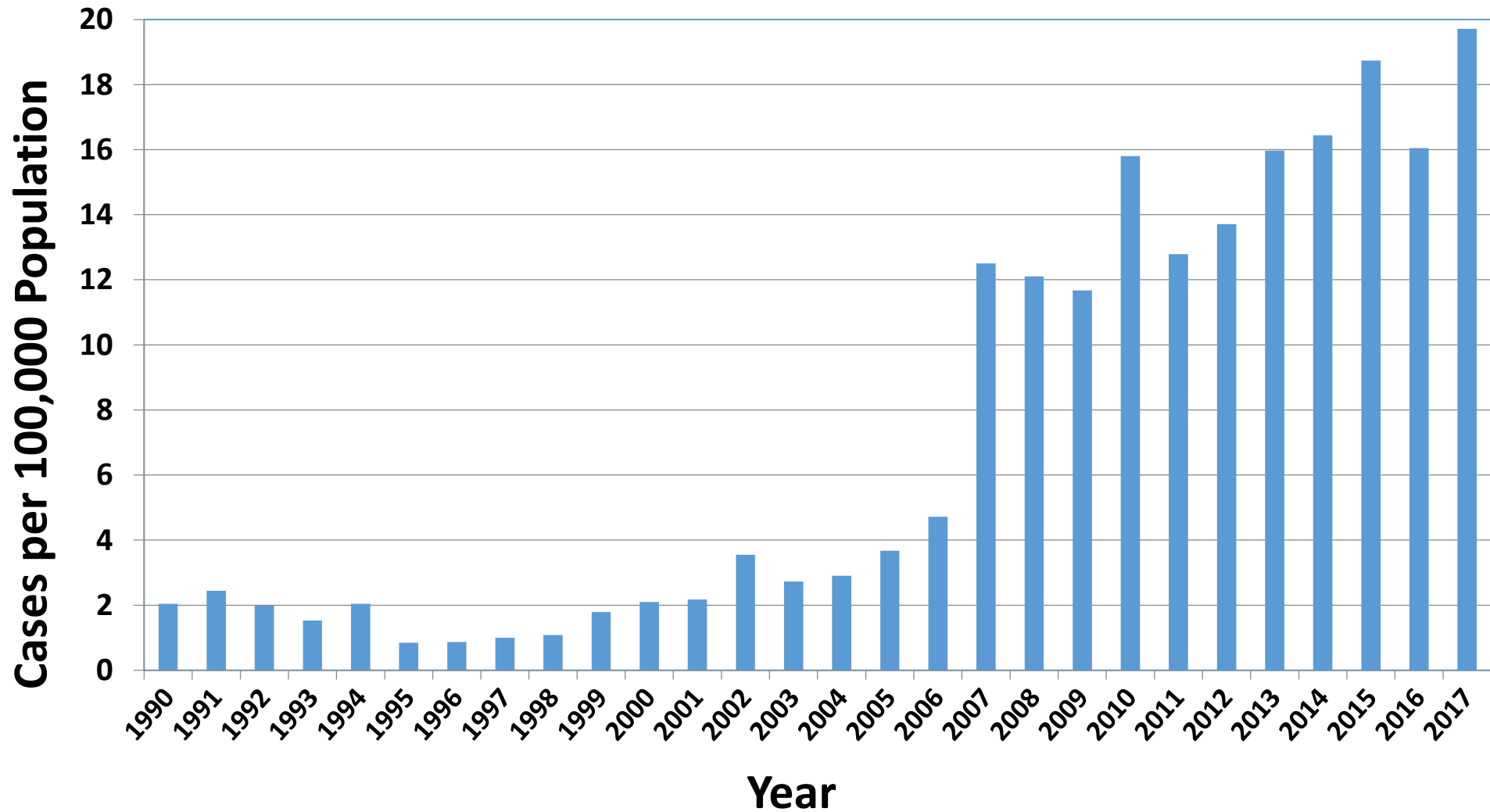
Blacklegged Ticks (a.k.a. deer tick)

The blacklegged ticks that transmit Lyme disease and other diseases to people in Virginia are the “northern variant” blacklegged tick whose populations expanded southward out of New England and eventually reached the Eastern Shore of Virginia sometime around the late 1980s.

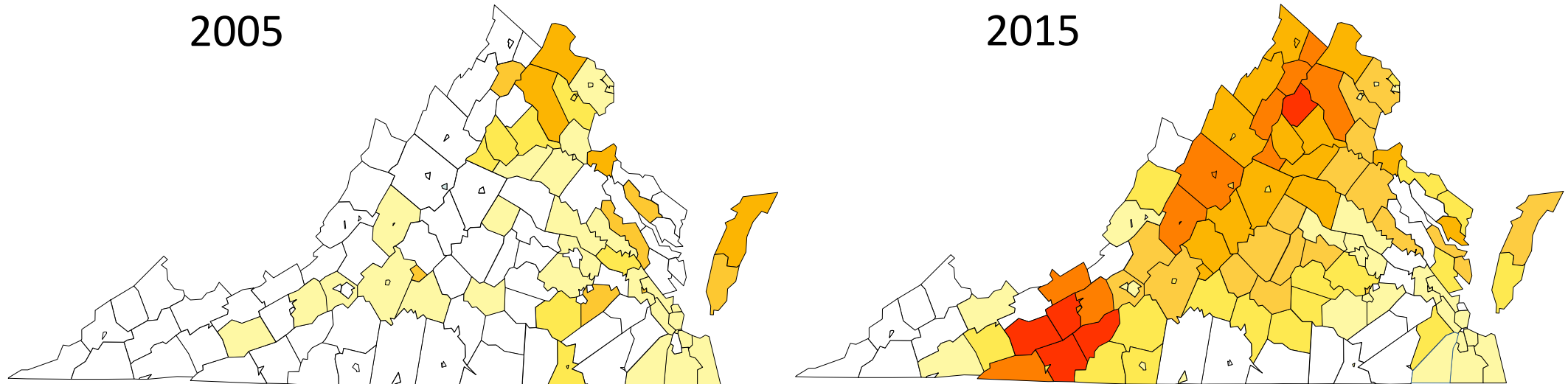
As they are “northern variant ticks”, they are intolerant of the hot summer temperatures in Virginia’s lowland and coastal areas, so their populations only survive in small numbers in shady suburban forests of the Eastern Shore, Hampton Roads, or the Richmond Area.

Blacklegged ticks are more common in the upper piedmont region and mountain regions of VA, where summertime temperatures are lower. They are also somewhat common in forests of heavily suburbanized areas of Northern Virginia and the Upper Piedmont, but predominate in the highlands of southwestern VA.

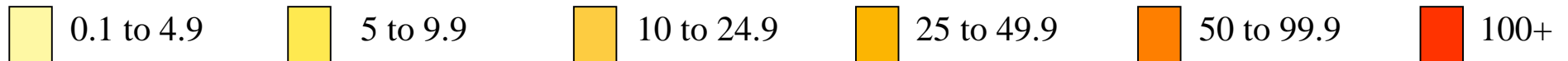
Lyme Disease Incidence in Virginia, 1990 - 2017



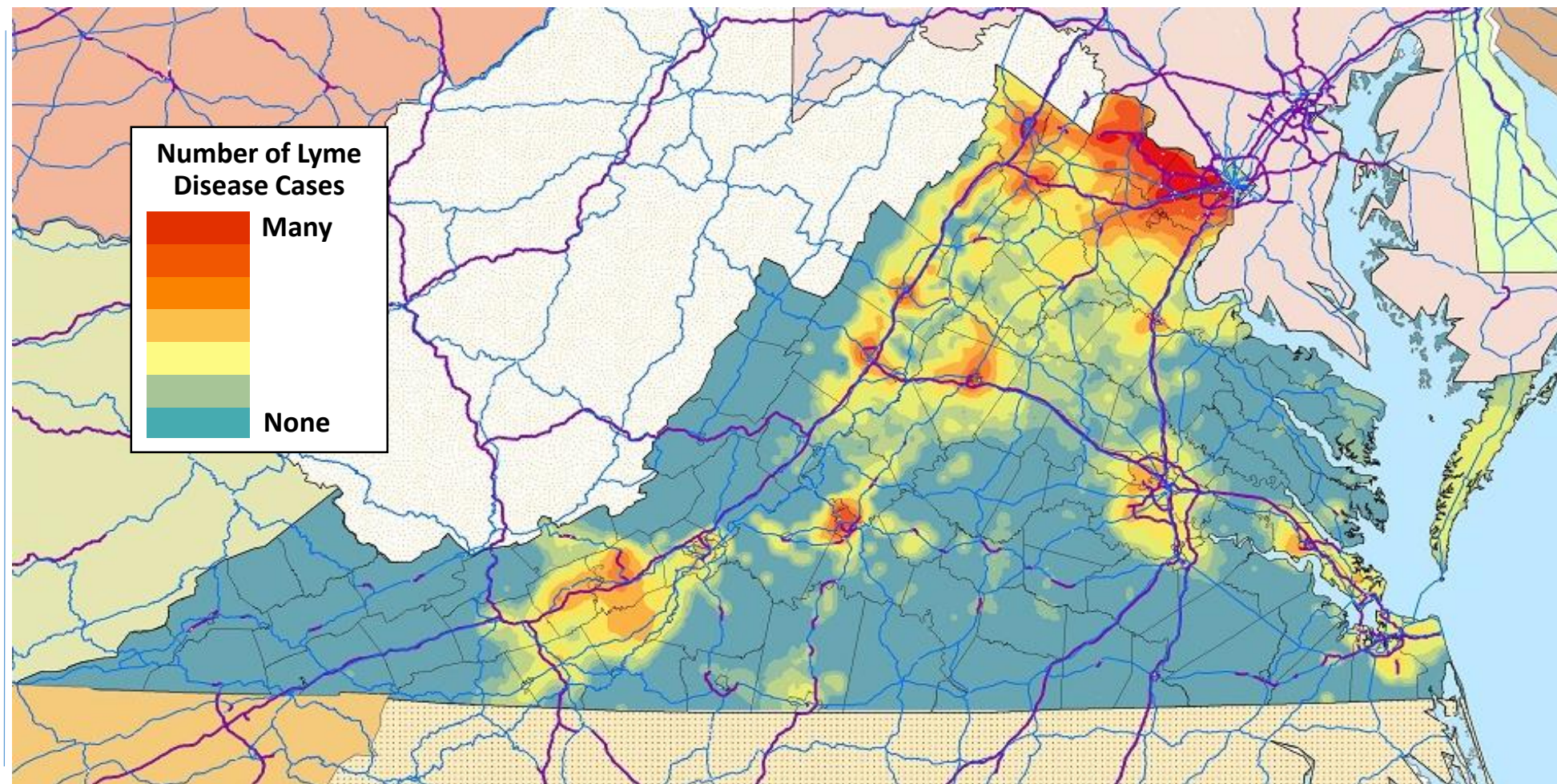
Change in Lyme Disease Rate by County from 2005 to 2015



Cases per 100,000 population



Geographic distribution of Lyme disease cases[^] counted in Virginia from 2008 to 2015, (based on the number of cases per unit area*)



* Number of cases per unit area = cases per 5.25 mile square in a grid pattern overlaid on Virginia; map created using empirical Bayesian Kriging . [^] ~ 12,000 cases total

Blacklegged Tick Associated Diseases

Among other blacklegged tick - associated diseases in Virginia are Anaplasmosis and Babesiosis.

Anaplasmosis patients develop symptoms that are similar to those of ehrlichiosis and cases are best diagnosed through use of the multiplex PCR assays for ehrlichiosis and anaplasmosis.

The arrival of anaplasmosis in Virginia lagged behind the appearance of “northern variant” blacklegged ticks and Lyme disease. And, like some other diseases transmitted by “northern variant” blacklegged ticks, anaplasmosis is becoming more common in northern and eastern VA, but has been slow to follow the geographic expansion of blacklegged ticks into southwestern Virginia; most cases being seen are in the northern and central Piedmont regions of VA.

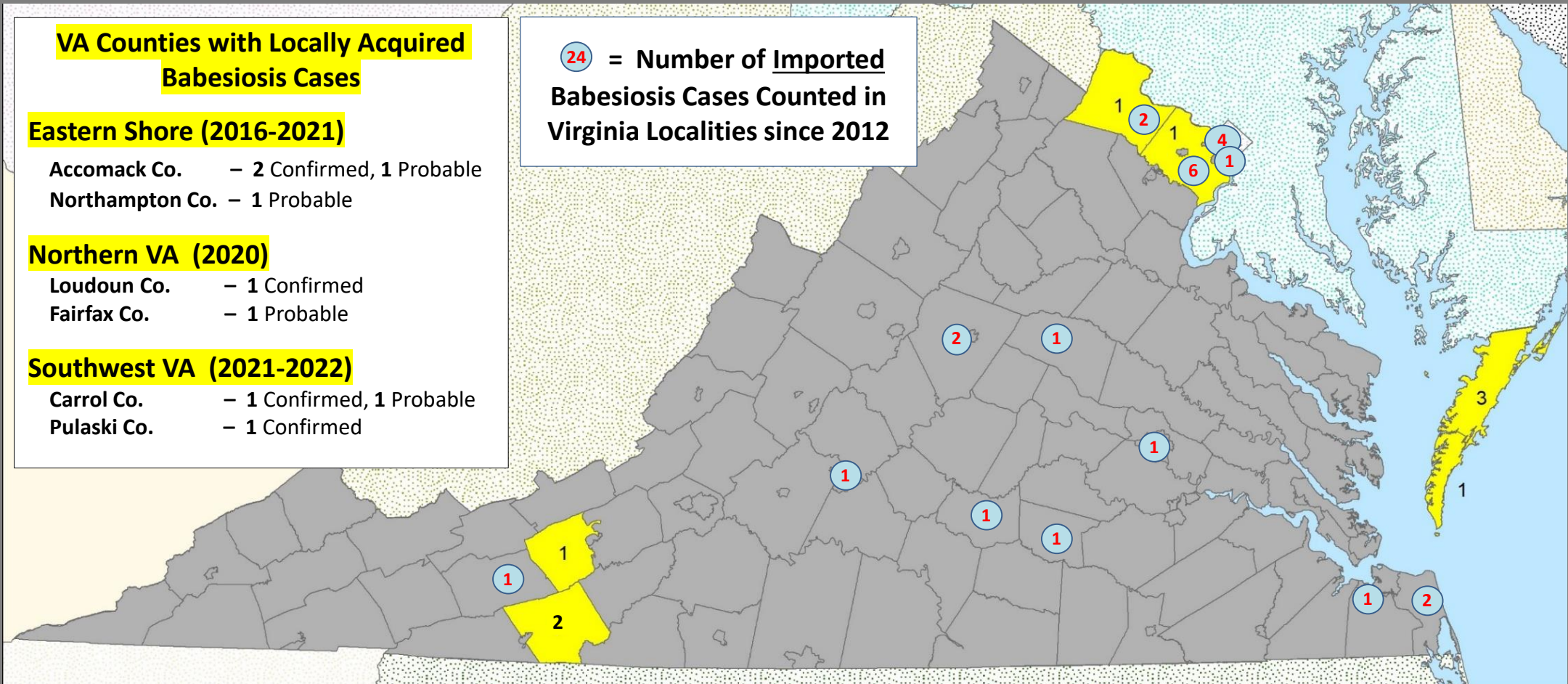
Blacklegged Tick Associated Diseases

Babesiosis

Babesiosis is a blacklegged tick-borne parasitic disease somewhat similar to Malaria. Healthy, immune-competent patients may have symptoms that last for several weeks, but can recover from babesiosis without treatment. Babesiosis infections may be more severe and longer lasting in immunosuppressed, splenectomized, or elderly patients. .

Babesiosis was slow to follow the blacklegged tick's southward expansion out of New England, and Virginia's first Babesiosis case was seen on Virginia's Eastern Shore in 2016. By 2020, three more cases had been identified on the Eastern Shore and one case each had been identified in Fairfax and Loudoun Counties in Northern Virginia. Unexpectedly, by 2022, three more cases had been identified in Carrol and Pulaski Counties in Southwestern VA.

Imported & locally transmitted babesiosis cases seen in Virginia from 2012 - 2022



Imported babesiosis cases have been counted in Virginia since 2012, but locally transmitted cases were first seen on the Eastern Shore of VA starting in 2016, and then in Northern VA in 2020, and three more locally acquired cases were reported to VDH from the Highlands of Southwestern VA from 2021 to 2022 .

Powassan Virus

The Powassan virus is a Flavivirus that is distantly related to WNV. To date, three human Powassan virus cases have been seen in persons who were bitten by blacklegged ticks while in the Virginia's Blue Ridge Mountains.

Like WNV, Powassan can cause severe neurologic infections that result in long term patient disability, and occasional fatalities.

Of the three Powassan patients known to have been infected in Virginia since 2009, one patient suffered long term disabilities, and a North Carolina resident that was exposed to it by tick bite while hiking along in Virginia's Blue Ridge became severely disabled and subsequently died.

Questions ?