MISSOURI DEPARTMENT OF
HEALTH &
SENIOR SERVICES

Uptick in Tick-borne Diseases

Bistate Infectious Disease Conference,
St Louis, Missouri, October 3, 2025

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SUPPOSED TO BE A HUGE TICK PROBLEM THIS YEAR...
HAVEN'T SEEN ANY YET...
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Tick-borne Diseases (TBD)

- Ticks responsible for 75% of vector-borne diseases in US
- Ticks can transmit bacterial, parasitic, and viral illnesses.
- Reported TBD cases in the United States more than doubled since 2004, with 50,865 reported in 2019.
- Between 2004 and 2016, 7 new TBDs reported in the US

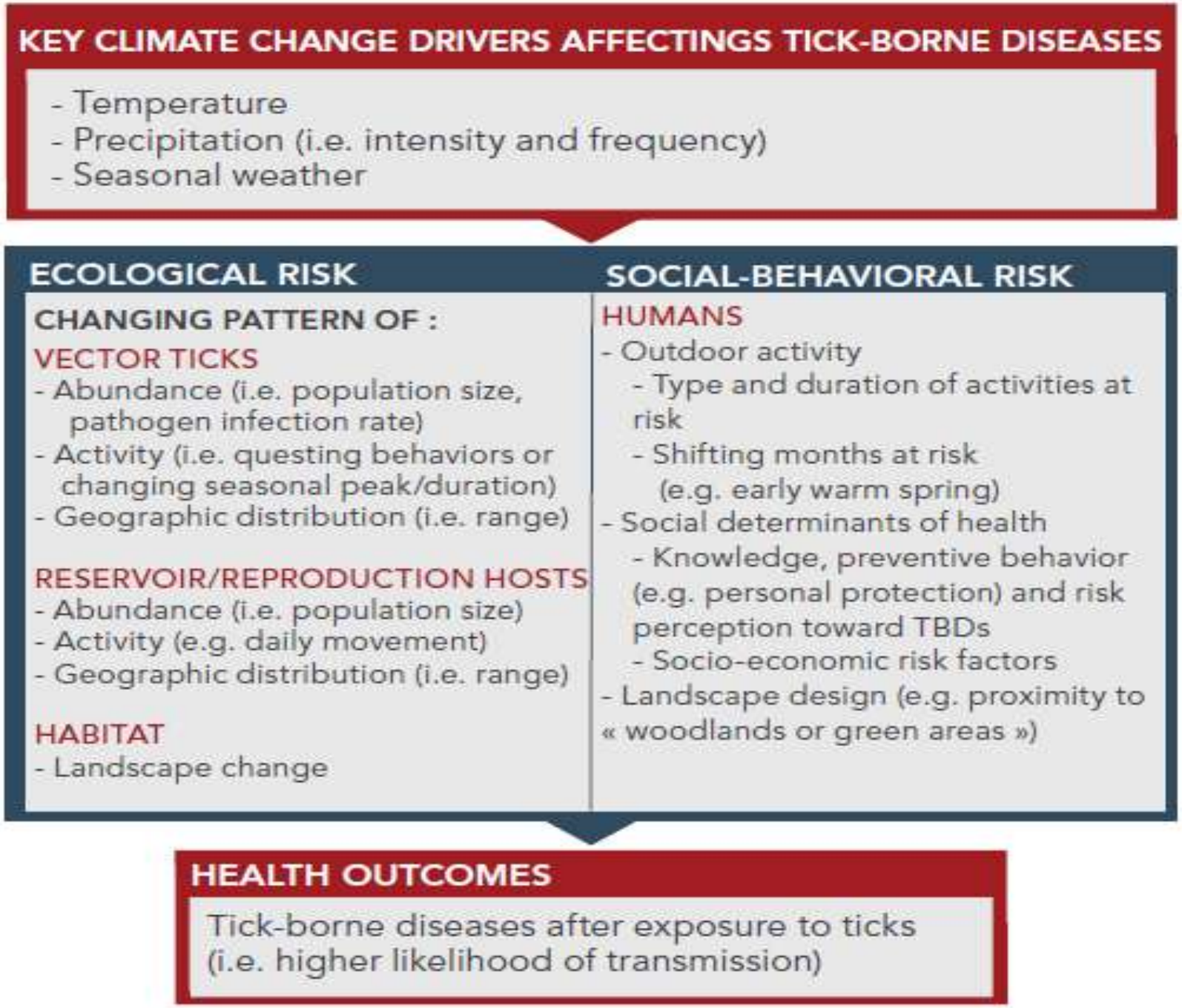
TBD Risk

Main risk groups for TBDs are those:

- engaged in recreational or occupational outdoor activities (hunting, fishing, hiking, camping, gardening, mushroom or berries picking, dog walking, forestry and farming) in or near endemic areas;
- primary or secondary residence located in or near endemic areas;
- either very young (5–9 years of age) or older (55 years of age and older)

What Could Be Driving the Rise?

- Climate Change with Warming Trend
- Changing Landscapes and Wildlife Ecology
- Ecology of Hosts
- Increased Awareness, Testing, and Diagnosis
- Human Behavior and Exposure Patterns
- Public awareness

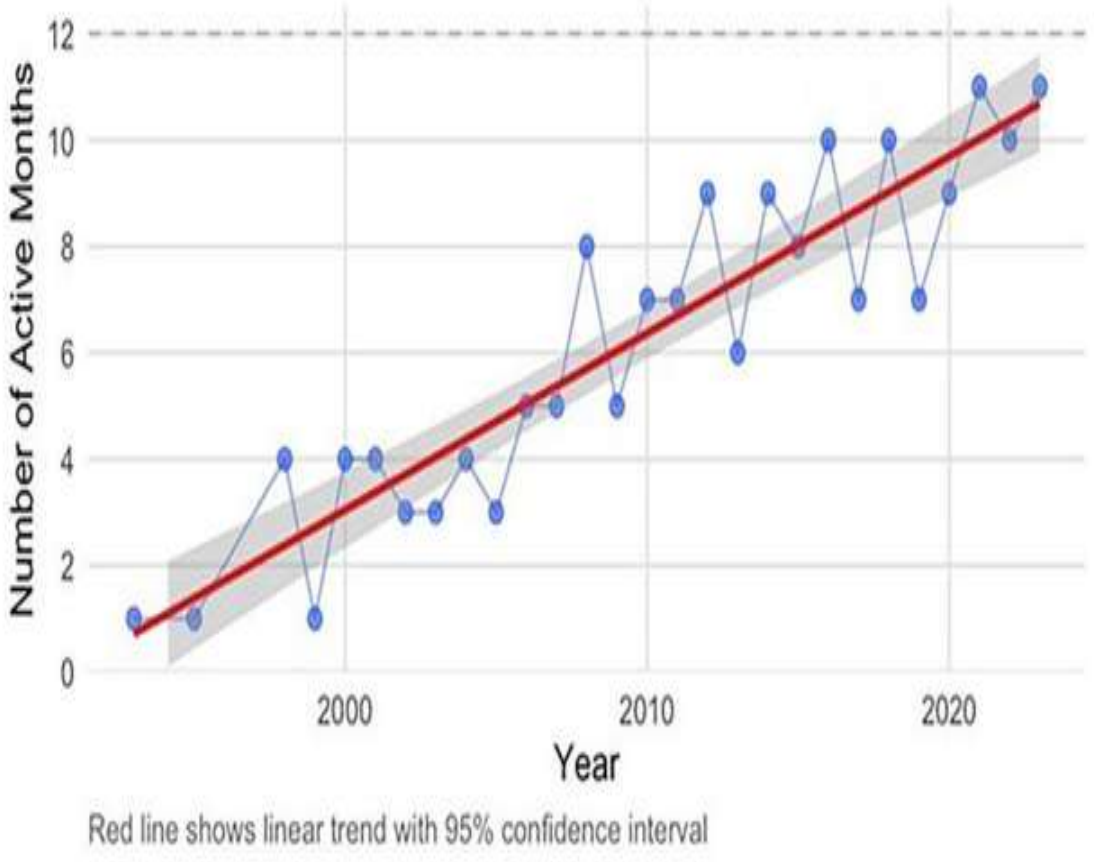


Adapted from Beard et al. 2016 (50)

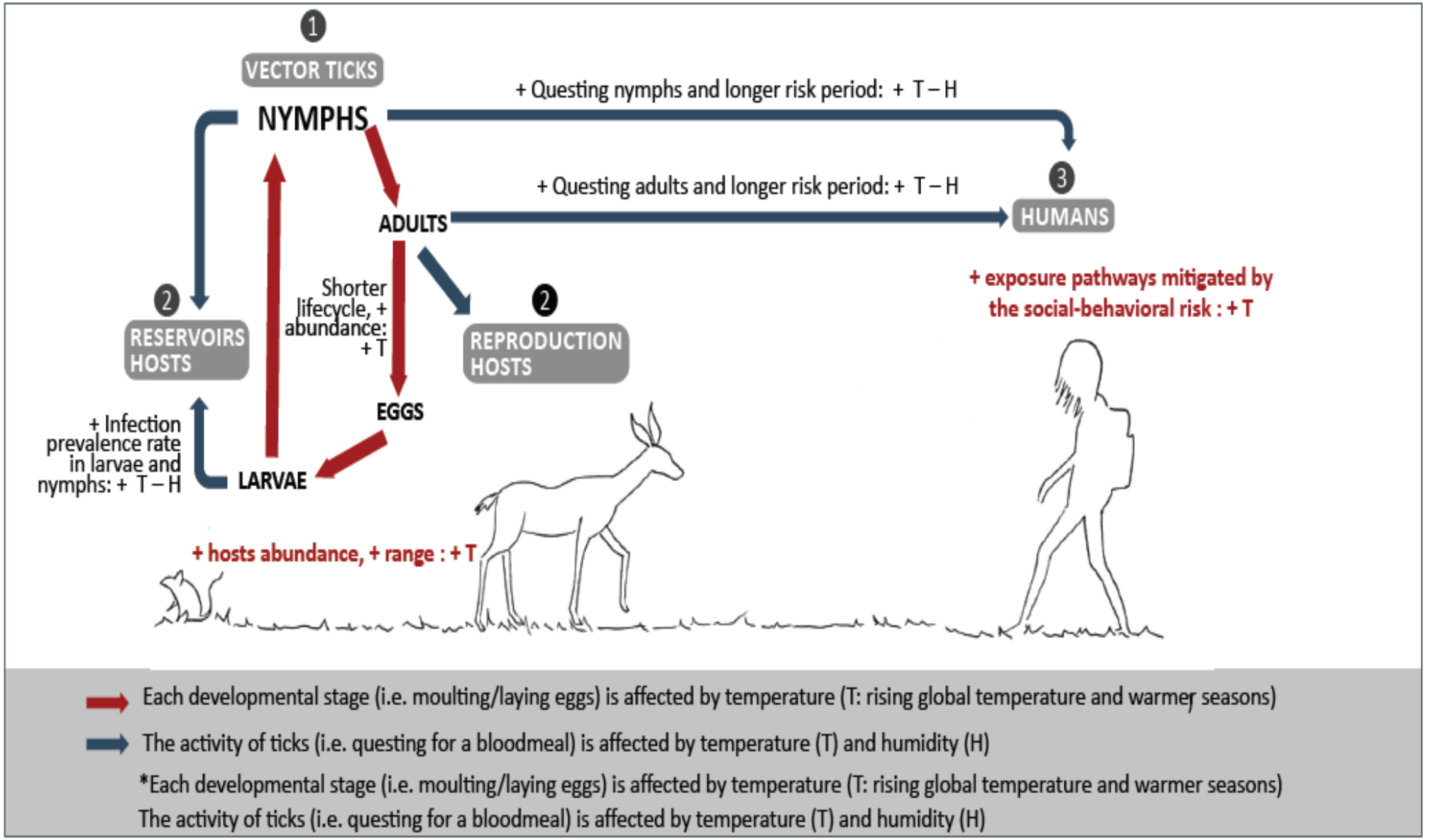
Key climate changes, ecological factors and social-behavioral risks that affect the acquisition of tick-borne diseases

Expansion of the active season for the development of symptomatic babesiosis over time

- In a generalized linear model, # of months in which symptom onset occurs increased **by 1 month every 3 years**
- Mean # of months of the active season for *Babesia microti* rose **from 2.2 before 2000 to 9.2 after** 2015



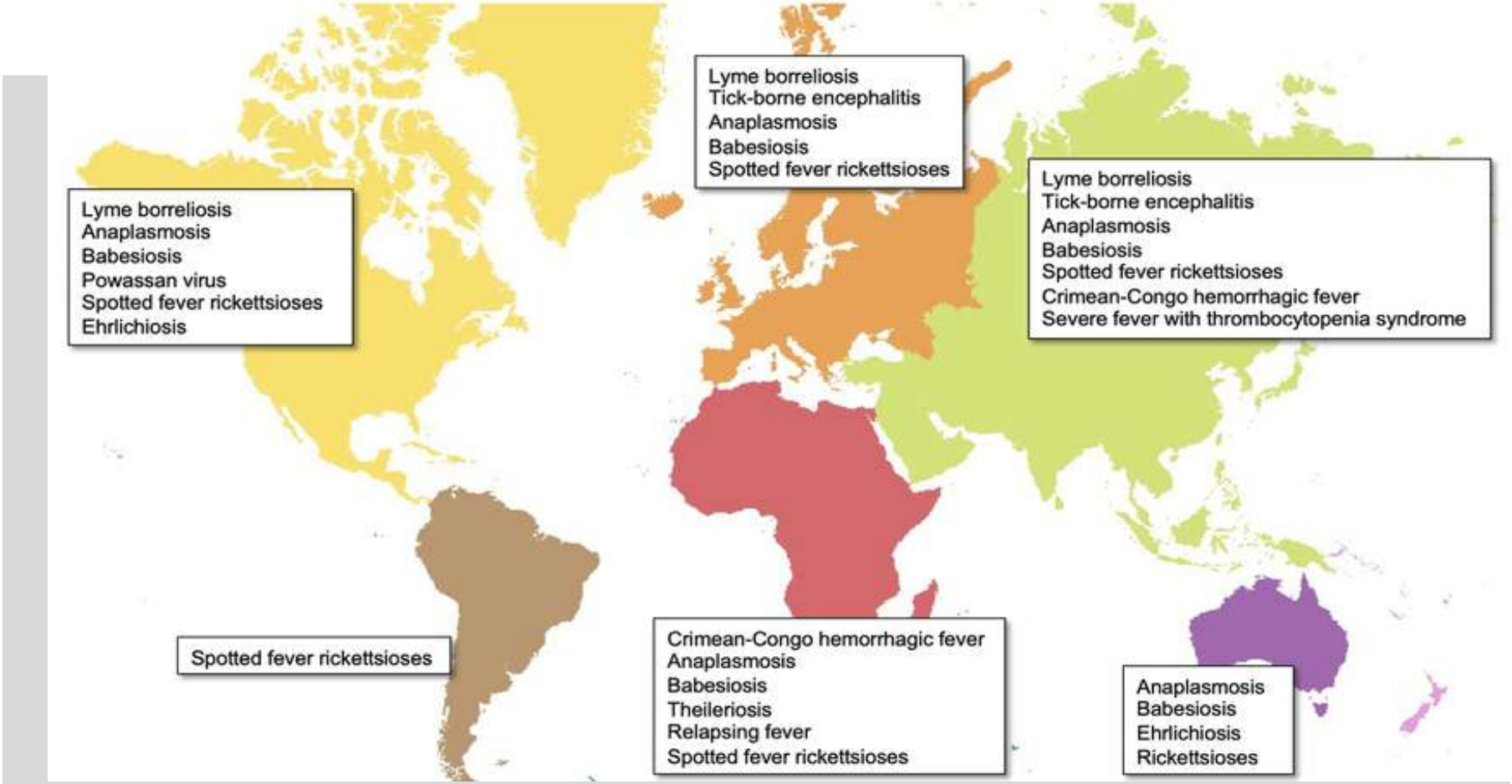
https://doi.org/10.1093/ofid/ofaf458



Adapted from Ogden & Lindsey, 2016 (5)

Climate Change and TBDs

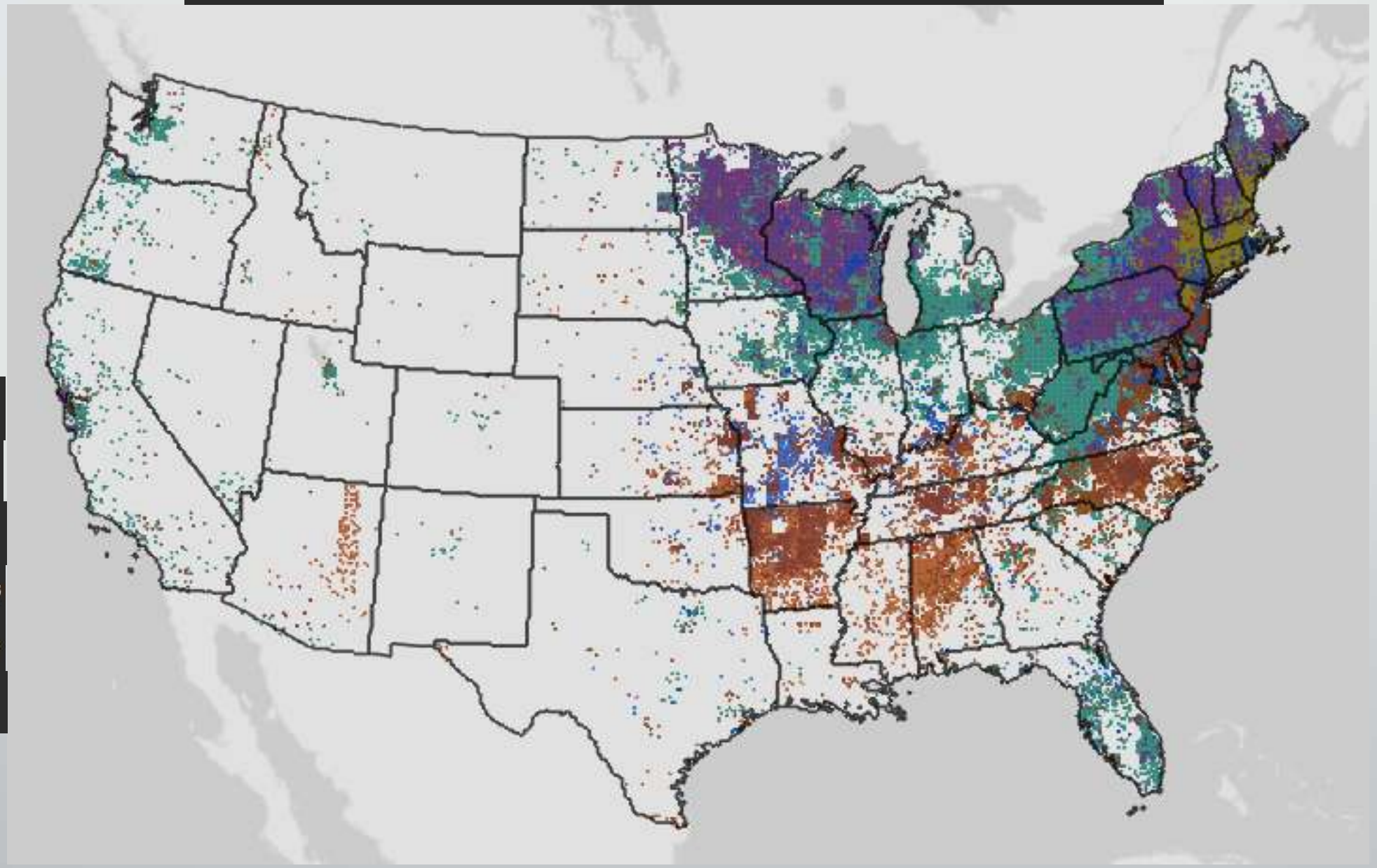
- Climate change plays mixed and relatively minor role in emergence of most TBDs
- Climate change effects probably less than those of changes in land use and social factors
- Effects of climate on transmission are multiple, non-linear, and act in opposing directions
- In core transmission areas, warming may even decrease transmission if decreases in vector survival through heat and moisture stress overwhelm other influences *(Kilpatrick & Randolph,* Lancet, 2012*)*



Global distribution of major tick-borne diseases by continent

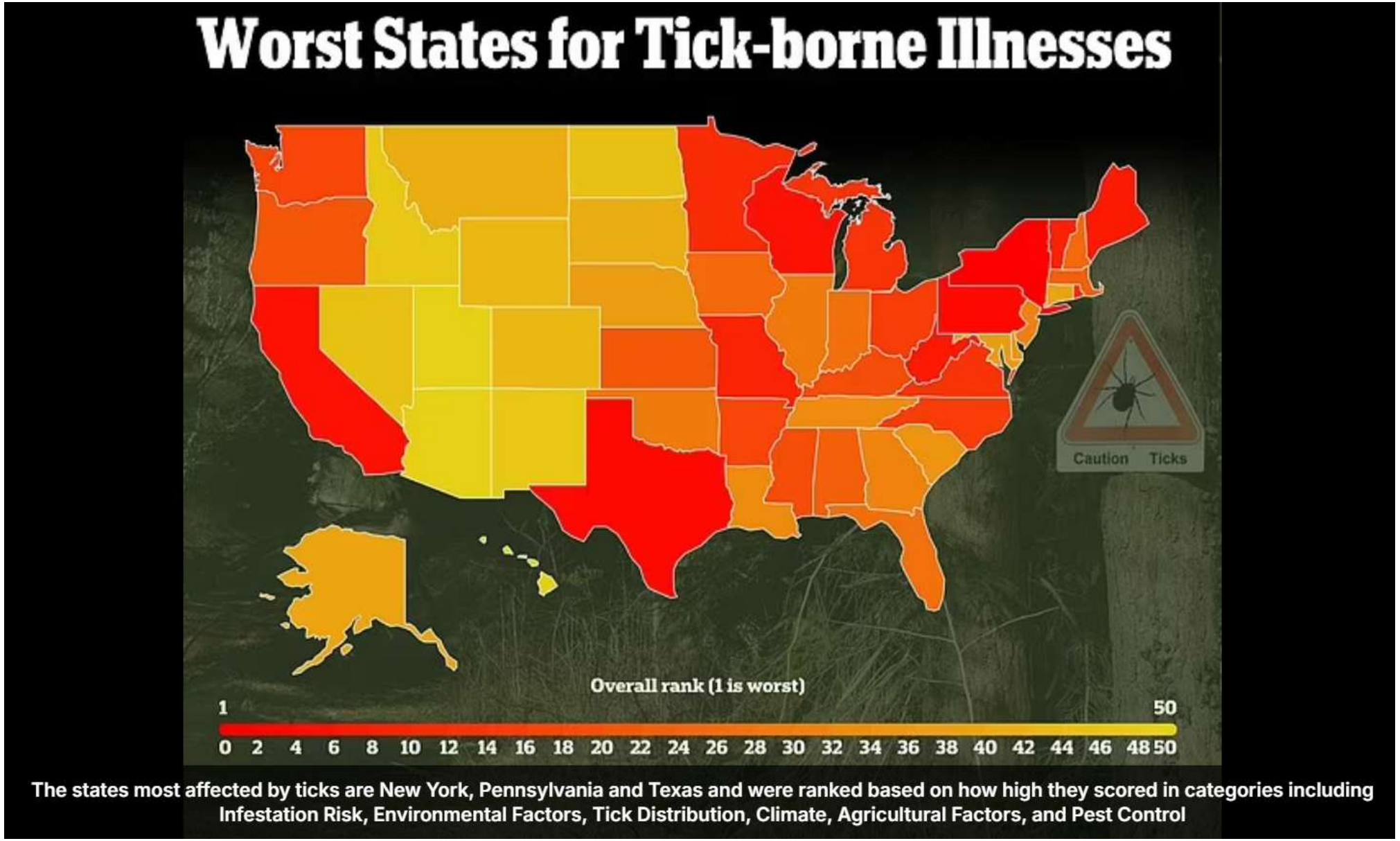
Selected Tickborne Disease Surveillance

Dot density map of total cases from 2019 - 2022



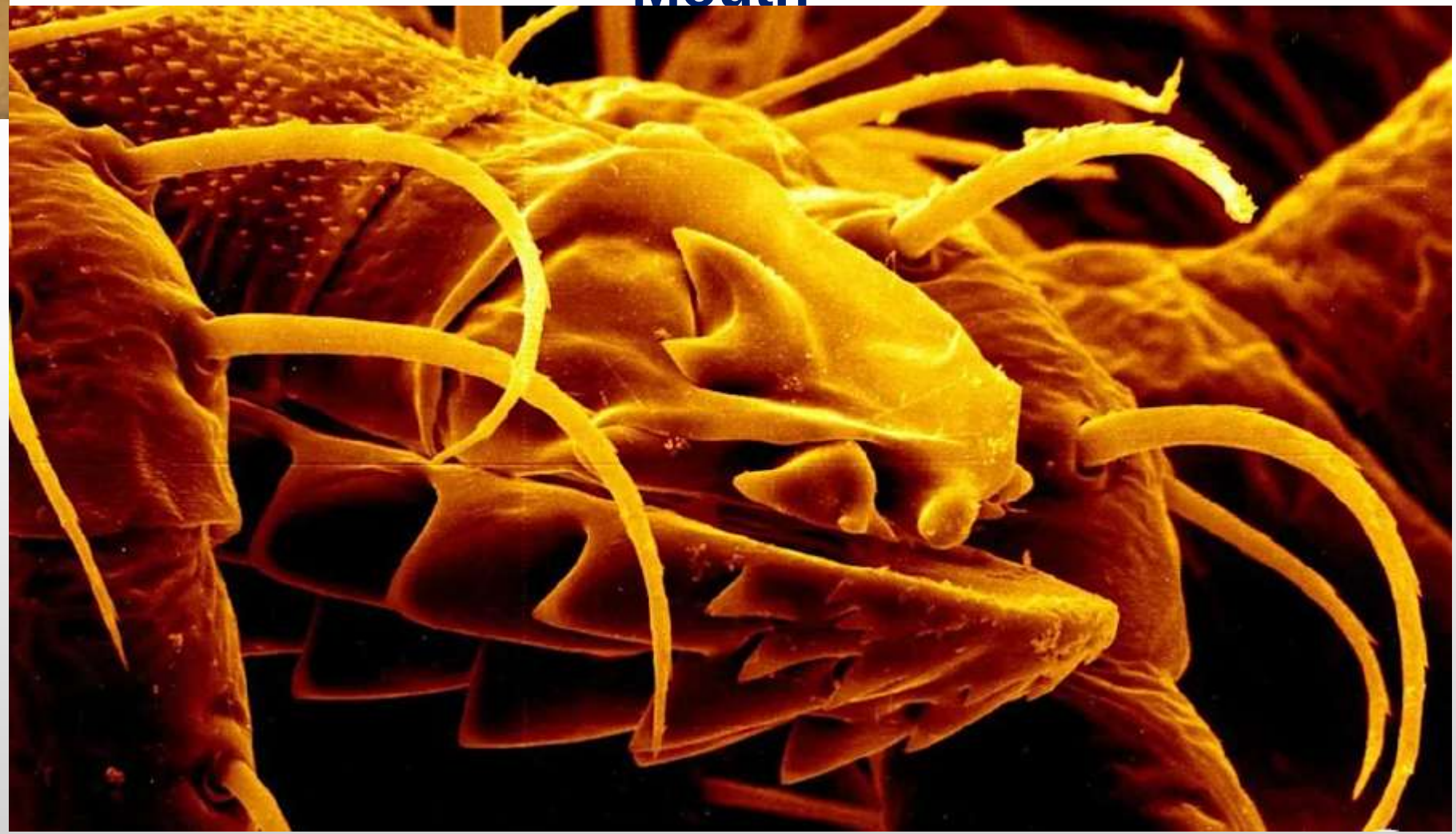
Tick-borne Diseases in Missouri

- Missouri in “epicenter” of tick-borne infections in USA
- In 1995, Missouri first reported a southern tick-associated rash illness (STARI), a Lyme-like rash illness of unknown cause
- In 2012, a newly discovered phlebovirus, Heartland virus, was first reported as a cause of severe febrile illness in two patients in Missouri
- In 2016, a novel Bourbon virus infection, first reported from a fatal human case in Bourbon County, Kansas in 2014, was also reported in Missouri
- Alpha-gal syndrome (AGS)
- Missouri ticks infection rates: in adult lone star ticks 6% for *B.lonestari*, 19% for *E. chaffeensis*, 3% for *E. ewingii*, 36% for *R. amblyommatis,* and 1% for *R. montanensis;* in American dog ticks 19% for *E.chaffeensis*, 15% for *E. ewingii*,4% for *R. amblyommatis*, and 5% for *R. montanensis* *(MoMed, 2018)*



The states most affected by ticks are New York, Pennsylvania and Texas and were ranked based on how high they scored in categories including Infestation Risk, Environmental Factors, Tick Distribution, Climate, Agricultural Factors, and Pest Control

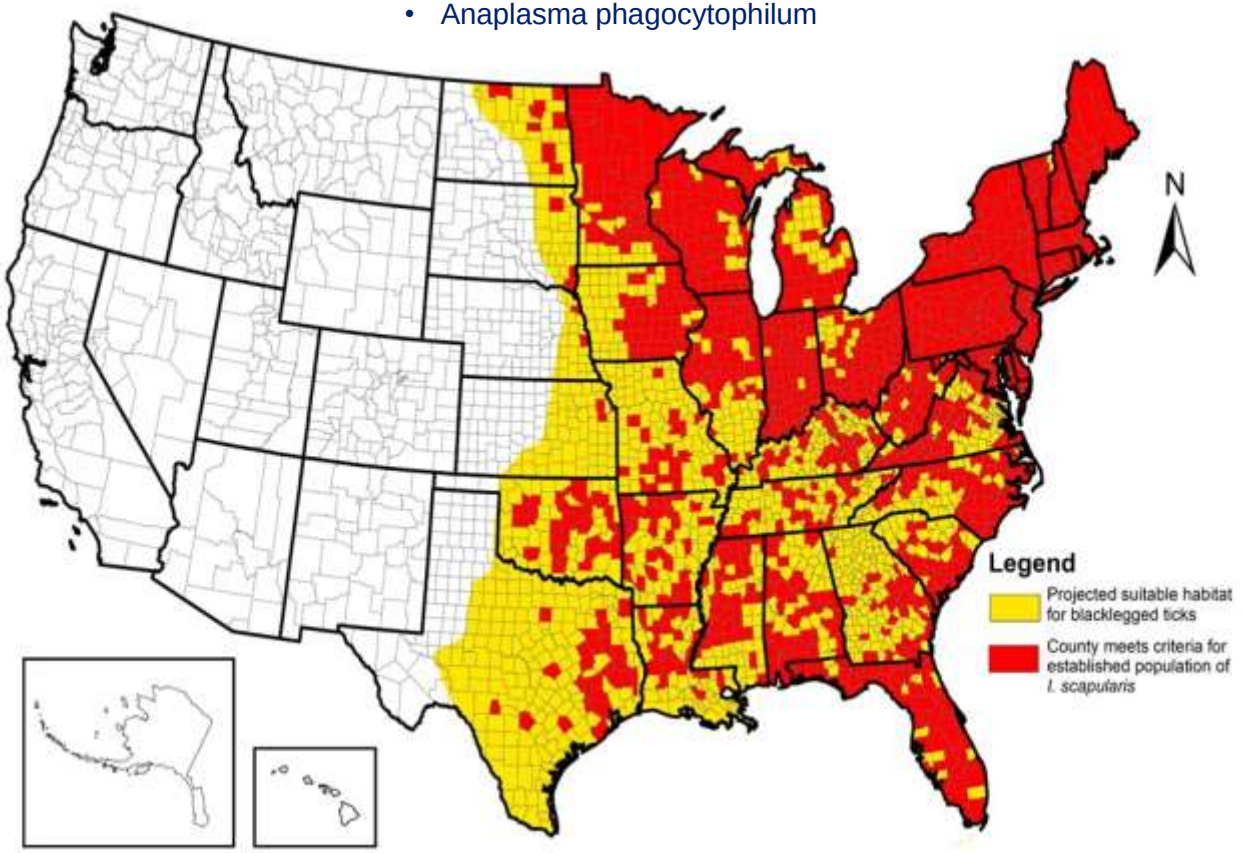
Magnified View of Tick's Mouth

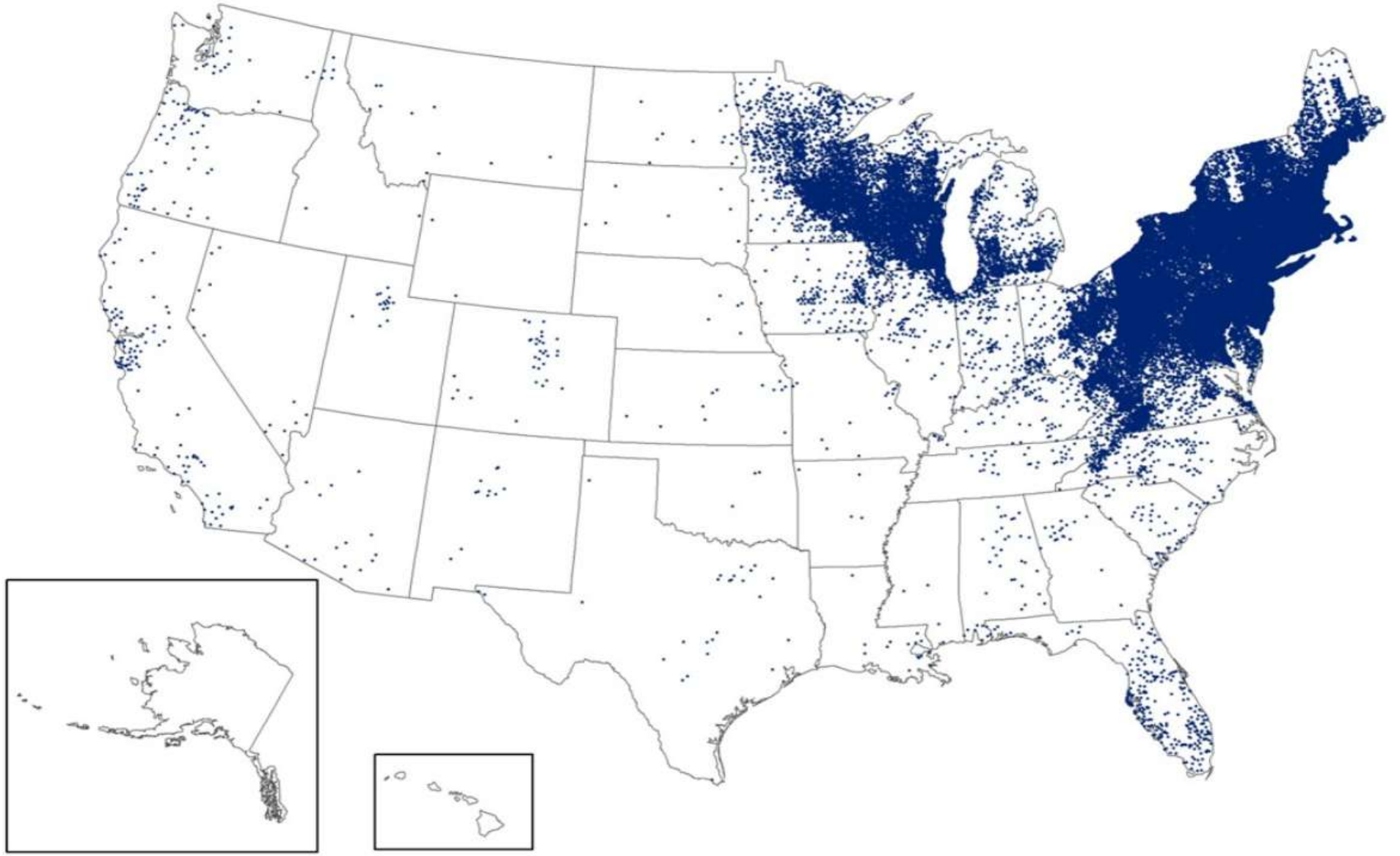


Ixodes scapularis serves as a vector for many pathogens.

- *Babesia microti* (Babesiosis)
- *Borrelia burgdorferi* (Lyme disease)
- *Borrelia mayonii* (Lyme disease)
- *Borrelia miyamotoi* (Borrelia miyamotoi disease)
- *Ehrlichia muris eauclairensis*
- Powassan virus (Powassan virus disease)

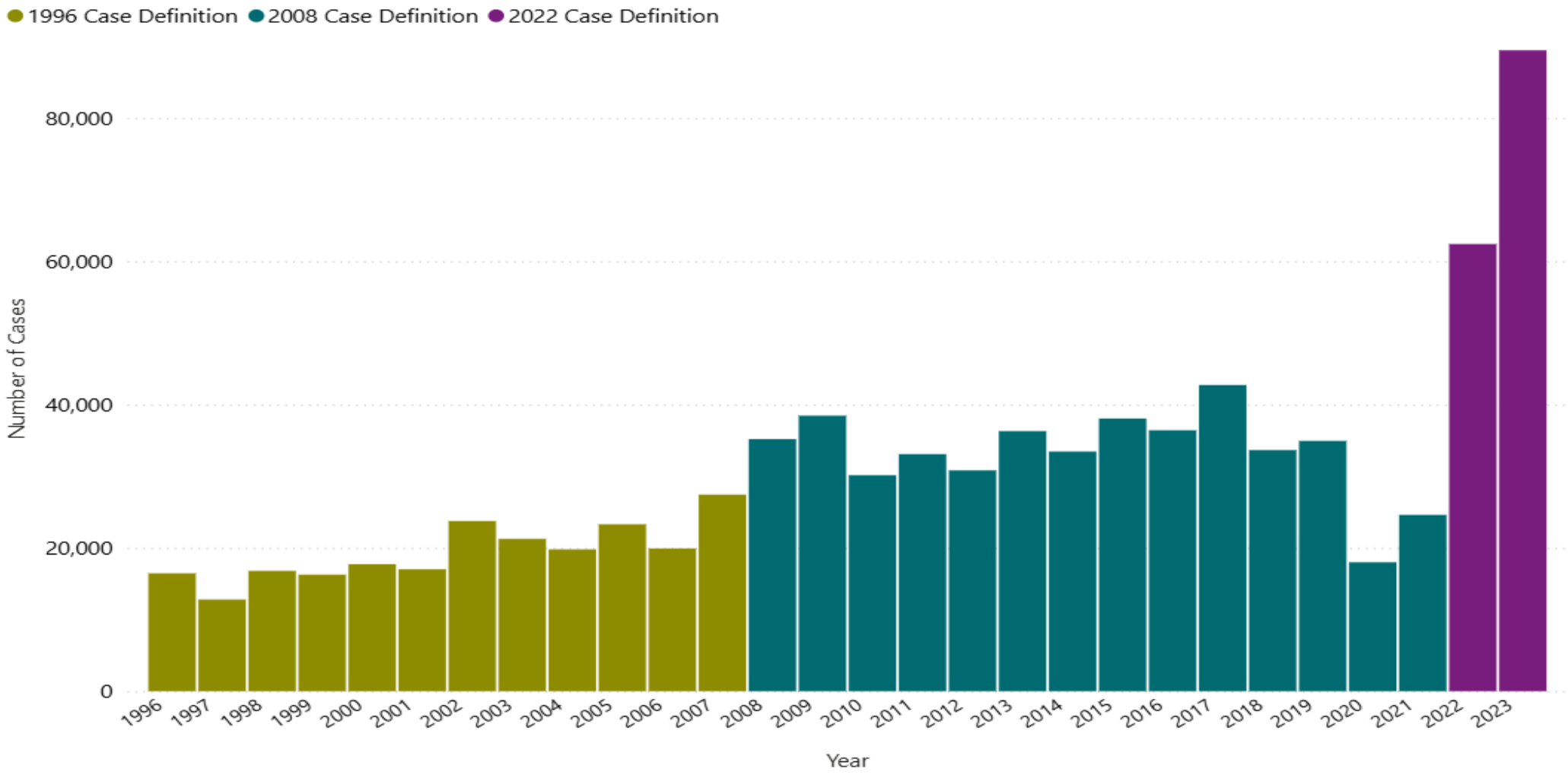
- Anaplasma phagocytophilum



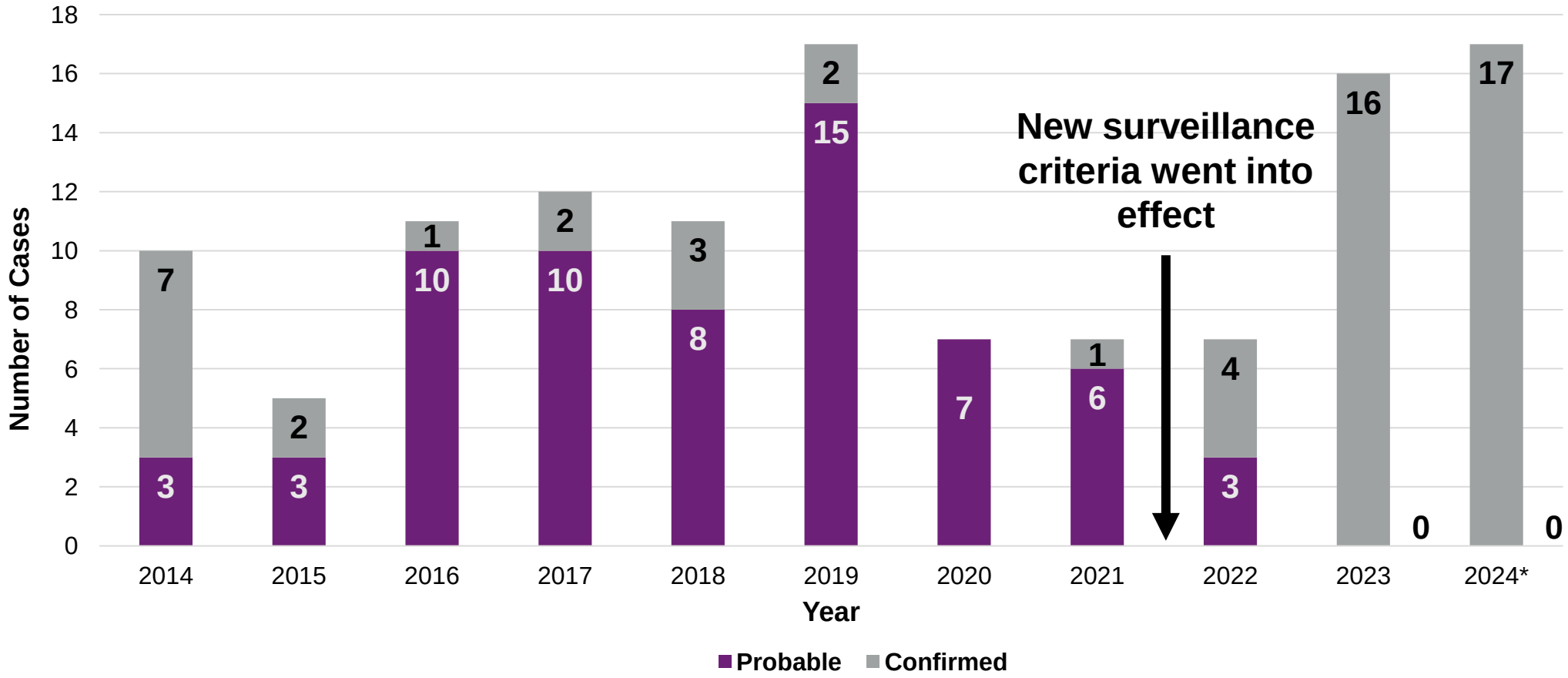


Reported cases of Lyme disease, 2023

Lyme Disease – Total Reported Cases by Year, United States



Lyme Disease Cases, Missouri, 2014 – 2024*



*2024 data are provisional and subject to change as investigations are finalized.
Data Source: Missouri Health Surveillance Information System (WebSurv).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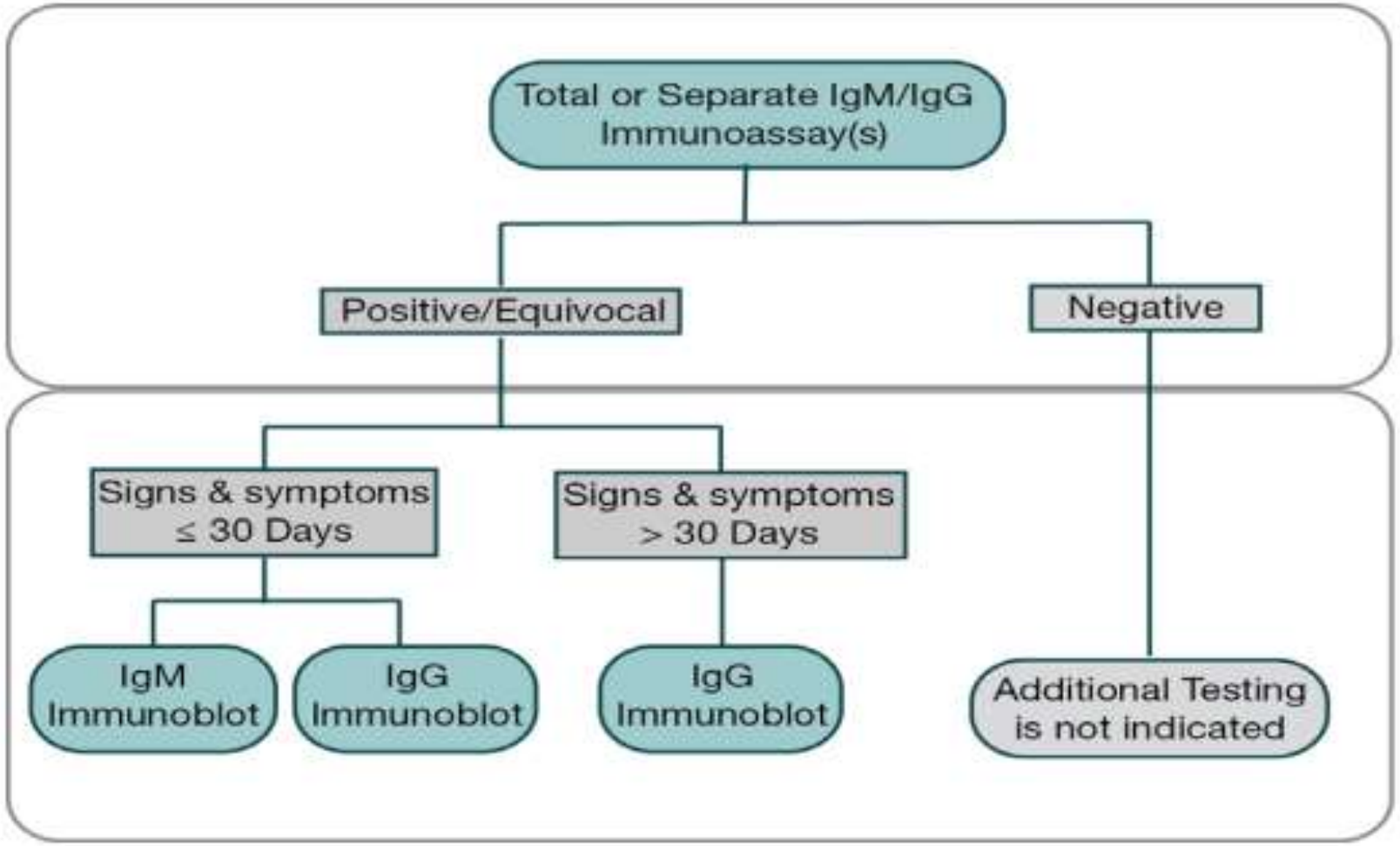
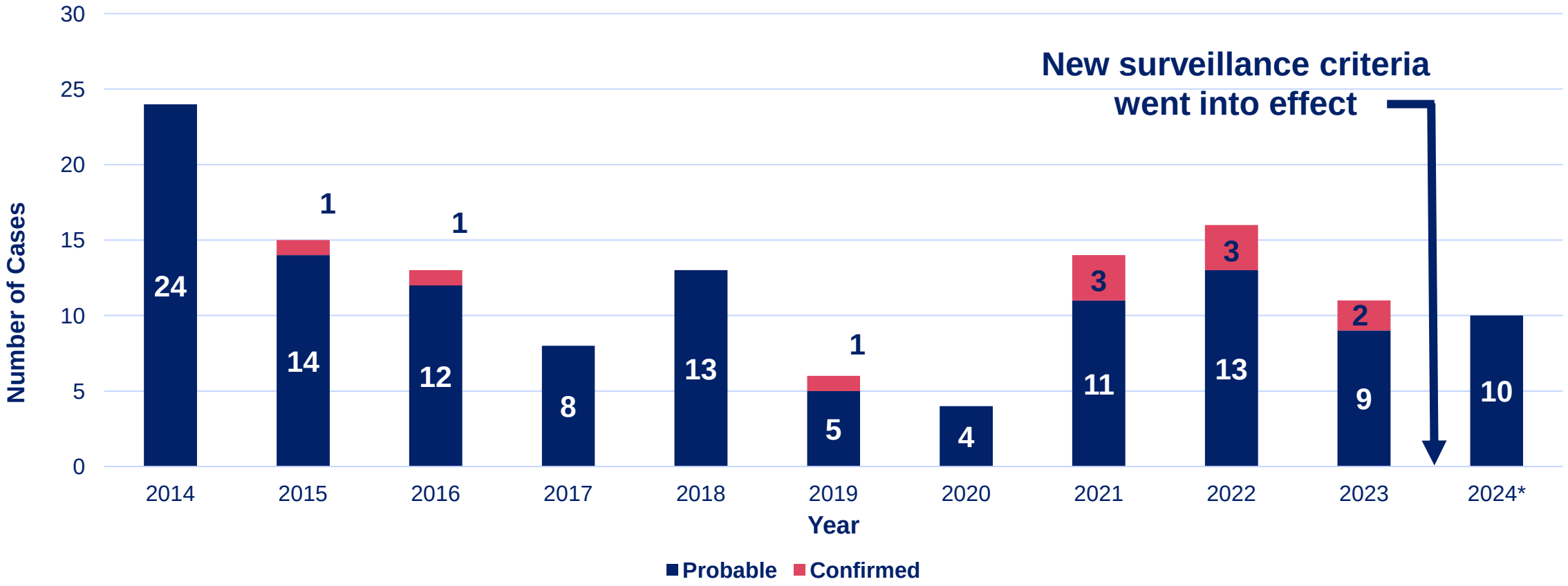
Standard Two-Tiered Testing for Lyme Disease



Age Category	Drug	Dosage	Maximum	Duration, Days*	References
Adults	Doxycycline OR	100 mg, twice per day orally	N/A	10-14	1 – 6
	Amoxicillin OR	500 mg, three times per day orally	N/A	14	1, 3, 6
	Cefuroxime	500 mg, twice per day orally	N/A	14	6, 10, 11
Children	Doxycycline OR	4.4 mg/kg per day orally, divided into 2 doses	100 mg per dose	10–14	7,9
	Amoxicillin OR	50 mg/kg per day orally, divided into 3 doses	500 mg per dose	14	7,8
	Cefuroxime	30 mg/kg per day orally, divided into 2 doses	500 mg per dose	14	8, 10, 11

CDC, 2025

Anaplasmosis Case Counts 2014 – 2024*



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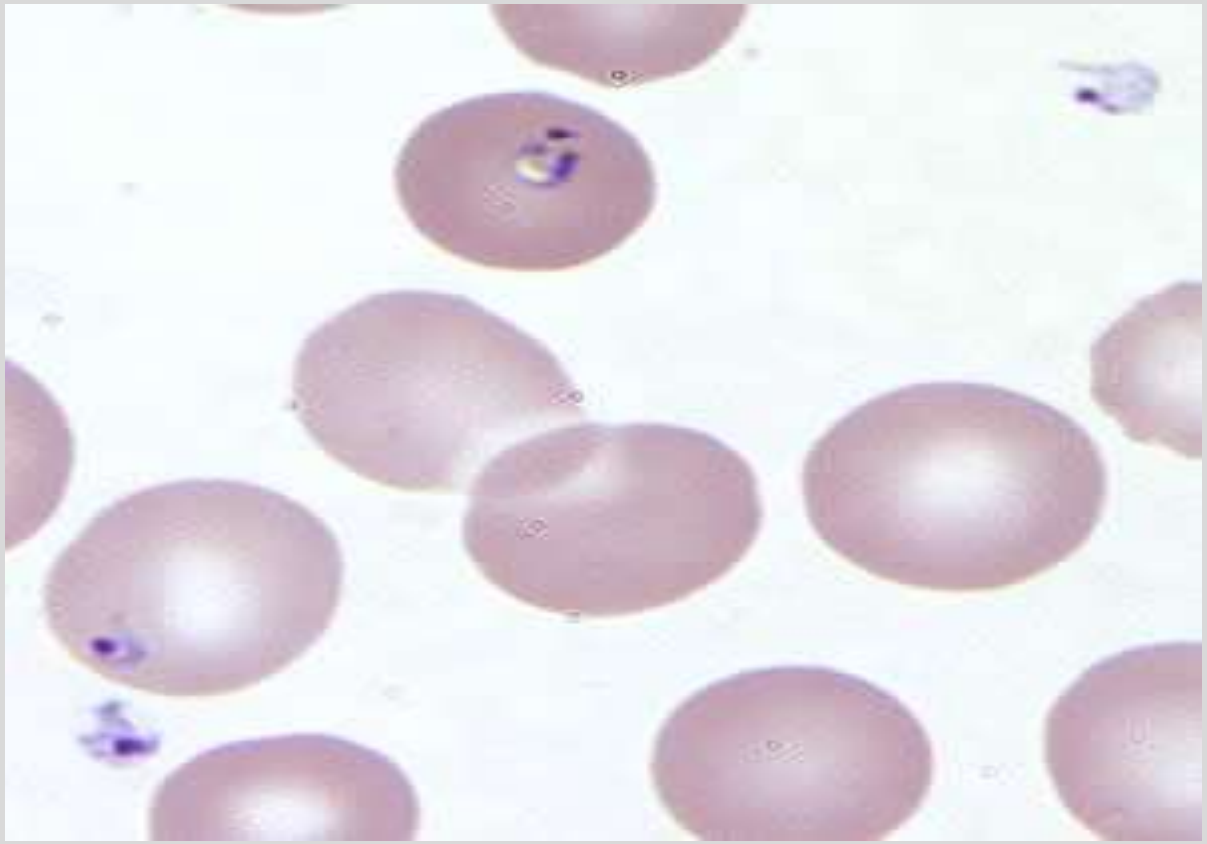
Data Source: Missouri Health Surveillance Information System (WebSurv).

Babesiosis

- Emerging zoonotic tickborne parasitic disease primarily in Northeast and Midwest with significant increase in 2011–2019 *(MMWR, 2023)*
- Incubation period likely **1-6 weeks**
- Spectrum: (1) a mild-to-moderate viral-like illness, (2) severe disease with fulminant course and death or relapsing course, or (3) asymptomatic infection
- Typically, hemolytic anemia and flu-like symptoms; some have splenomegaly, hepatomegaly, or jaundice; rarely rash. Usually lasts several weeks to months
- In symptomatic acute patients, *Babesia* **typically detected by blood smears**
- Serology and PCR for persons with low levels of parasitemia (blood donors), after infection is cleared by therapy, and for discrimination between *Plasmodium falciparum* and *Babesia*
- Most asymptomatic persons do not require treatment even if smears are positive; treatment course 7-10 days for symptomatic
- Case-fatality 5-9%, up to 21% in immunocompromised



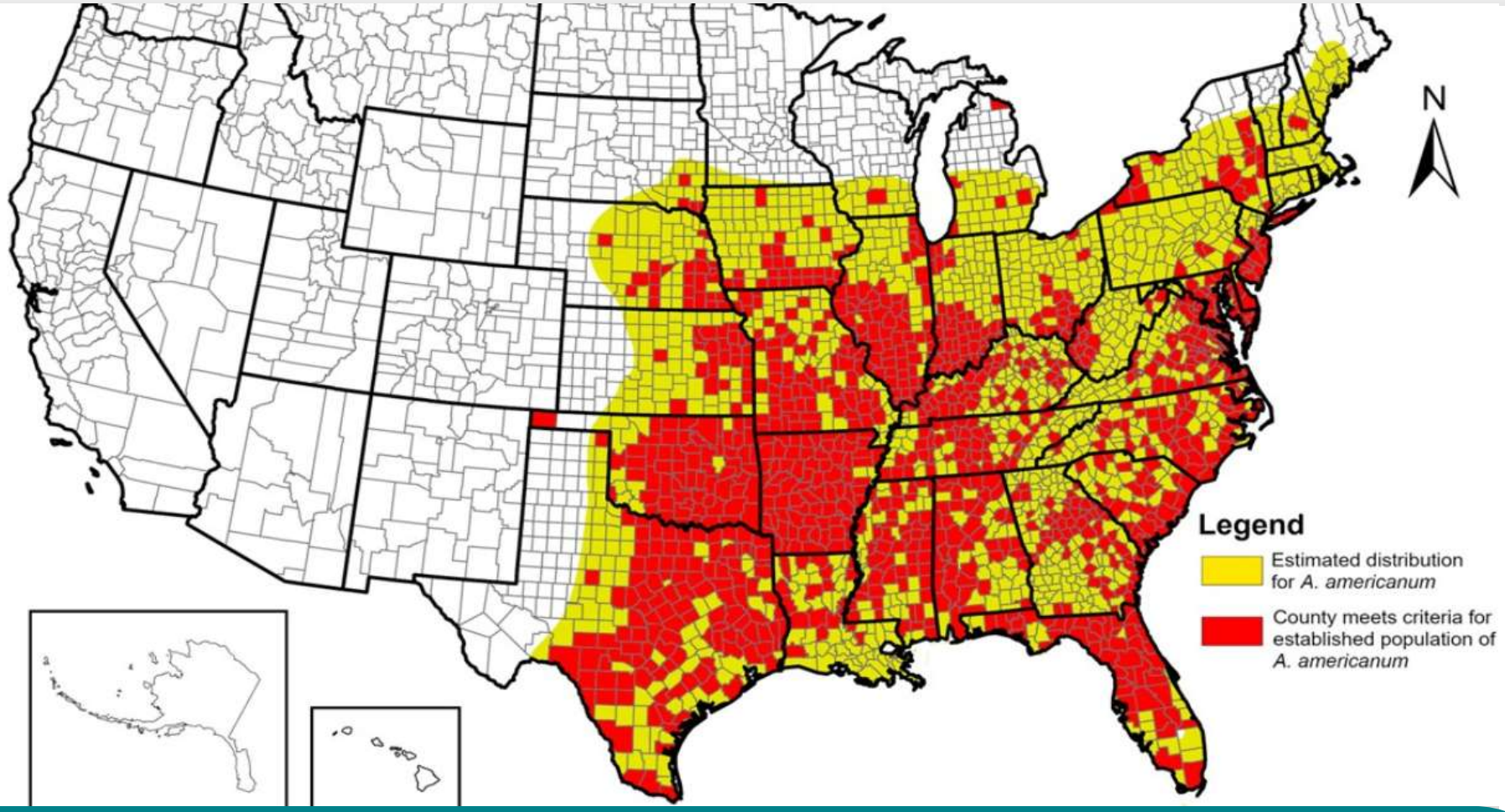
Babesia parasites in red blood cells on a stained blood smear

Powassan Virus

- Transmitted by *Ixodes cookei* and *I. marxi*, lineage II by *I. scapularis*
- Can be transmitted within 15–30 minutes of tick attachment
- Lowest # of annual cases of *I. scapularis* transmitted diseases: 42 cases reported as of 2024 and all neuroinvasive
- Presentation can vary from asymptomatic infections to fatal encephalitis (CFR of 10%)
- Symptoms: fever, headache, nausea, vomiting, generalized weakness.
- Leukopenia, thrombocytopenia, and elevated liver enzymes possible.
- Those with neuroinvasive disease have symptoms of meningoencephalitis with meningeal signs, seizures, altered mental status, paresis, cranial nerve palsies, or movement disorders
- ≈ half of survivors have ongoing neurologic manifestations.
- Treatment is supportive only

Lone Star Tick

Amblyomma americanum (Lone Star tick) is vector for:
- **Ehrlichiosis** due to *E. chaffeensis*and *E. ewingii*,
- **Tularemia** due to *Francisella tularensis*,
- **Heartland** virus disease
- **Bourbon** virus disease.
- **STARI** (southern tick-associated rash illness)
- **Alpha-gal** syndrome (a.k.a. meat allergy).



Estimated distribution of the lone star tick (*Amblyomma americanum)* in the United States and counties with established populations through 2024.

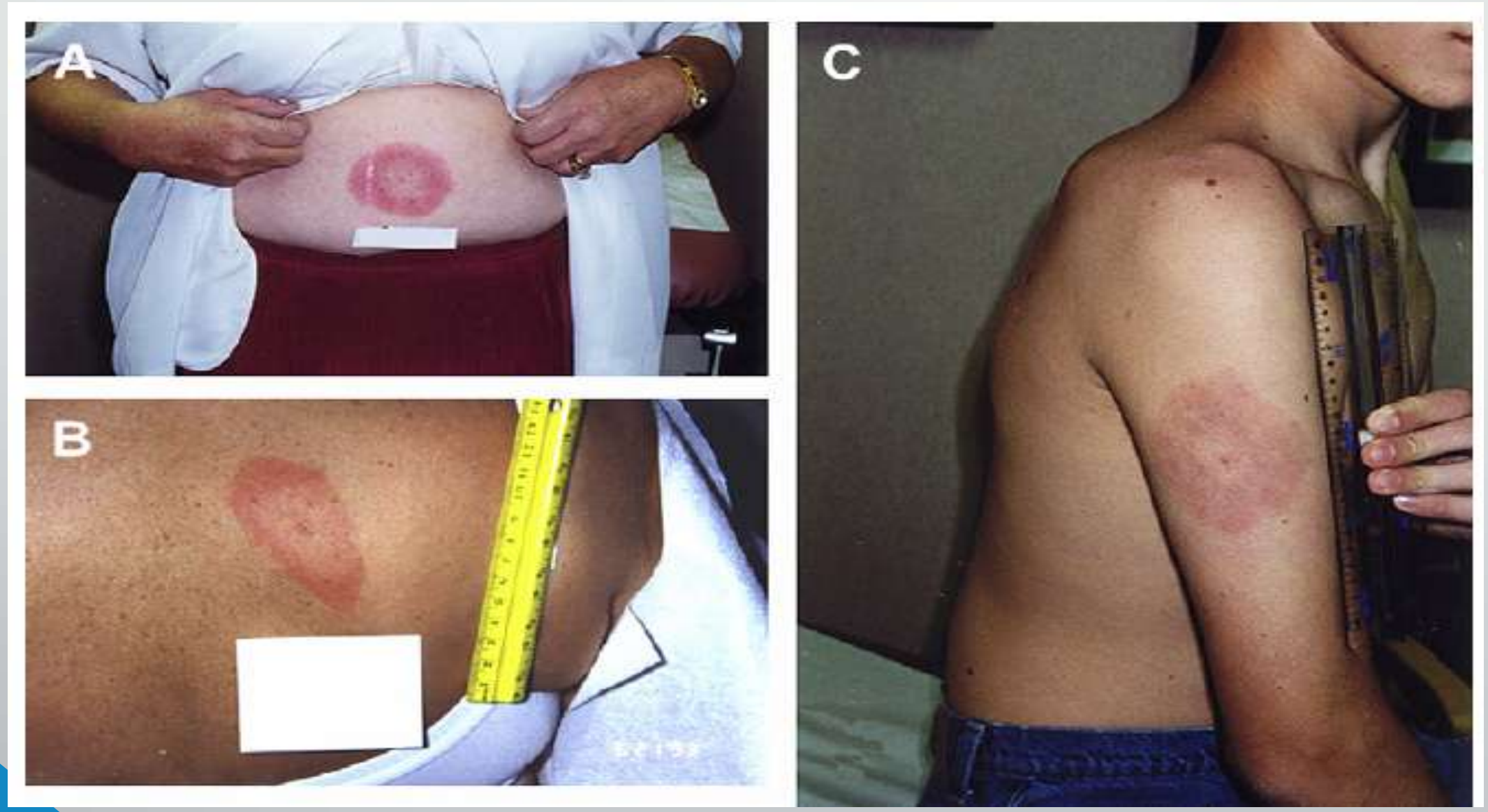
Southern Tick–associated Rash Illness (STARI)

- STARI or Masters disease is a Lyme-like illness in the southern US
- Likely vector, Lone Star tick, is the most common cause of tick bites in the south-central US
- First described in Missouri in1984; etiology largely unknown
- B. lonestari recovered from patient with EM-like lesion following bite of a Lone Star tick in one report (James AM, et al. J Infect Dis 2001); currently, B. lonestari not considered an agent of STARI
- Cause of STARI is not known, but *Borrelia burgdorferi* was excluded
- Long-term sequelae of STARI are unknown
- STARI isn’t reportable, and the incidence is unknown

STARI

- Rash usually within 7 days around tick bite
- Red circular rash at the tick attachment site expanding to a diameter of 3 inches (8 centimeters) or more, sometimes clearing as it enlarges to produce a target or "bull's-eye" appearance.
- Difficult to visually differentiate lesions from LD rash due to overlap and range of appearances.
- In a comparative study, a nearly perfect EM rash was four times as likely to be from Missouri as from New York (CID, 2005)
- Overall, STARI skin lesions tend to be smaller, more circular in appearance and more likely to have central clearing, usually solitary.
- Rash accompanied by mild illness with fatigue, headache, stiff neck, and occasionally fever
- Patients with STARI have much less severe arthritis and recover more rapidly than patients with Lyme disease

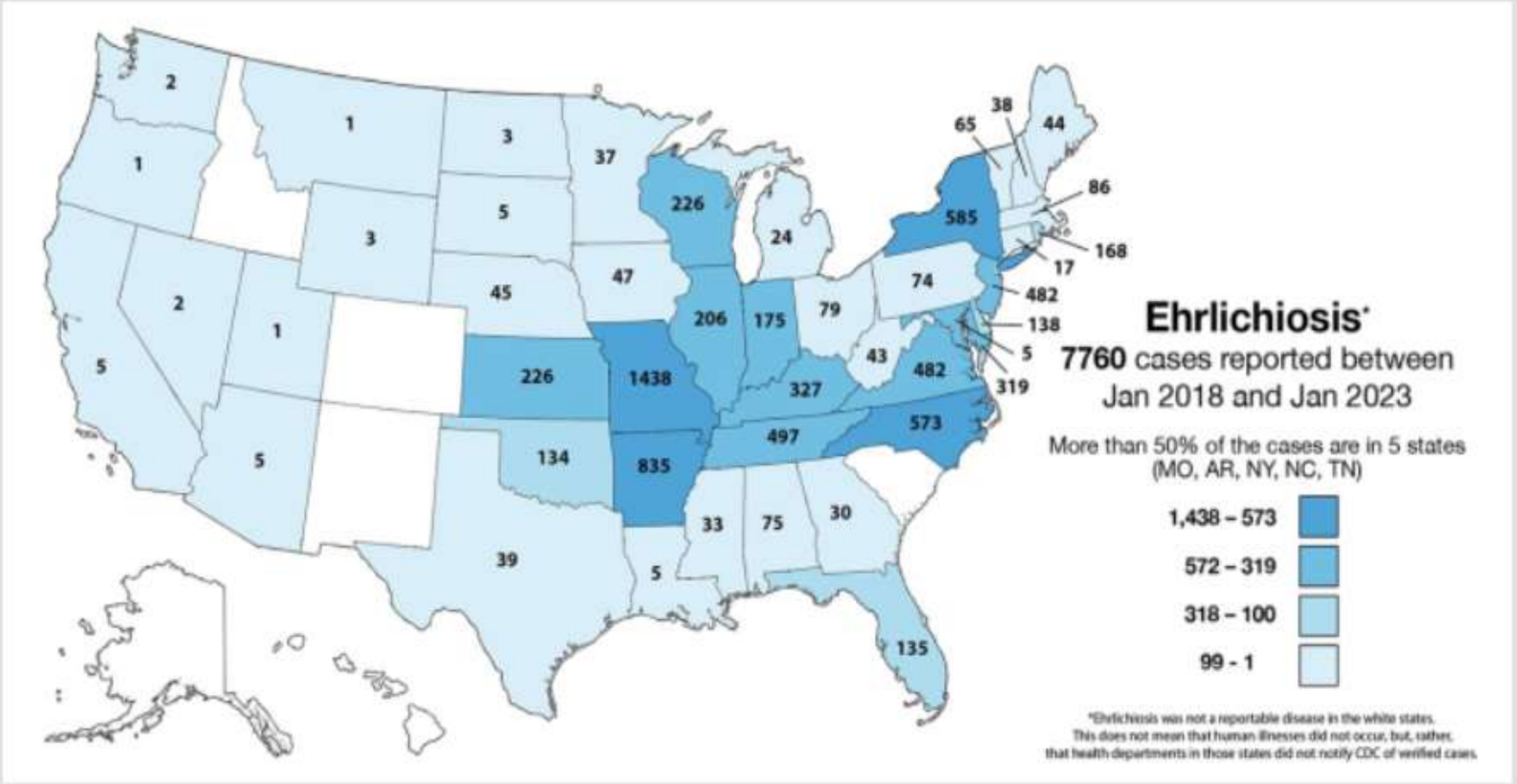
Lyme-like Lesions



Masters et al. Infect Dis Clin N Am 22 (2008) 361–376

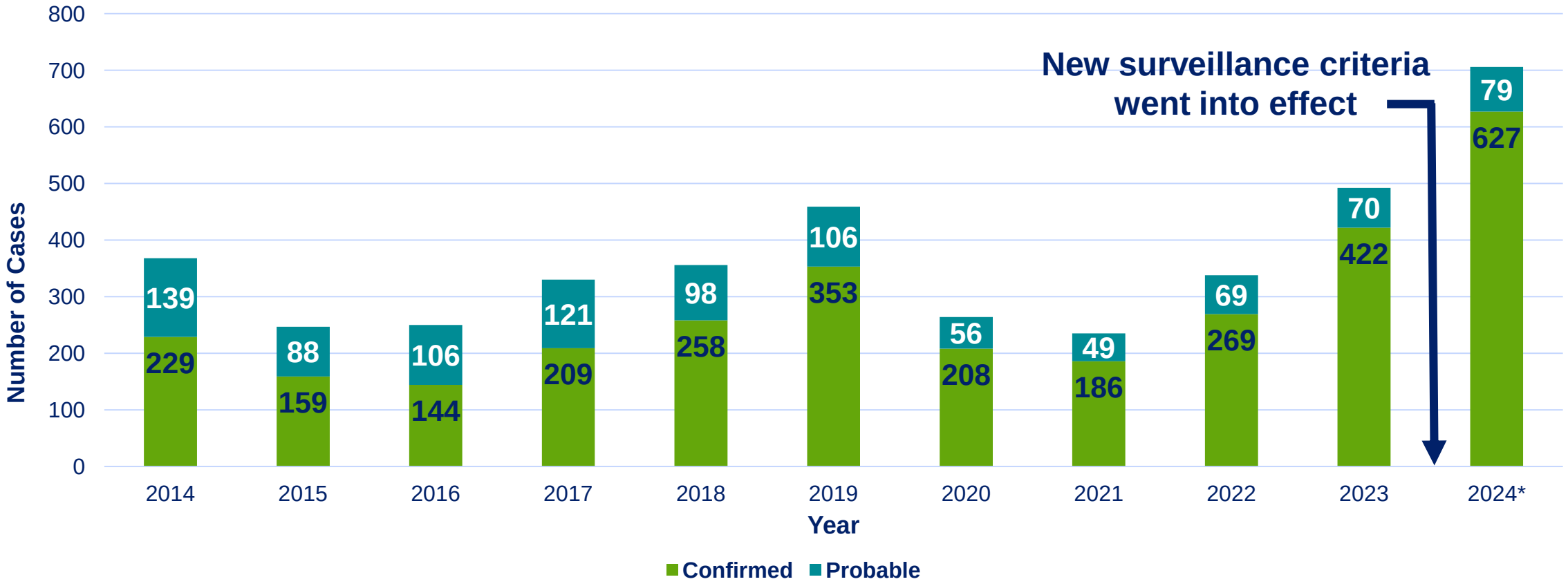
STARI

- Since the disease agent is unknown, diagnostic tests for STARI cannot be developed
- Conventional tests, ELISAs and Western blots, based on *B. burgdorferi* usually negative
- Cross-reactivity with *B. burgdorferi* can occur with ELISA test, but Western blots on Lyme-like illness patients are usually negative
- It is not known whether antibiotic treatment is necessary or beneficial
- Because STARI resembles early Lyme disease, physicians will often treat patients with oral antibiotics.
- Some evidence that doxycycline is therapeutically helpful, but it is questionable



Source: Centers for Disease Control and Prevention,
National Notifiable Diseases Surveillance System

Ehrlichiosis Case Counts 2014 – 2024*



*2024 data are provisional and subject to change as investigations are finalized.
Data Source: Missouri Health Surveillance Information System (WebSurv).

- Fever (96%)
- Headache (72%)
- Myalgia (73%)

Significant number ehrlichiosis cases could be asymptomatic

Gastrointestinal (GI) signs

- Nausea (57%)
- Vomiting (47%)
- Diarrhea (25%)

50%
of patients have infiltrates on chest x-ray.

NOTE

- GI signs are more common in children.
- They are also less common in *E. ewingii* and *E. muris eauclairensis* ehrlichiosis.

Skin rash is not a common feature of ehrlichiosis and should not be used to rule in/rule out infection

Severe illness may involve:

- Central nervous system (CNS) involvement (including meningoencephalitis)
- Acute Respiratory Distress Syndrome (ARDS)
- Septic shock-like syndrome
- Hemophagocytic lymphohistiocytosis
- Renal failure

Unknown whether patients recovered from ehrlichiosis are immune or susceptible to re-infection

Risk factors for severe disease

- Delayed treatment
- Extremes of age
- Immunosuppression
- Pulmonary and CNS involvement are poor prognostic indicators

Case fatality rate: 1-3%

Ehrlichiosis

- **Pancytopenia** is a hallmark of ehrlichiosis.
- **Anemia** in ≈1/2 of cases within 2 weeks.
- **Leukopenia** (largely lymphopenia) in ≈ 2/3 of cases.
- Marked **thrombocytopenia** is pathognomonic (70-90%)
- Some elevation in **hepatic transaminases** in ≈90%, with increased ALP and bilirubin in some
- Elevated CRP common in the first week of illness
- Mild/moderate **hyponatremia** in ≈1/2 of adults, and more often in children
- Routine blood cultures cannot detect *Ehrlichia or Anaplasma*

PCR tests can accurately diagnose ehrlichiosis or anaplasmosis during the first week of illness. IgM is insensitive in diagnosing incident cases of ehrlichiosis and anaplasmosis. IFA IgG is a reliable diagnostic test when paired samples are compared, one from the first week of illness, and the second 2-4 weeks later. A four-fold increase in titer values confirms diagnosis. *Ehrlichia* and *Anaplasma* are obligate intracellular agents and cannot be grown using standard blood culture systems.

EHRLICHIOSIS DIAGNOSIS

Blood Transfusion and Organ Transplantation

Survive in refrigerated blood > 1 week

Transmission through blood transfusion is rare, but possible.

- Has occurred in leukoreduced and non-leukoreduced red blood cells and platelets.
- Blood products are not routinely screened for these agents.
- Both *Ehrlichia* and *Anaplasma* species may be spread via blood transfusion.

- Donor-derived *Ehrlichia* infections among kidney and liver recipients have been confirmed.
- *Ehrlichia* infections among lung and heart recipients are suspected.
- *Anaplamsa* infections among kidney and pancreas recipients are also suspected.

- Less likely to experience rash
- Lower hepatic enzymes
- More likely to experience leukopenia and renal dysfunction

Adults and Children >100lbs
100 mg BID

Children <100lbs
2.2 mg/kg BID

Duration

- Ehrlichiosis: at least 3 days after fever subsides (min. 5-7 days)
- Anaplasmosis: 10-14 days

- Never wait for test results before initiating empiric treatment!
- Doxycycline is the most effective treatment for ehrlichiosis and anaplasmosis.
- Recommended treatment for all age groups.

Doxycycline safety in children

- Short courses are safe to use in children of all ages.
- No evidence that ≤ 21 days of doxycycline causes tooth staining in children.

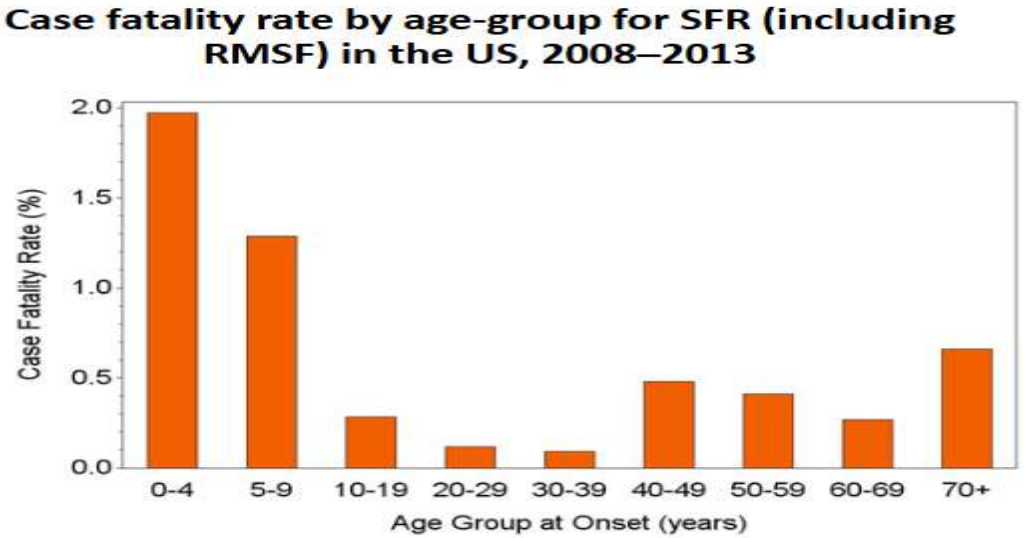
Post-exposure prophylaxis is NOT RECOMMENDED following tick bite to prevent ehrlichiosis or anaplasmosis.

Spotted Fever Rickettsiosis (SFR)

- RMSF is a tickborne disease caused by infection with *Rickettsia rickettsii*.
- RMSF most severe spotted fever rickettsiosis (SFR) worldwide.

Vectors:

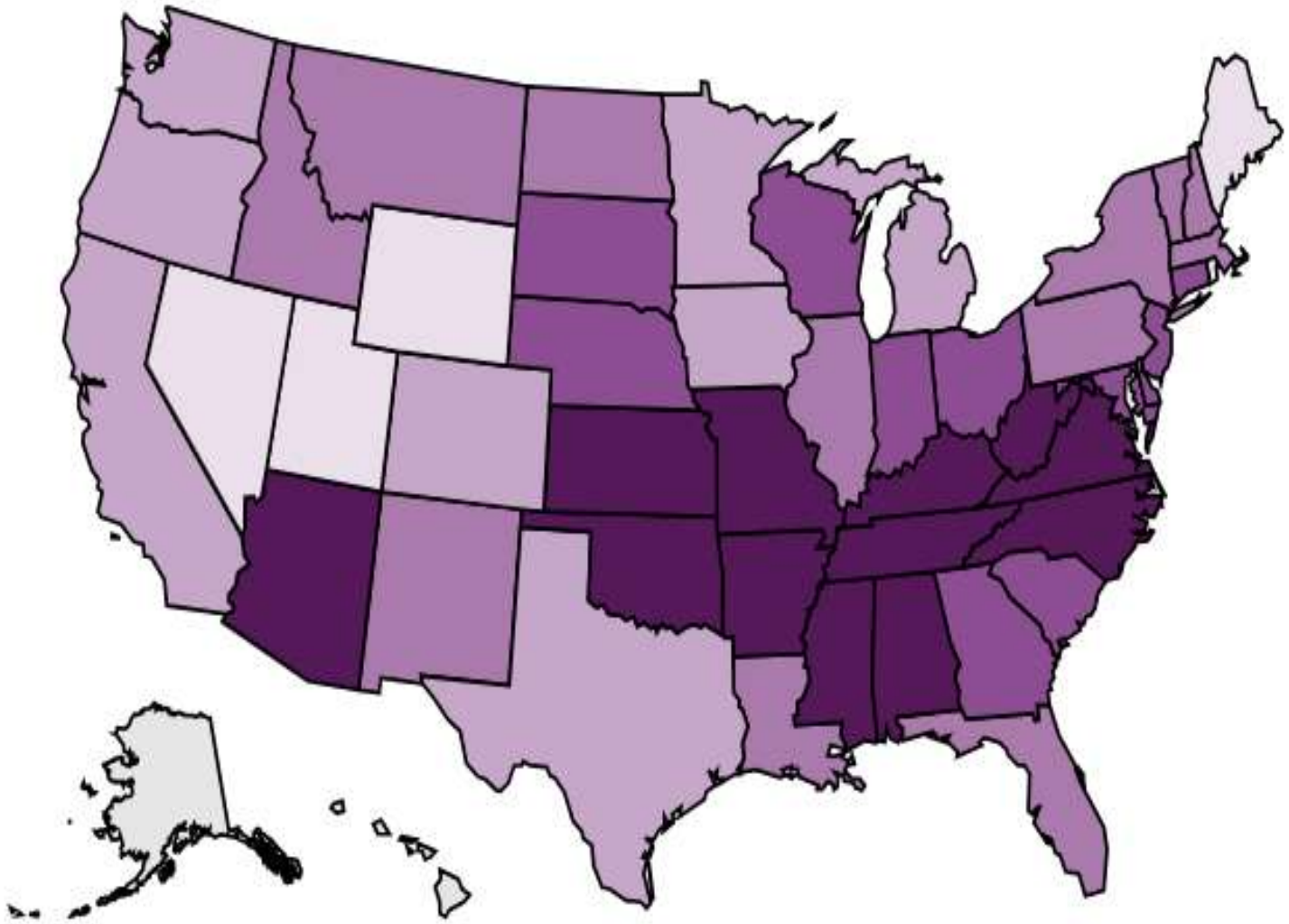
- American dog tick (*Dermacentor variabilis*)
- Brown dog tick (*Rhipicephalus sanguineus*) parts of southwestern US and Mexico
- Rocky Mountain wood tick (*Dermacentor andersoni*)



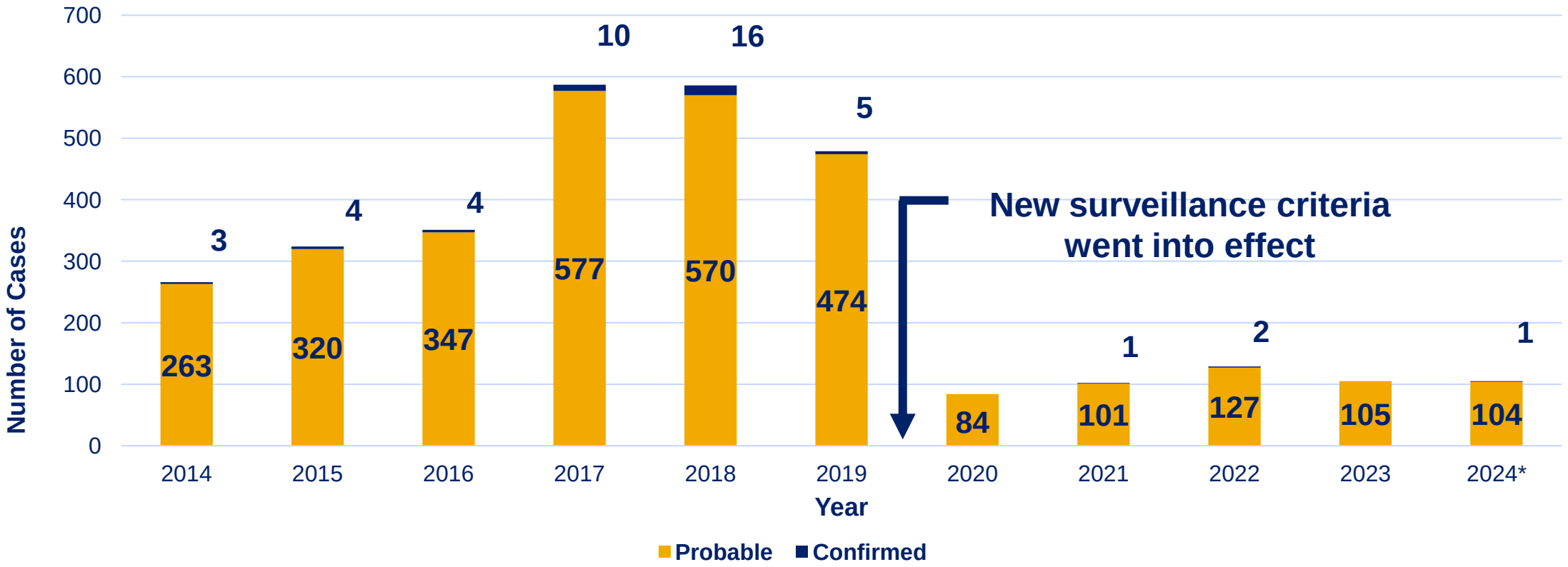
Annual incidence (per million population) of reported spotted fever rickettsiosis–United State

0 0 to < 0.71 0.71 to < 2.04 2.04 to < 4.85 4.85+ Not Notifiable

2023



Spotted Fever Rickettsiosis Case Counts, 2014 – 2024*



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Data Source: Missouri Health Surveillance Information System (WebSurv).

RMSF Disease

Initial stage (Days 1-2) days: Abrupt fever, headache, chills, malaise, myalgia. Rash may not be present. White blood cells (WBC), platelets, and hepatic transaminases normal

Early illness (Days 2-4): Persistent high fever ≥104°F. Abdominal pain, nausea/vomiting, cough. Edema of dorsum of hands or feet or peri–orbital edema (especially in children). Mild thrombocytopenia and transaminase elevation. Faint maculopapular rash on wrists and ankles may spread to the trunk.

Intermediate to Late Illness (Days 5–7) Persistent fever, worsening abdominal pain and respiratory status, altered mental status. Leukocytosis or leukopenia, thrombocytopenia worse, elevations in hepatic transaminases, hyponatremia. Rash becomes petechial (red to purple spots), may spread involving palms and soles.

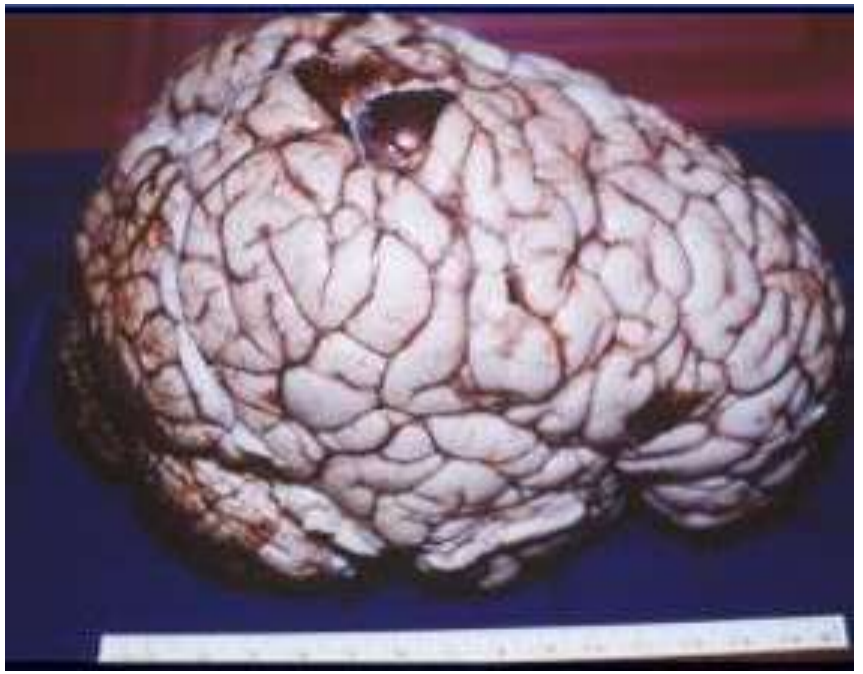
Late Illness (Days 7–9) Septic shock, cerebral edema, seizures, coma, pulmonary edema, ARDS, myocarditis, cardiac arrhythmias Severe thrombocytopenia. Rash spreads and petechiae coalesce, forming purpura. Skin and digits may become necrotic or gangrenous, requiring debridement and/or amputation.

RMSF Disease

- Incubation period of 3–12 days following infected tick bite (only about half of RMSF patients recall tick bite).
- Patients appear very sick, at times out of proportion to their exam
- Late appearance of rash is associated with delayed disease recognition and treatment leading to increased mortality.
- **Never wait for the rash to begin treatment!**
- Untreated RMSF can be fatal in 20–25% of cases, with most deaths on 7th and 9th day of illness.
- **Treat with doxycycline within the first 5 days of symptoms**

Sequelae of RMSF

- Severe cases of RMSF may lead to vascular damage during acute illness, resulting in long–term health problems including:
  - Necrosis necessitating amputation
    - Permanent organ damage
  - Profound neurologic deficits:
    - Hearing loss
    - Paralysis
    - Mental disability
      - Developmental delays in children



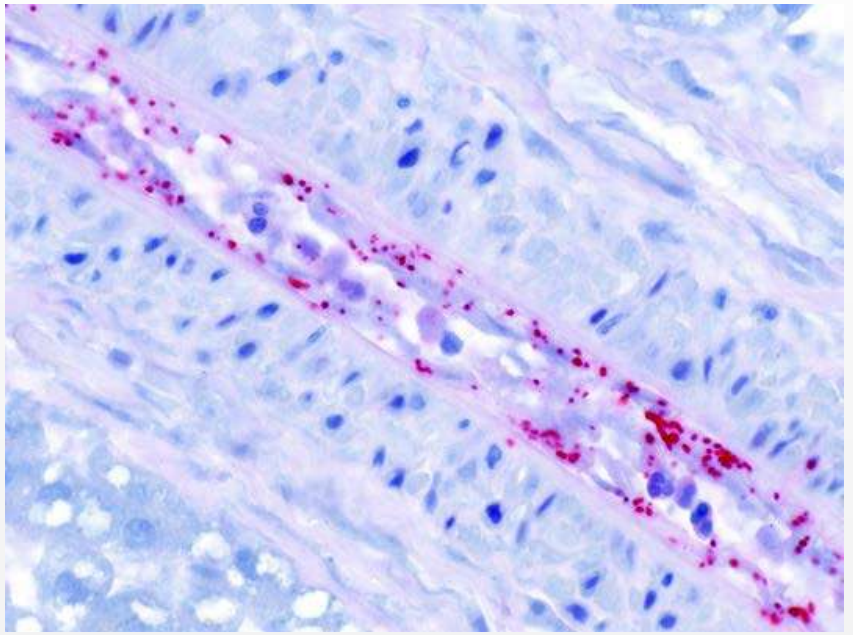
RMSF Diagnosis

Early illness:

- Acute-phase serology followed by testing convalescent sample taken 2–4 weeks later for IgG antibody.
- IgM is not reliable for the diagnosis of RMSF and should not be used to confirm or rule-out a diagnosis of RMSF
- PCR of **whole blood**; negative result in early illness does not rule out RMSF

Intermediate-to-late illness:

- PCR of whole blood
- Punch biopsy of rash for immunohistochemical (IHC) staining or PCR
- Fatal cases: Post-mortem samples for IHC or PCR



Tularemia

- Disease of animals and humans caused by highly infectious bacterium *Francisella tularensis* considered Tier-1 select bioterrorism agent
- Just 4 states (AK, KS, MO, OK) accounting for 50% of cases
- Cases up 56% compared to 2001–2010 *(MMWR, 2025)*
- The average fatality rate is <2% in the US (higher for certain type A genotypes)
- Antibiotic therapy is essential for minimizing complications and fatalities.
- Analysis of antimicrobial treatments and outcomes from tularemia 2006–2021 cases found aminoglycosides, fluoroquinolones, and tetracyclines were independently associated with increased odds of survival
- Vaccination for tularemia is not generally available in the US, nor is it useful in management of ill patients.

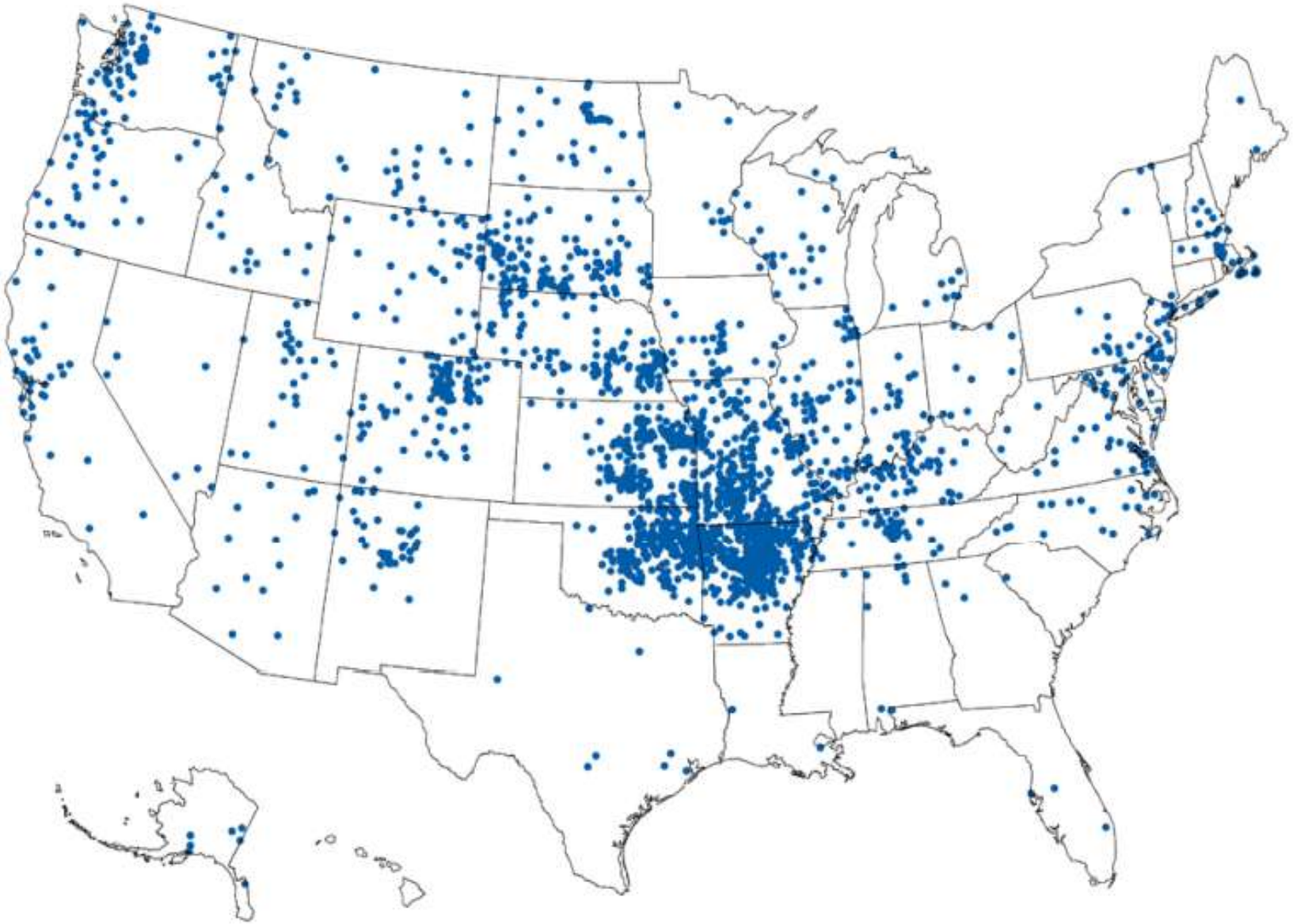
Basic Text Slide

- Humans are infected through:
  -Biting vectors: tick and deer fly bites; mosquitoes, fleas, mites also possible
  -Skin contact with infected animals;

-Ingestion of contaminated food and water;
-Laboratory exposure;
-Inhalation of contaminated dusts or aerosols

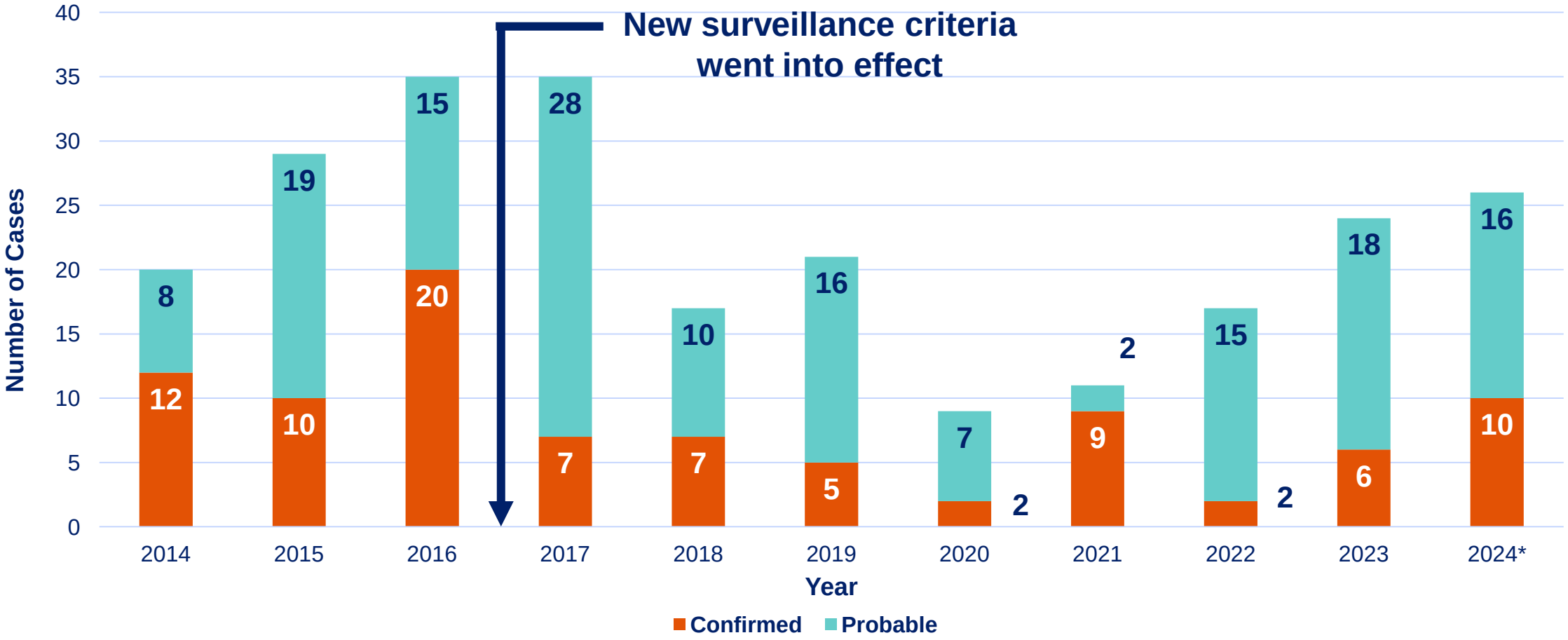
- In the US, cottontail rabbits and ticks (dog tick, wood tick, and Lone Star tick) transmit tularemia type A to humans. Deer flies transmit tularemia in the western United States

Cottontail rabbit



Tularemia Cases, USA, 2010-2022, CDC

Tularemia Case Counts 2014 – 2024*



*2024 data are provisional and subject to change as investigations are finalized.
Data Source: Missouri Health Surveillance Information System (WebSurv).

Tularemia

- Incubation period 2-10 days (range, 1-21)
- Presentation varies depending on how the bacteria enters the body; ranges from mild to life-threatening
- All forms of tularemia are accompanied by fever: Ulceroglandular (most common), Glandular, Oculoglandular, Oropharyngeal, Pneumonic (most serious)
- No documented transmission from person to person
- Treatment with Gentamycin (preferred), Ciprofloxacin, Doxycycline
- **Exposures from tick bites or other low-risk settings do not require preventive antibiotics**

Tularemia Diagnosis

Confirmatory

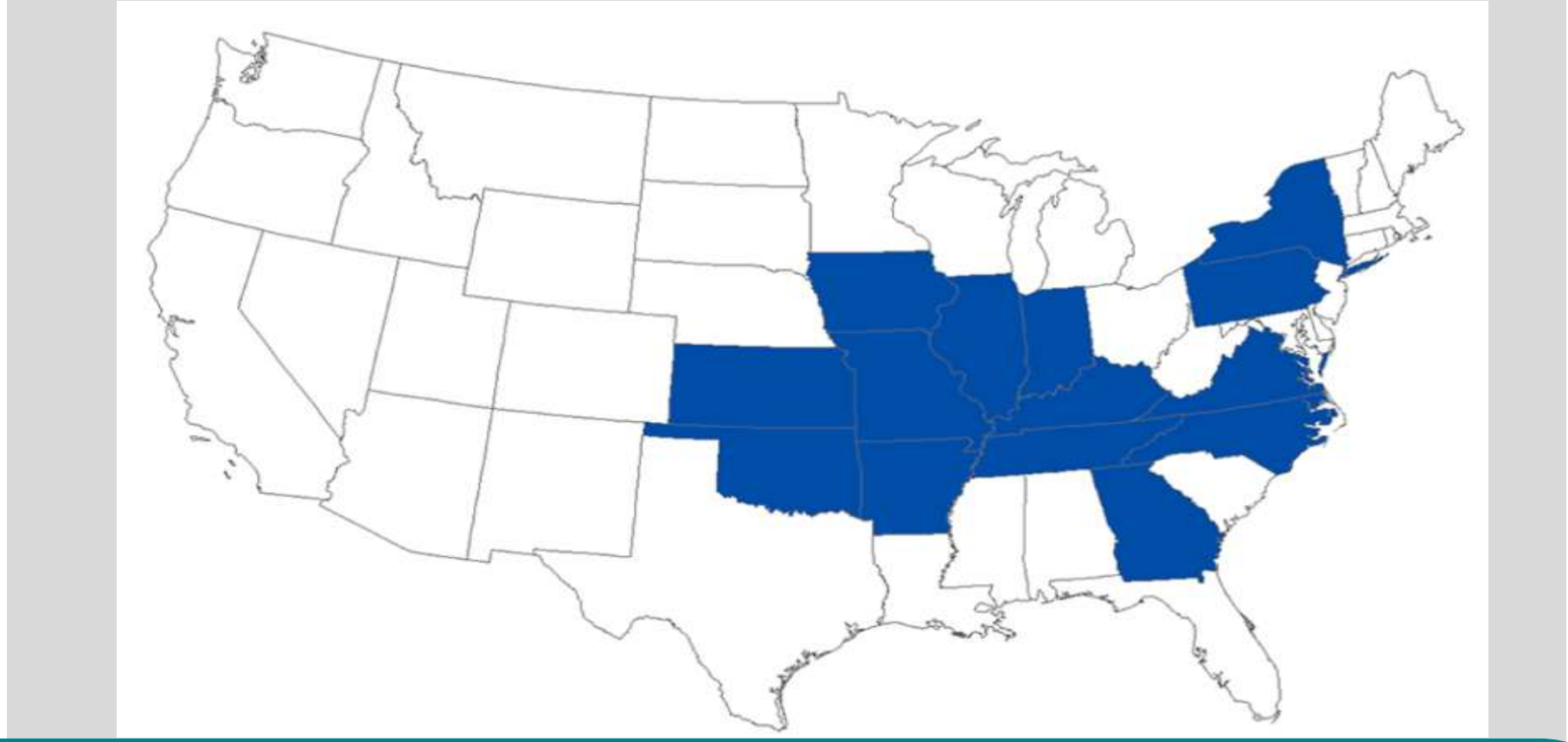
- Isolation of *F. tularensis* from a clinical specimen
- Alert lab if *F. tularensis* suspected for culture incubation for longer periods
- Seroconversion from negative to positive IgM and/or IgG antibodies in paired sera.

Supportive

- Detection of *F. tularensis* in a clinical specimen by immunohistochemical staining, sequence-based technologies, or polymerase chain reaction (PCR)
- Detection of antibodies to F. tularensis through a single serologic test (ideally, serum collected at least 14 days after illness onset)

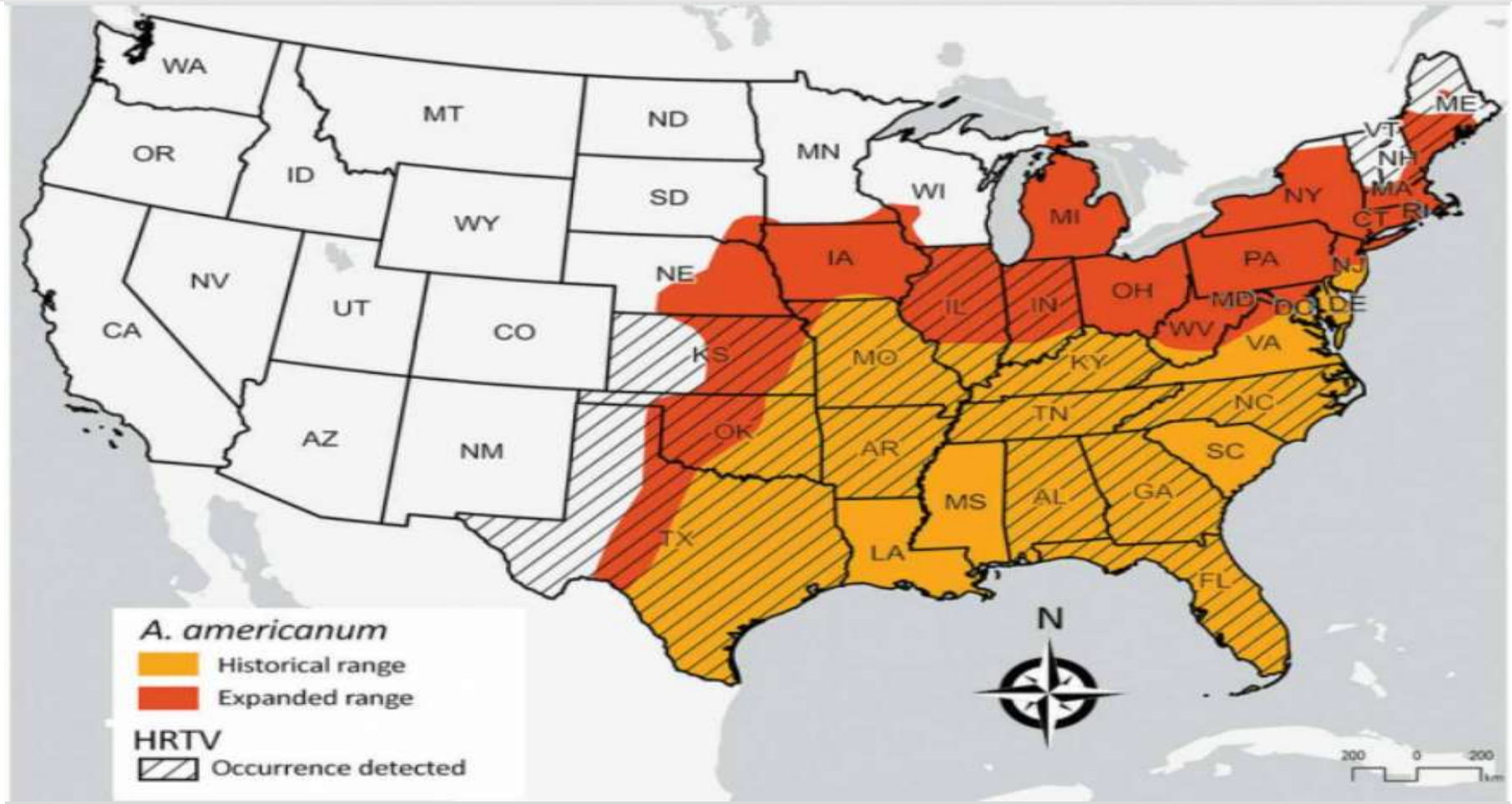
Heartland Virus (HRTV)

- HRTV is a *Bandavirus* first discovered as a cause of human illness in 2009 in Missouri in two farmers *McMullan et al, NEJM, 2012*
- RNA virus transmitted by the Lone Star tick
- 10/2,113 pools of *A. americanum* nymphs at index patient farm and nearby conservation area (+) for HRTV by RT-PCR, and 8 pools yielded viable viruses *Savage et al, Am. J. Trop. Med. Hyg., 2013*
- While the exact reservoir is not known, antibodies to the virus found in wild mammals like white-tailed deer, raccoons, and coyotes, suggesting role in the natural cycle.
- HRTV was closely related but distinct from severe fever and thrombocytopenia syndrome virus (SFTSV) found in China *Yu et al, NEJM, 2011*
- Seroprevalence of HRTV antibodies was 0.9% in a convenience sample of blood donors from NW Missouri *EID, Feb 2019*



States reporting Heartland virus disease cases

(**60** total cases as of November 2022)



Distribution of Heartland virus and Lone Star Ticks 2009–2020, CDC

Heartland Virus and Bourbon Virus Case Counts 2014 – 2024*

Year	Heartland Virus	Bourbon Virus
2014	2	0
2015	1	0
2016	0	0
2017	0	0
2018	2	1*
2019	1	0
2020	4	0
2021	2	0
2022	1	0
2023	2	0
2024*	1	0
TOTAL	**16**	**1***

*case not reflected in CDC ArboNET reporting for Missouri, but was confirmed infection

HRTV

- Incubation period ranges from a few days to two weeks.
- Symptoms often like those of other tickborne illnesses
- Most people have fever, fatigue, decreased appetite, headache, nausea, diarrhea, muscle or joint pain, and rarely rash
- Cases have low WBCs and platelets, elevated liver enzymes.
- HRTV infection rarely associated with severe disease, including hemophagocytic lymphohistiocytosis (HLH), and death in patients with immunocompromising conditions or multiple comorbidities.
- HRTV should be considered in patients being treated for ehrlichiosis who do not readily respond to treatment with doxycycline.
- There are no vaccines to prevent or medicines to treat HRTV infection

Bourbon virus (BRBV)

- BRBV is RNA virus discovered in Bourbon County, Kansas in 2014
- Data suggest that BRBV is transmitted to humans by *A. americanum* ticks
- Study of 39,096 ticks collected in 2013 from NW Missouri detected BRBV by rRT-PCR in 3 pools of *A. americanum*
- BRBV strain from KS patient and MO tick pool were very similar for PB2 gene segment *Savage et al, EID, 2017*
- During 2013, BRBV infection prevalence for nymphs 0.07/1,000 compared to 1.79/1,000 for HRTV
- Patients with this rare, potentially fatal disease have fever, fatigue, anorexia, nausea, vomiting, maculopapular rash, thrombocytopenia and leukopenia.
- Currently there are no specific medications or therapies for BRBV

HRTV and BRBV Diagnosis

- No commercially available tests for HRTV in the US
- Testing considered for patients with an acute febrile illness within the past 3 months AND at least one epidemiologic criterion AND at least one clinical criterion.

Heartland virus

•Reverse transcription-polymerase chain reaction (RT-PCR)
•IgM microsphere-based immunoassay (MIA)
•Plaque reduction neutralization test (PRNT)

Bourbon virus

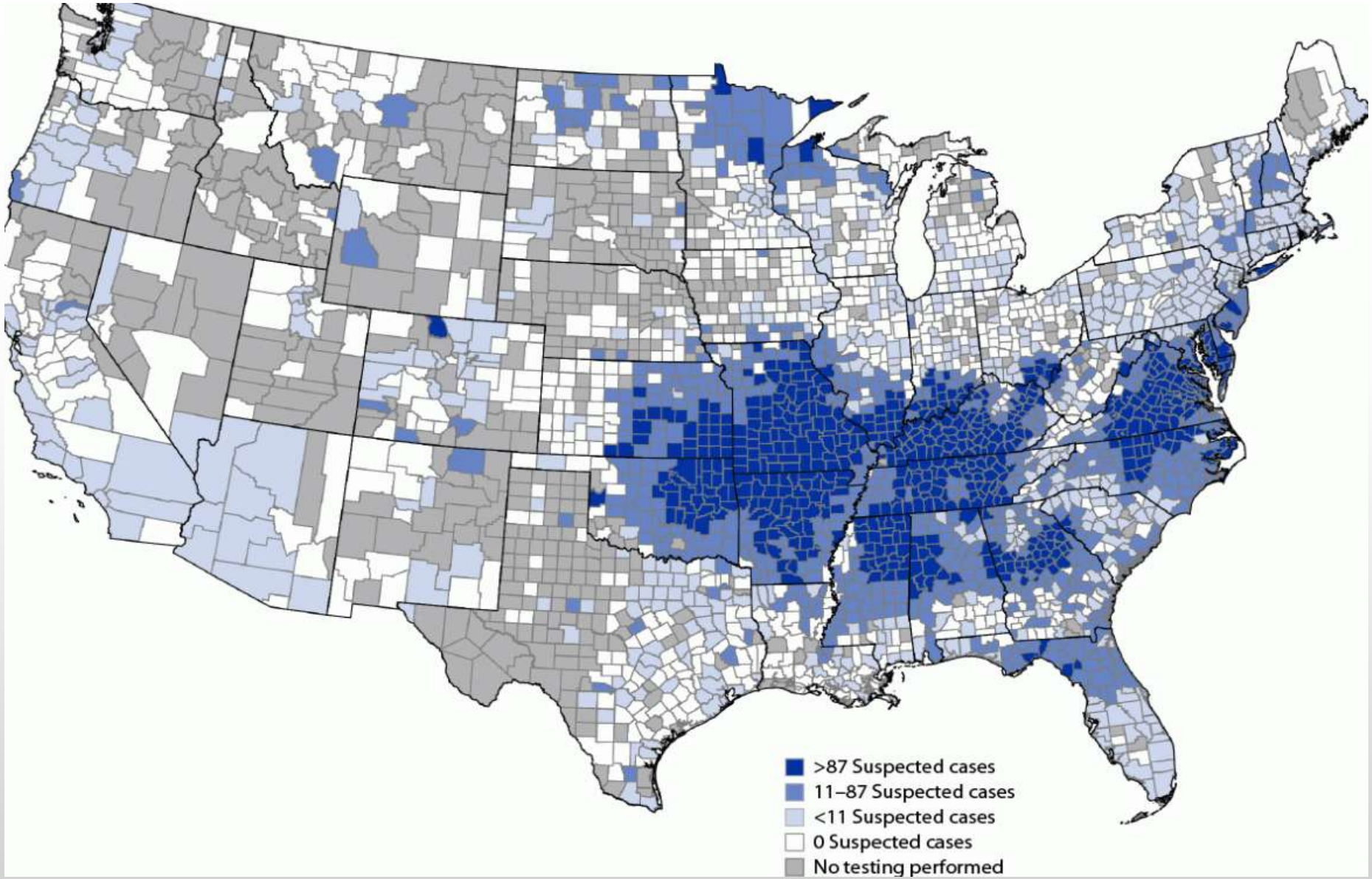
•RT-PCR
•PRNT

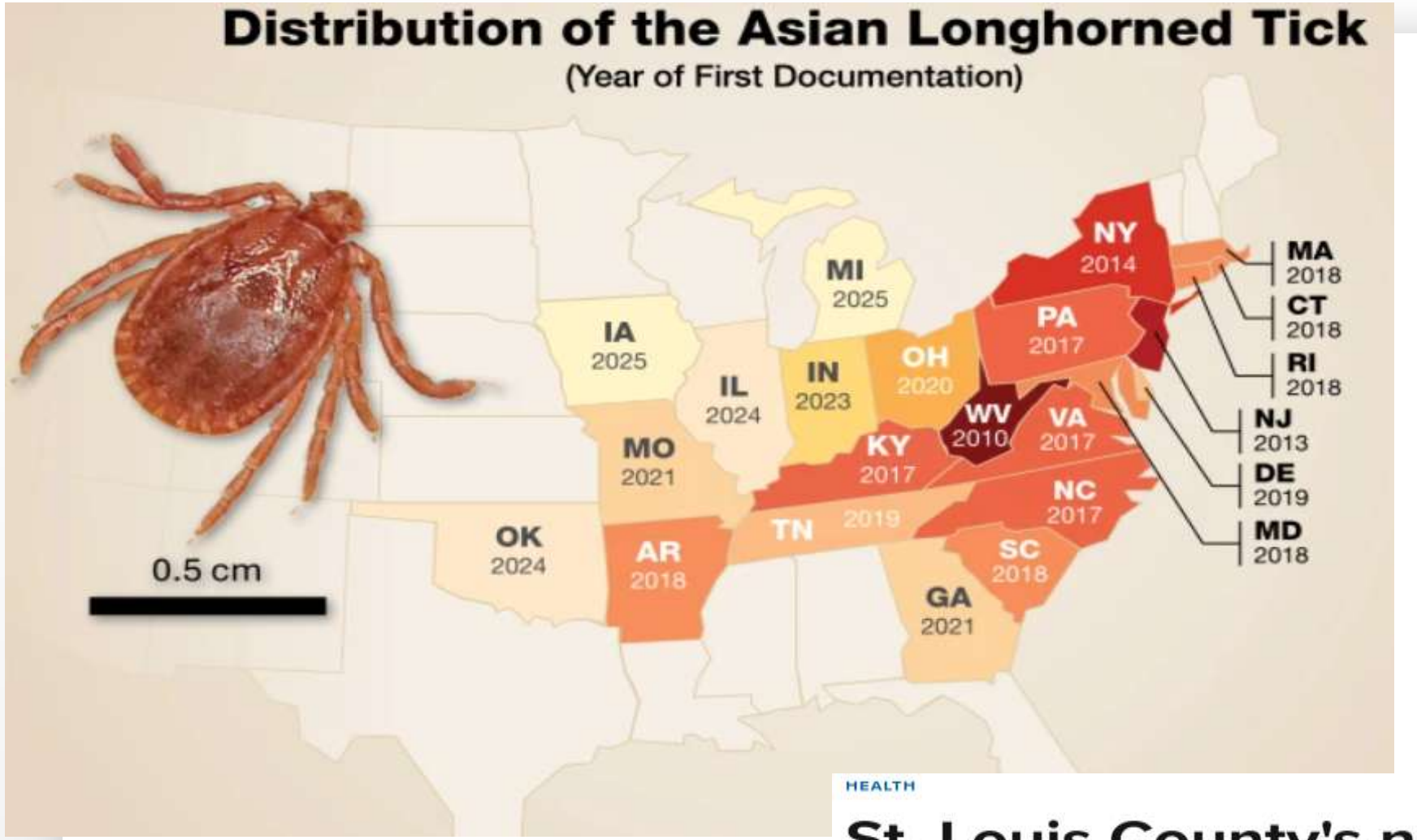
Alpha-gal Syndrome (AGS)

- AGS is potentially life-threatening allergy and tickborne disease, also known as “red meat allergy” or “tick bite meat allergy”.
- Alpha-gal is a molecule (galactose-α-1,3-galactose) naturally present in most mammals but not in people
- People with AGS can have an allergic reaction after eating red meat or being exposed to products containing alpha-gal.
- AGS is primarily associated with lone star tick bite, but other ticks could be also involved
- Allergic reaction develops several hours after alpha-gal exposure and ranges from mild to life-threatening
- A blood test for alpha-gal specific IgE antibodies is used to detect sensitization
- Best way to prevent AGS is to prevent tick bites.

Geographic distribution of suspected alpha-gal syndrome cases per 1 million population per year — United States, 2017–2022

MMWR, 2023





HEALTH

St. Louis County's new tick is a 'serious threat,' officials say

The sesame seed-sized arachnid causes serious problems in domestic animals and livestock, officials said.

Asian longhorned tick *(Haemaphysalis longicornis)*

- Usually found in eastern China, Japan, the Russian Far East and the Korean Peninsula.
- Since 2017, reported in 20 U.S. states.
- These ticks reproduce asexually and are spreading rapidly
- Feeds on wildlife, domestic animals (horses, cows, sheep), pets, and humans, but attracted less to humans
- This tick can spread **anaplasmosis, babesiosis, ehrlichiosis** and **rickettsiosis.**
- Full extent of risk of illness in humans in the U.S. from this tick's bite is still unknown.

MISSOURI DEPARTMENT OF
HEALTH &
SENIOR SERVICES

QUESTIONS?

This is my tick talk