

The Identification of the Range of Ixodidae Ticks in Kansas and the Epidemiological Evaluation of Lyme Disease and Spotted Fever Rickettsiosis in Kansas from 2008 to 2012

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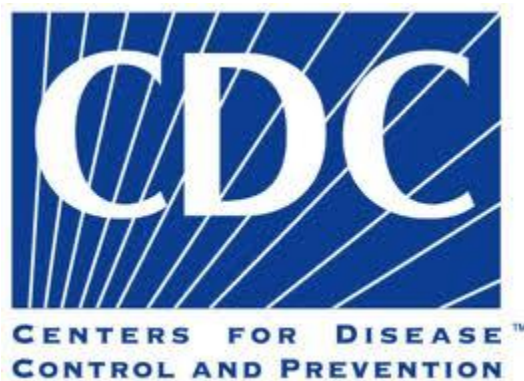
MPH Field Experience

Objectives

- Collect county level data on the *Ixodes scapularis*, *Dermacentor variabilis*, and *Rhipicephalus sanguineus* tick vector location and to determine the range of these ticks in Kansas
- Determine if counties in Kansas are considered endemic based on the Centers for Disease Control and Prevention (CDC) case definition
- Conduct a descriptive epidemiologic study on Lyme disease cases reported from 2008-2012
- Conduct a descriptive epidemiologic study on Spotted Fever Rickettsiosis cases reported 2008-2012

Surveillance Overview

- Step 1: Lyme or Spotted Fever Rickettsiosis Case is identified
- Step 2: Reported to the KDHE
- Step 3: Alerts local health department
 - Responsible for investigation and follow-up
- Step 4: KDHE reports cases to CDC



Lyme Disease

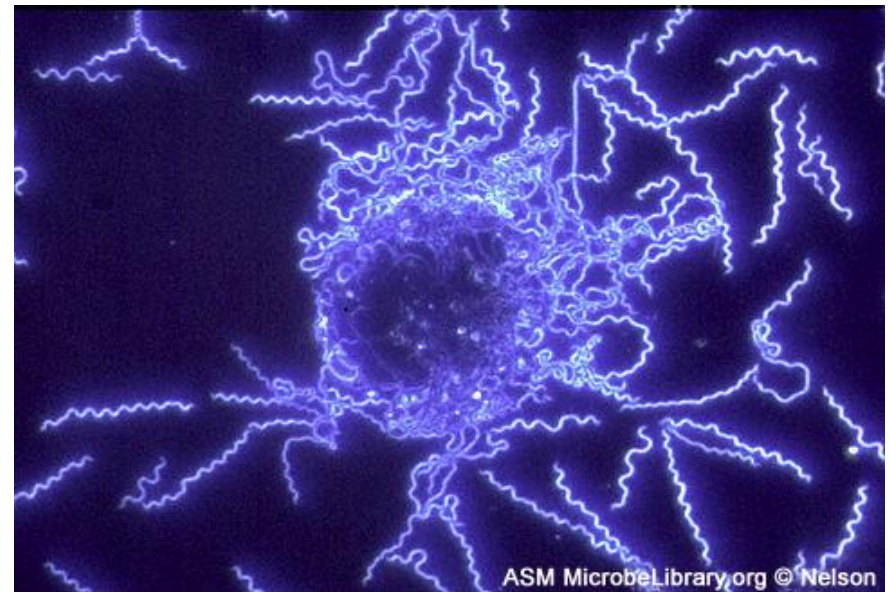
Background

Bacteria

- *Borrelia burgdorferi*
- Motile spirochete
- Obligate intracellular pathogen



Scanning Electron Microscope Image (CDC)



Dark Field Microscopy Image
(American Society of Microbiology)

Vector

- Vectors: *Ixodes scapularis* & *Ixodes pacificus*
- *Ixodes pacificus* not found in Kansas
- Habitat: woody, brushy areas with leaf litter

 **TickEncounter** Resource Center ***Ixodes scapularis* (Blacklegged ticks or Deer ticks)**



Larva



Nymph

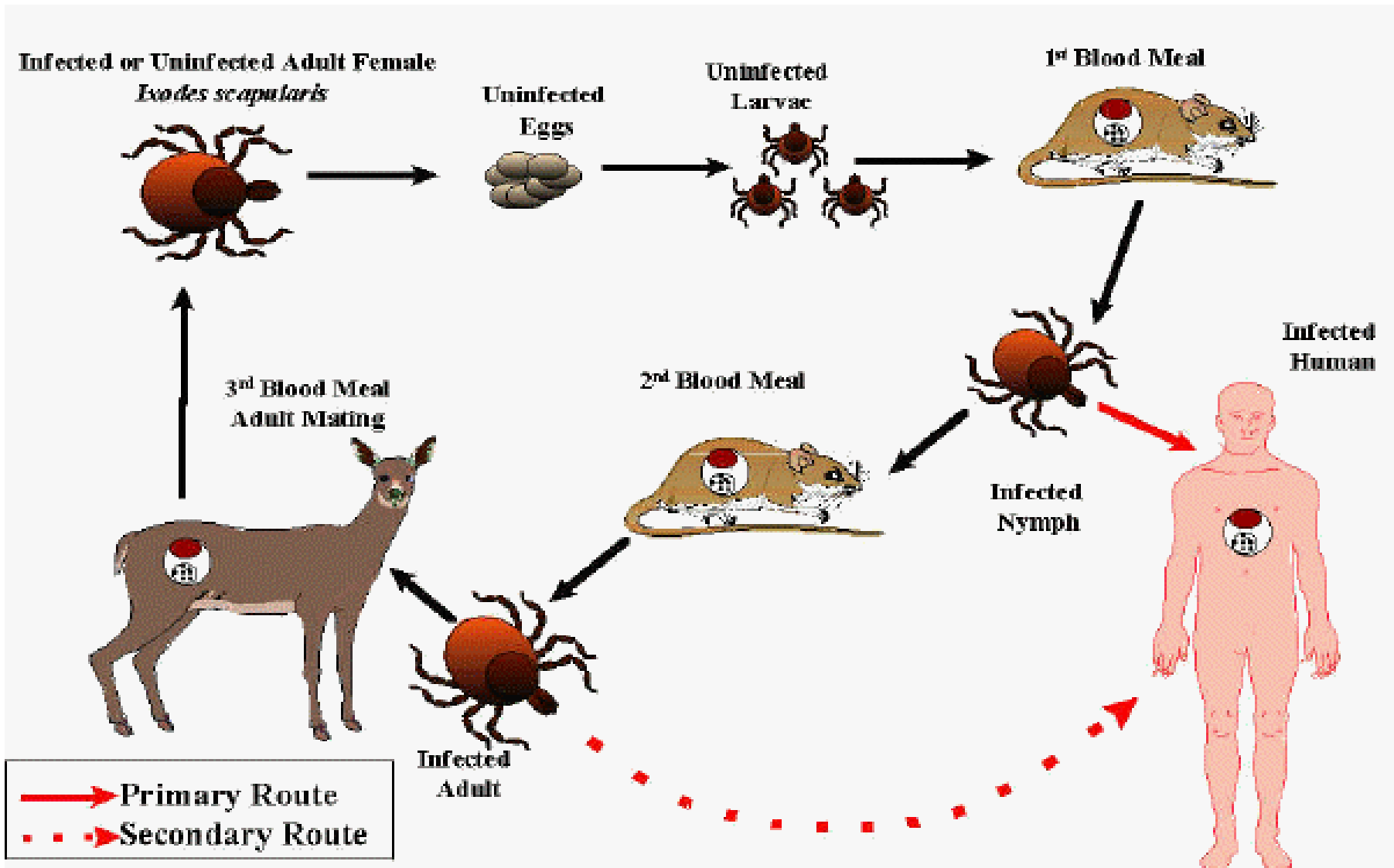


Adult Male



Adult Female

Ixodes scapularis Life Cycle



Acute Symptoms

- Occur within 3-30 days post bite
 - Mean 7-10 days
- Erythema Migrans (EM) rash
 - Seen in 60-80% of patients
- Fatigue
- Fever
- Headache
- Neck Pain
- Arthralgia
- Myalgia



Erythema Migrans Rash

Chronic Symptoms

- Chronic: Months to years post-bite
 - Musculoskeletal System:
 - Recurrent and brief of attacks of joint swelling
 - Chronic arthritis
 - Nervous System:
 - Lymphocytic meningitis
 - Cranial neuritis
 - Facial palsy/ Bells palsy
 - Radiculneuropathy
 - Encephalomyelitis
 - Cardiovascular System:
 - Acute onset of 2nd/3rd degree atrioventricular conduction defects



Bell's Palsy

Methods

Lyme Disease

Methods

- Conducted literature review and collected retrospective data on *Ixodes scapularis* vector location
 - Primary data from 2000 to 2012 obtained from Dr. Michael Dryden of Kansas State University's College of Veterinary Medicine (KSU-CVM)
 - Submissions to CVM
 - Additional data from Brillhart, 1993, White&Mock, 1991, and Anderson, unpublished data
 - Tick drags
 - Deer at the Chronic Wasting Disease (CWD) stations
 - Determined counties where *I. scapularis* ticks were reported
- Created maps depicting these counties using ArcMap 10.1 software

Methods- Epidemiologic Study

- Time period for the study: January 1st, 2008 – December 31st, 2012
- Retrospective data
 - Collected from two surveillance systems used by KDHE
 - The Kansas Electronic Disease Surveillance System (KS-EDSS)
 - Data from January 1st, 2008 - December 31st, 2011
 - EpiTrax
 - Data from January 1st, 2012 - December 31st, 2012

Methods- Epidemiologic Study

- Included only confirmed and probable cases
 - Confirmed cases
 - EM rash with an exposure in an endemic* county
 - EM rash with lab
 - One late manifestation with lab
 - Probable cases
 - Physician diagnosis and lab
- Laboratory criteria for diagnosis:
 - Two-tier testing
 - Positive IgM $\leq$ 30 days from symptom onset
 - Positive IgG at any point during illness
 - Single tier IgG immunoblot seropositivity
 - Positive culture for *B. burgdorferi*
 - Cerebral spinal fluid (CSF) positive for *B. burgdorferi*

*Endemic counties are counties that have two or more confirmed cases of Lyme disease reporting exposure or positive *I. scapularis*

Based on CDC definition

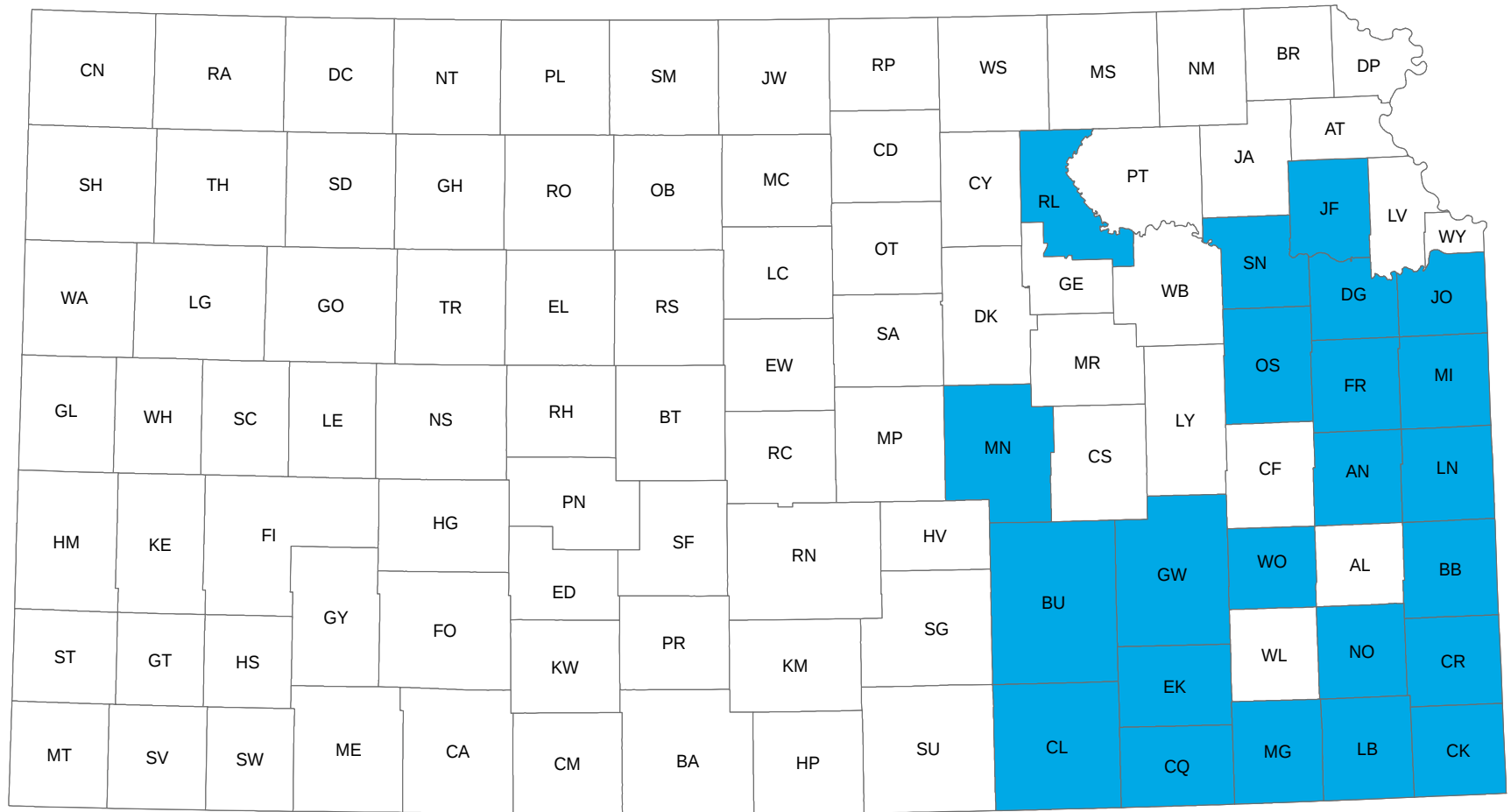
Methods- Epidemiologic Study

- Variables studied:
 - Number of probable and confirmed cases by year
 - Age
 - Gender
 - Race
 - Ethnicity
 - Seasonality
 - Exposure
 - Clinical presentation
- Population data to calculate incidence was obtained from U.S. Census Bureau statistics
- SAS 9.2 was used to calculate frequency for all demographic and clinical symptom variables

Results

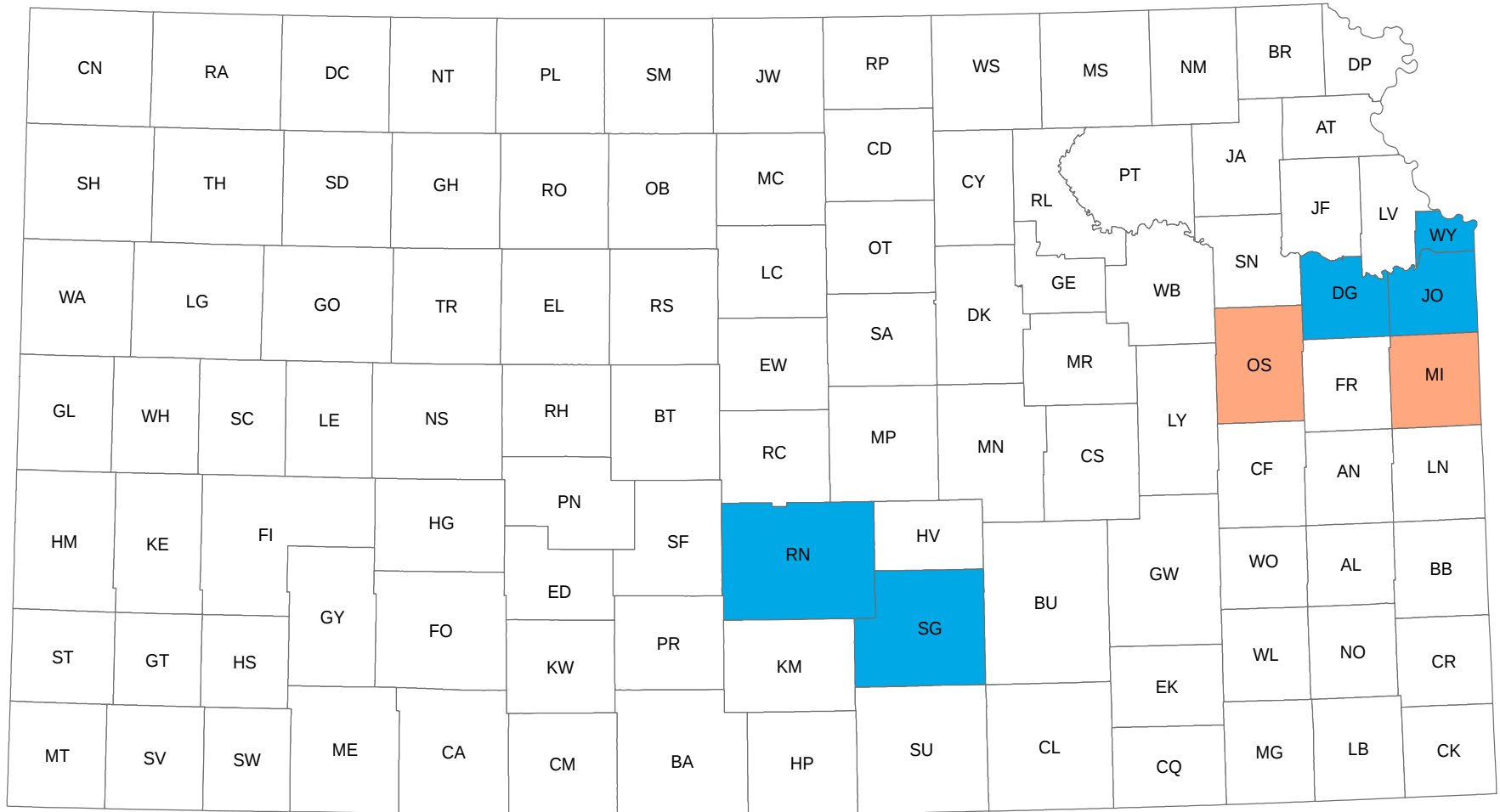
Lyme Disease

Map of Counties in Kansas where *Ixodes scapularis* ticks have been reported



Counties with *I. scapularis*

Endemic Counties in Kansas for CDC Case Classification



2 or more confirmed cases

 Positive *I. scapularis* tick

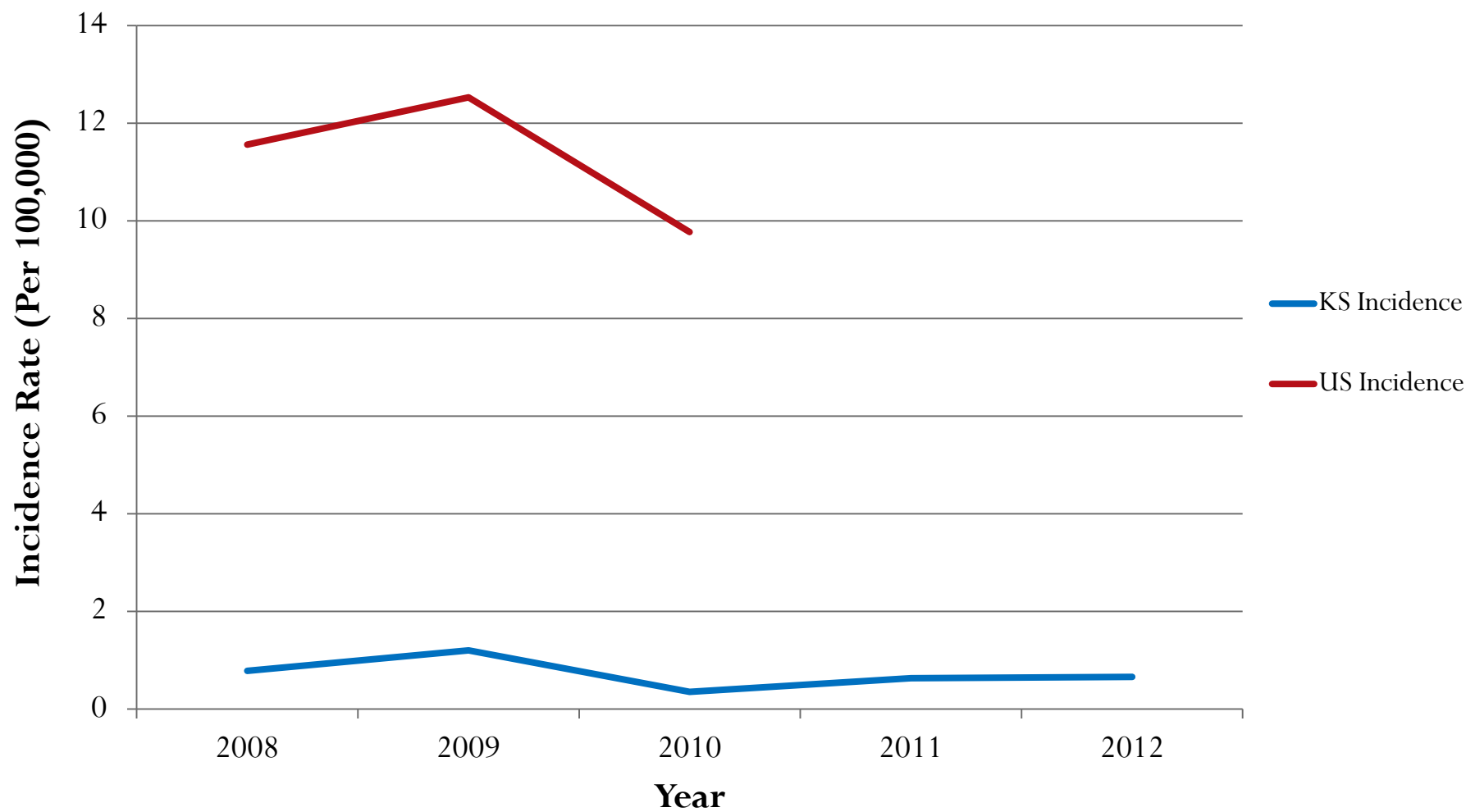
Results

- Total number of cases from 2008 to 2012
 - 103 cases
- Highest number of total cases in 2009
 - 34 cases
- Over the 5 year period, from 2008 to 2012:
 - 59 (57%) confirmed cases and 44 (43%) probable cases

Number of Confirmed and Probable Cases of Lyme Disease Reported in Kansas, 2008-2012



United States and Kansas Incidence of Lyme Disease, 2008-2012

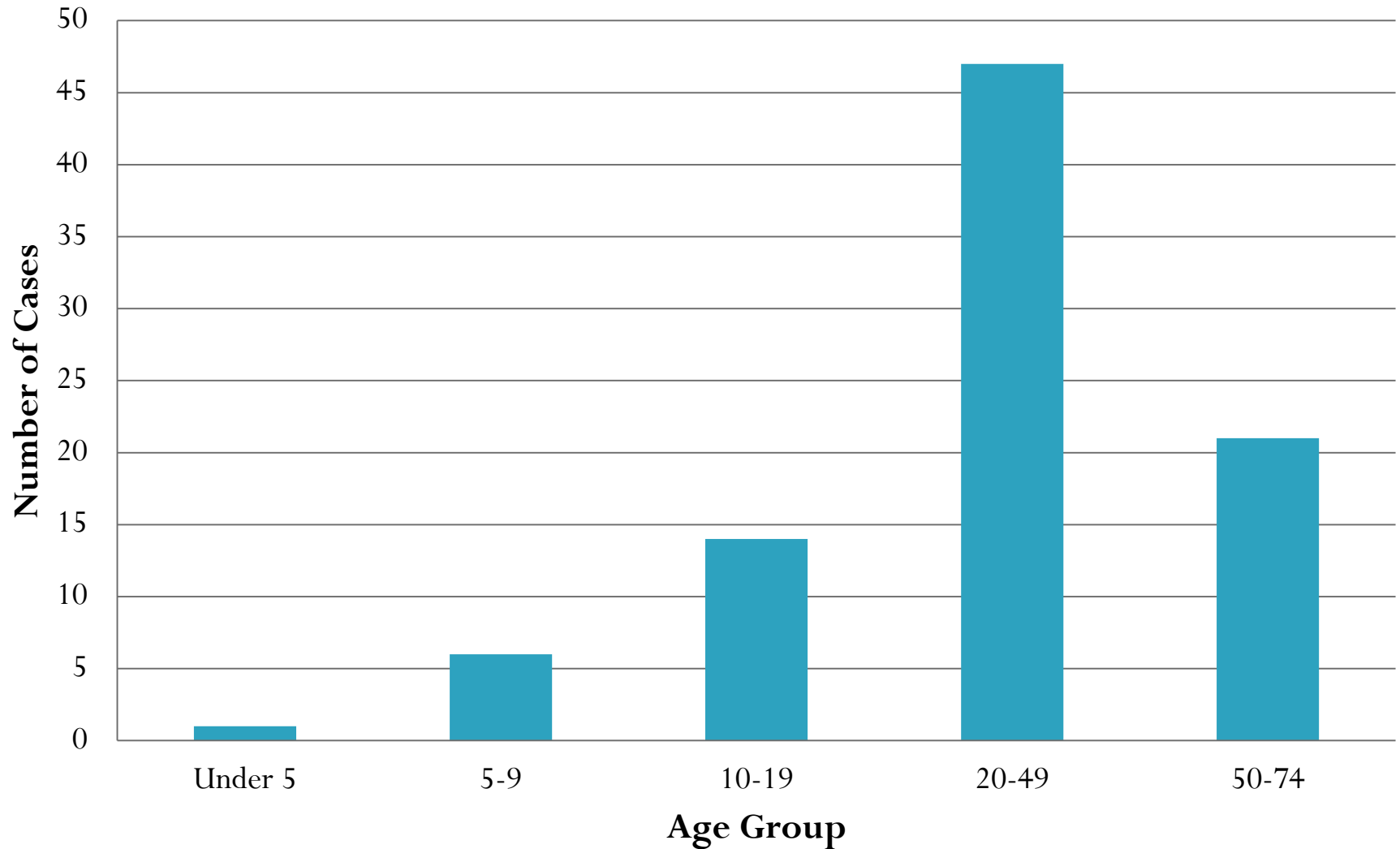


Results

- More males (59%) than females (41%) were reported to have Lyme disease
- Ethnicity
 - A majority of cases (97%) were Non-Hispanic/Latino
- Race
 - A majority of cases were white (71%)

Race	Number of Cases	Percentage of Cases	Percentage in Kansas
White	73	70.87	84.7
Black/ African American	3	2.91	6.10
Native Hawaiian/ Pacific Islander	1	0.97	0.10
Asian	1	0.97	1.20
Unknown	25	24.27	----

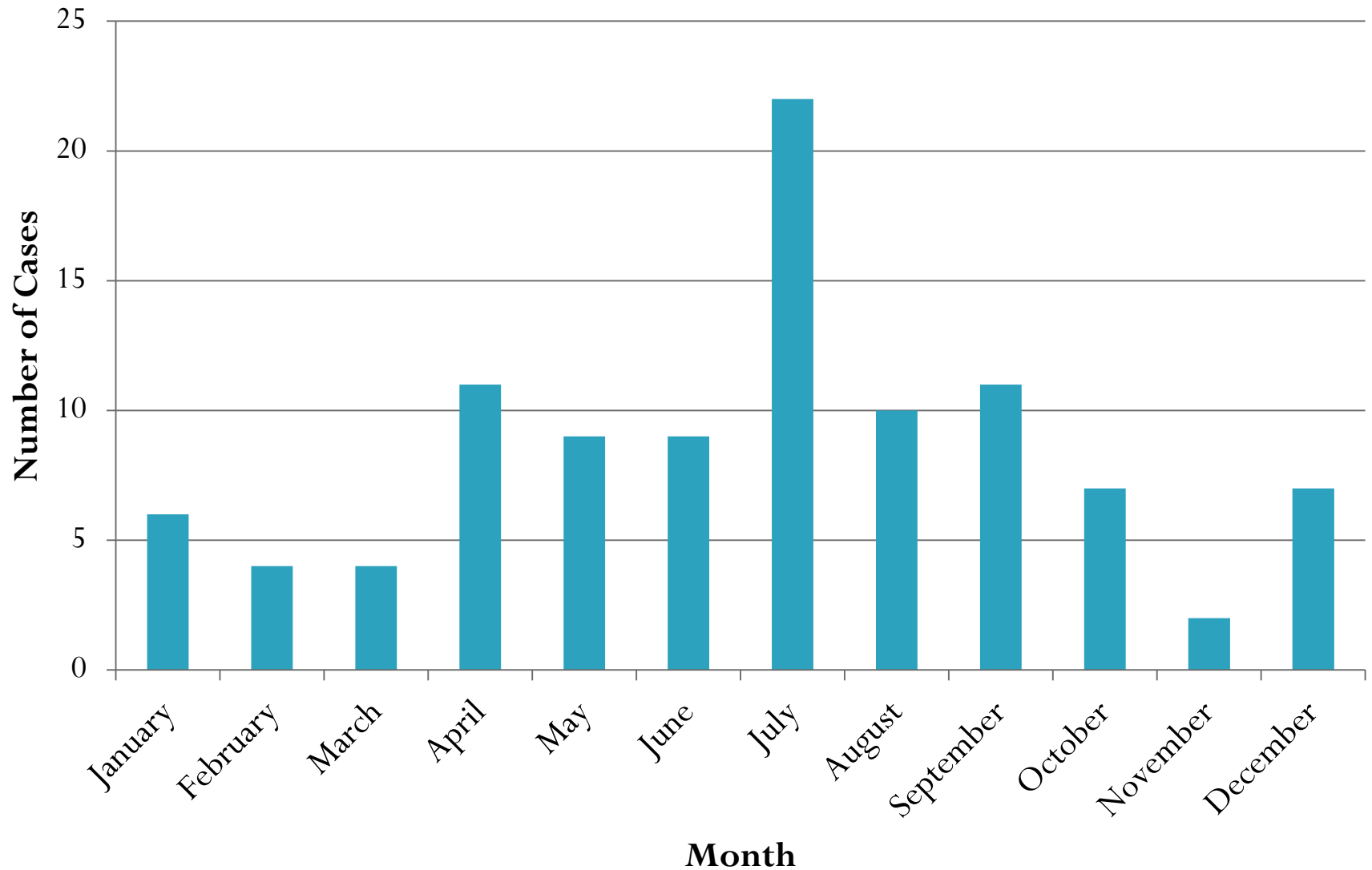
Number of Cases of Lyme Disease Reported in Kansas by Age, 2008-2012 (n=89)



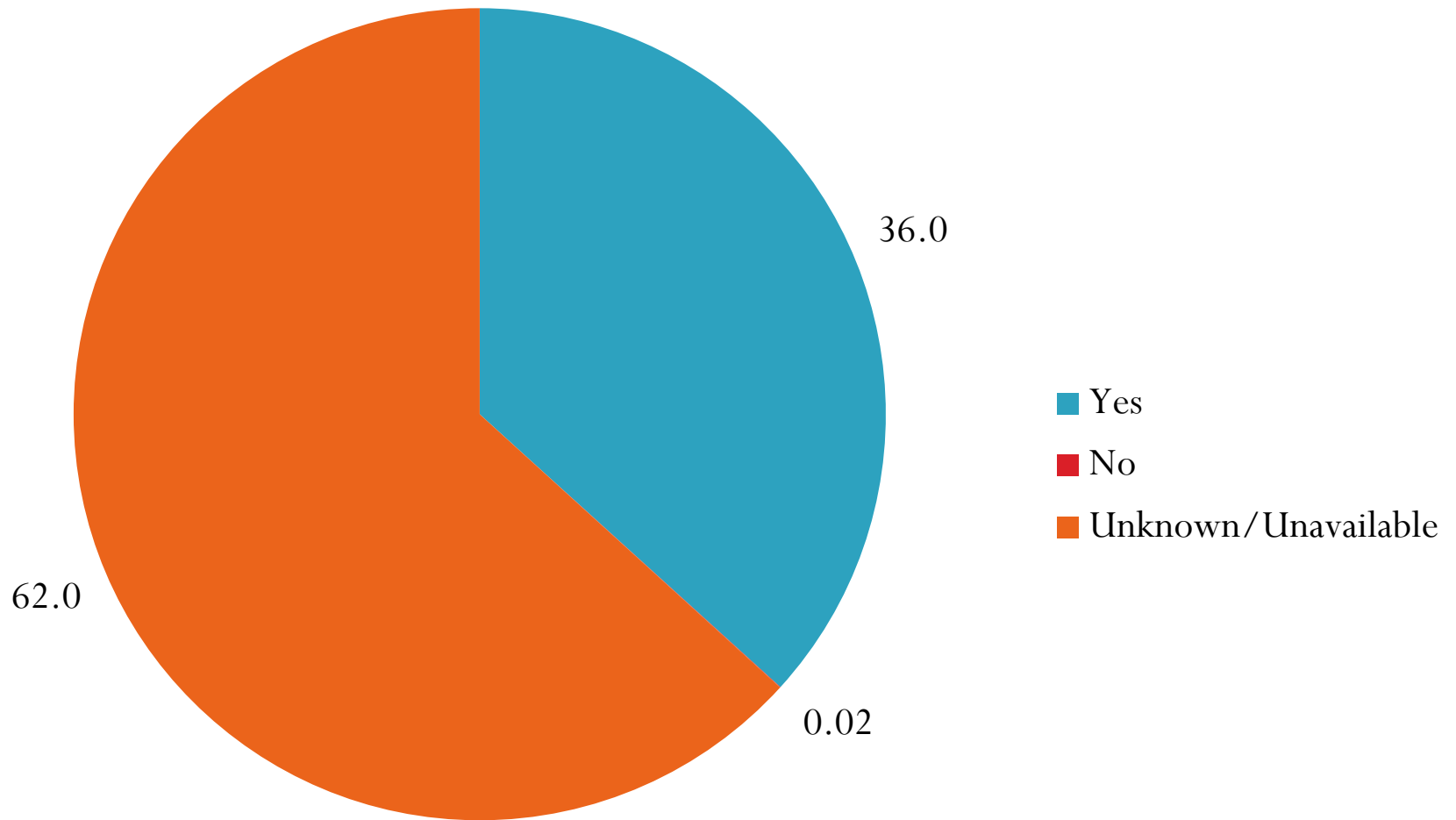
Clinical Manifestations of Lyme Disease

Acute Symptoms	Number of Cases
Erythema Migrans	36
Fatigue	34
Headache	24
Fever	23
Arthralgia	20
Myalgia	18
Neck Pain	6
Chronic Symptoms	Number of Cases
Musculoskeletal System	38
Nervous System	26
Cardiovascular System	2

Number of Cases of Lyme Disease by Month, 2008-2012



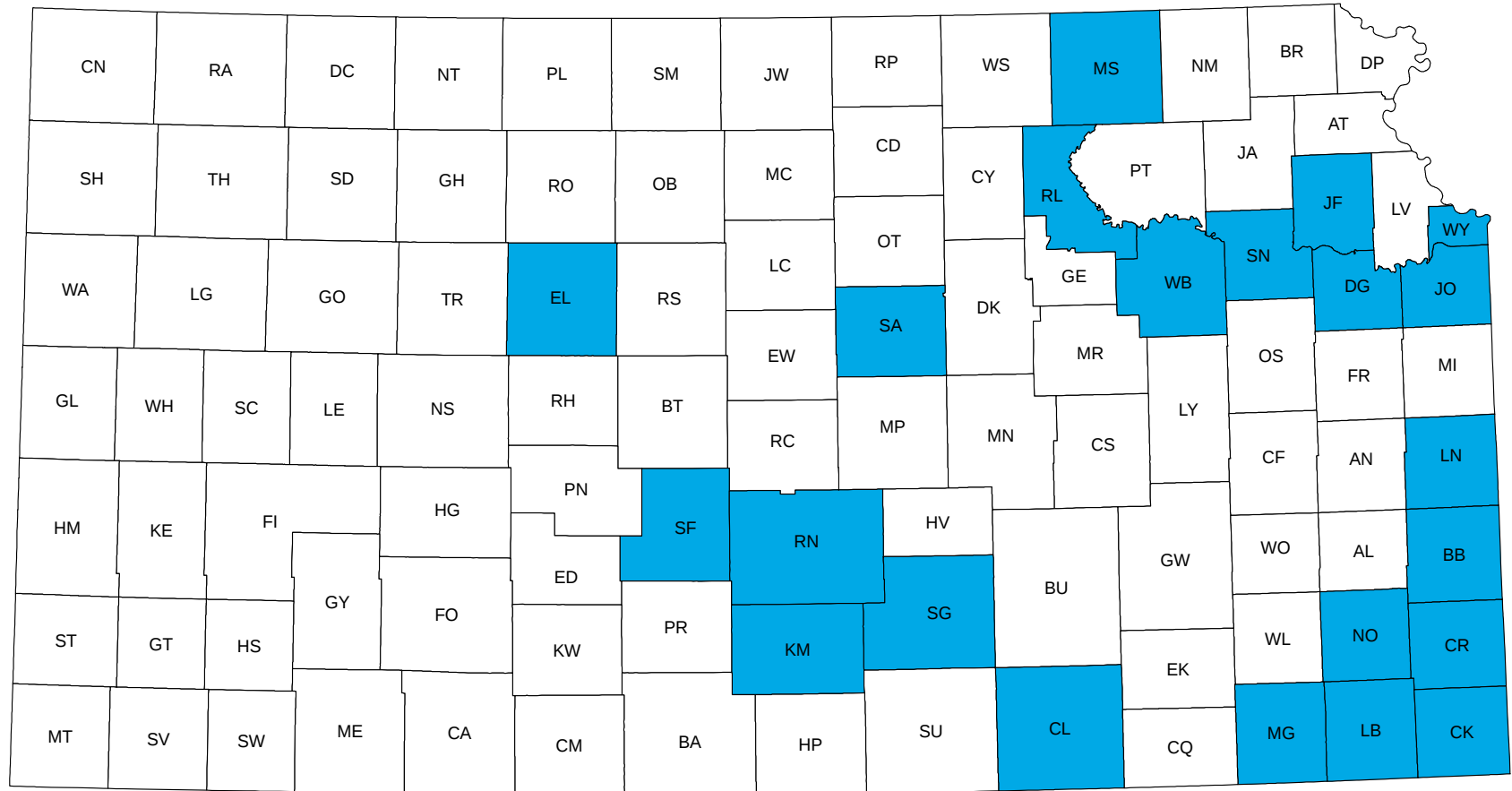
Percentages of Exposures for Lyme Disease Cases in Woody/Grassy/Brushy Areas, 2008-2012



Results

- For the 103 total cases
 - 59 cases reported exposure in Kansas
 - 22 cases reported out of state exposure
 - 22 cases either did not report place of exposure or their place of exposure is unknown

Counties in Kansas where reported exposures occurred for individuals with confirmed or probable cases of Lyme disease, 2008-2012



Counties of Exposure for Confirmed or Probable Cases

Discussion

Lyme Disease

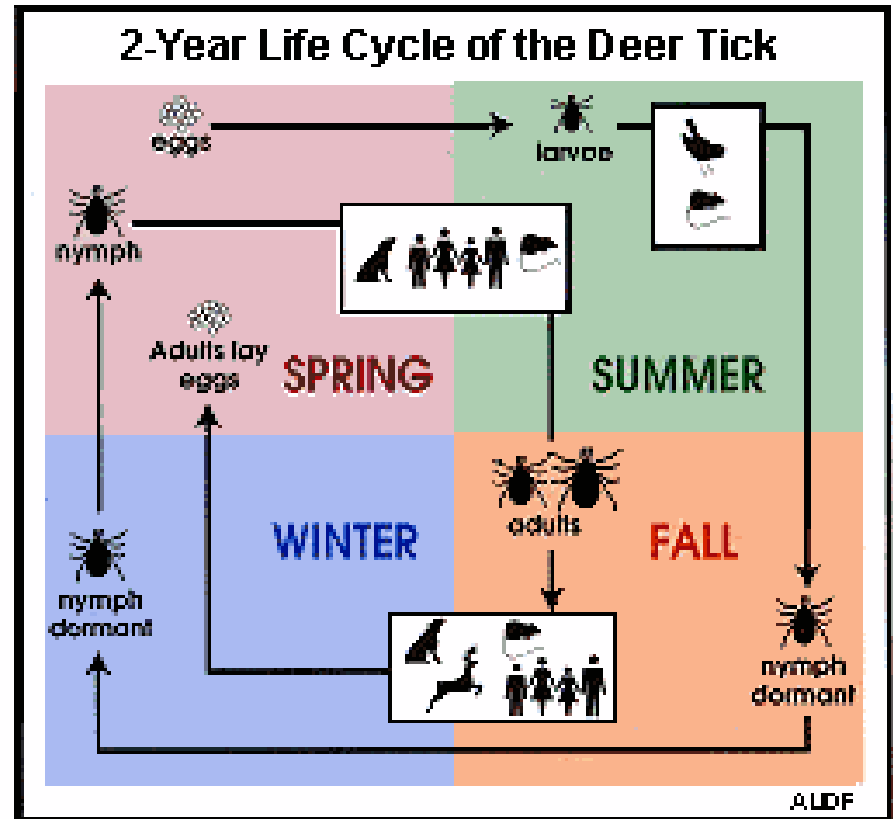
Discussion

- Prior to 1988 – *I. scapularis* only identified in Cherokee County
- Currently – *I. scapularis* identified in 23 counties all in the Eastern half of the state
- 13 counties have cases reporting both exposure and identified tick vector
 - 9 counties – cases reported exposure but no tick vector identified
 - Recall
 - Vague definition
 - Passive surveillance for ticks
- Endemic counties
 - Reno & Sedgwick County → no tick vector
 - Data importance

Discussion

- Increase in Lyme disease reports in 2009
 - Moisture conditions in 2007
- Increased nymph survival
- PHDI July of 2006 is -2.40
 - Low moisture
- PHDI from July of 2007 is 3.47
 - Increase in moisture

(Subak et al, 2003)



(American Lyme Disease Foundation)

Discussion

- Adults most commonly reported with Lyme disease
 - Rural occupations
 - Increased outdoor exposures
- Seasonality
 - Spring to early Fall
 - Similar to United States
- Kansas' incidence lower than US
 - Suitable habitat
 - Most US reports in 13 Eastern states
- Exposure
 - Definition of exposure
 - Recall ability
 - Investigation by local health department

Public Health Implications

- Greater awareness of the tick vector location
- Targeting Lyme disease education to susceptible populations
- Further development of Lyme disease surveillance activities

Background

Spotted Fever Rickettsiosis

Bacteria

- *Rickettsia spp.*
- Gram negative
- Cocobacillus
- Obligate intracellular pathogen
- Tropism for endothelial cells



Rickettsia rickettsia Bacteria (CDC)

Vectors

- *Dermacentor variabilis*
- *Rhipicephalus sanguineus*
- Habitats: woody, brushy areas

 TickEncounter Resource Center

***Rhipicephalus sanguineus* (Brown Dog Tick)**

 TickEncounter Resource Center

***Dermacentor variabilis* (American Dog ticks)**



Larva



Nymph



Adult Male



Adult Female



Larva



Nymph



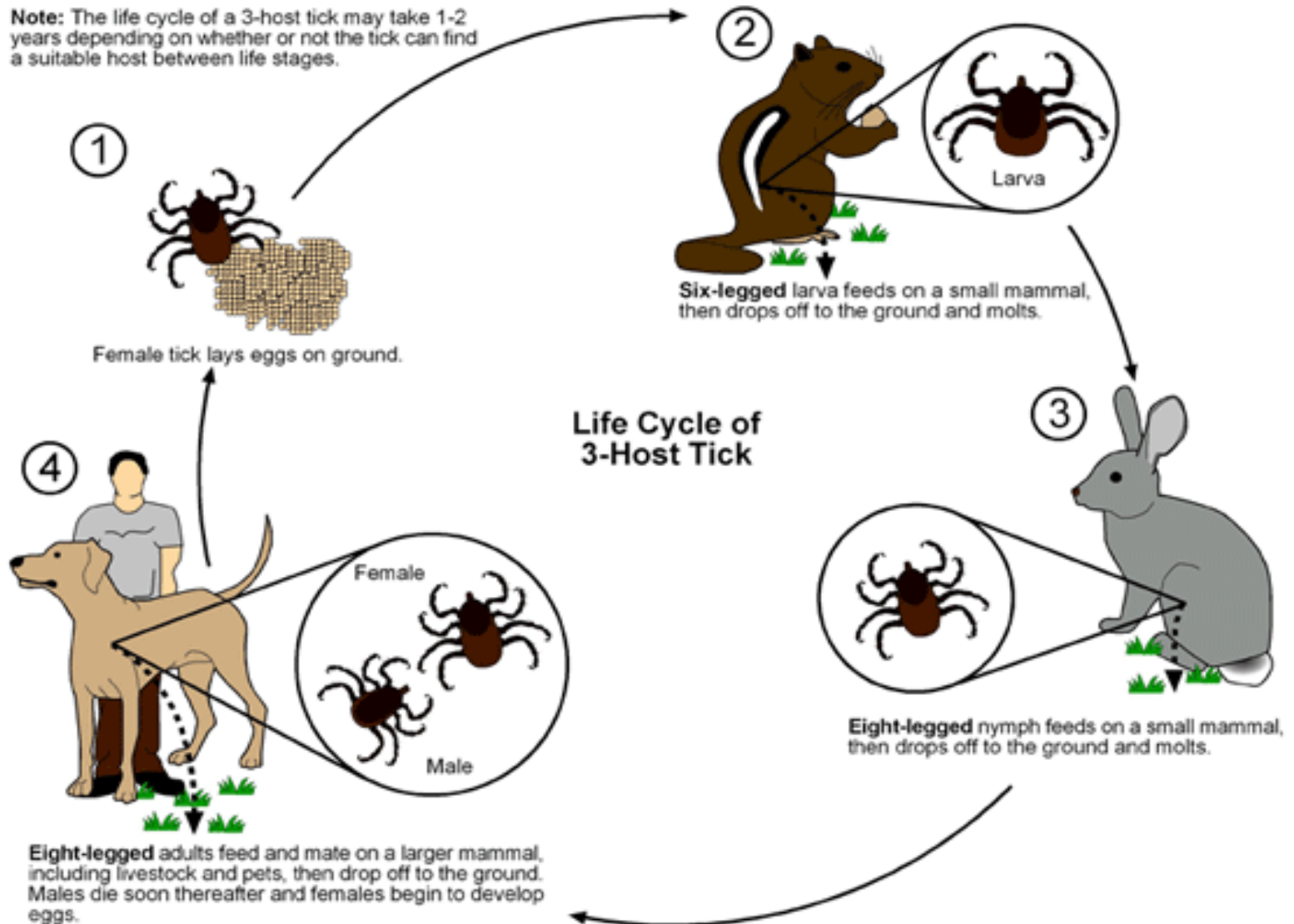
Adult Male



Adult Female

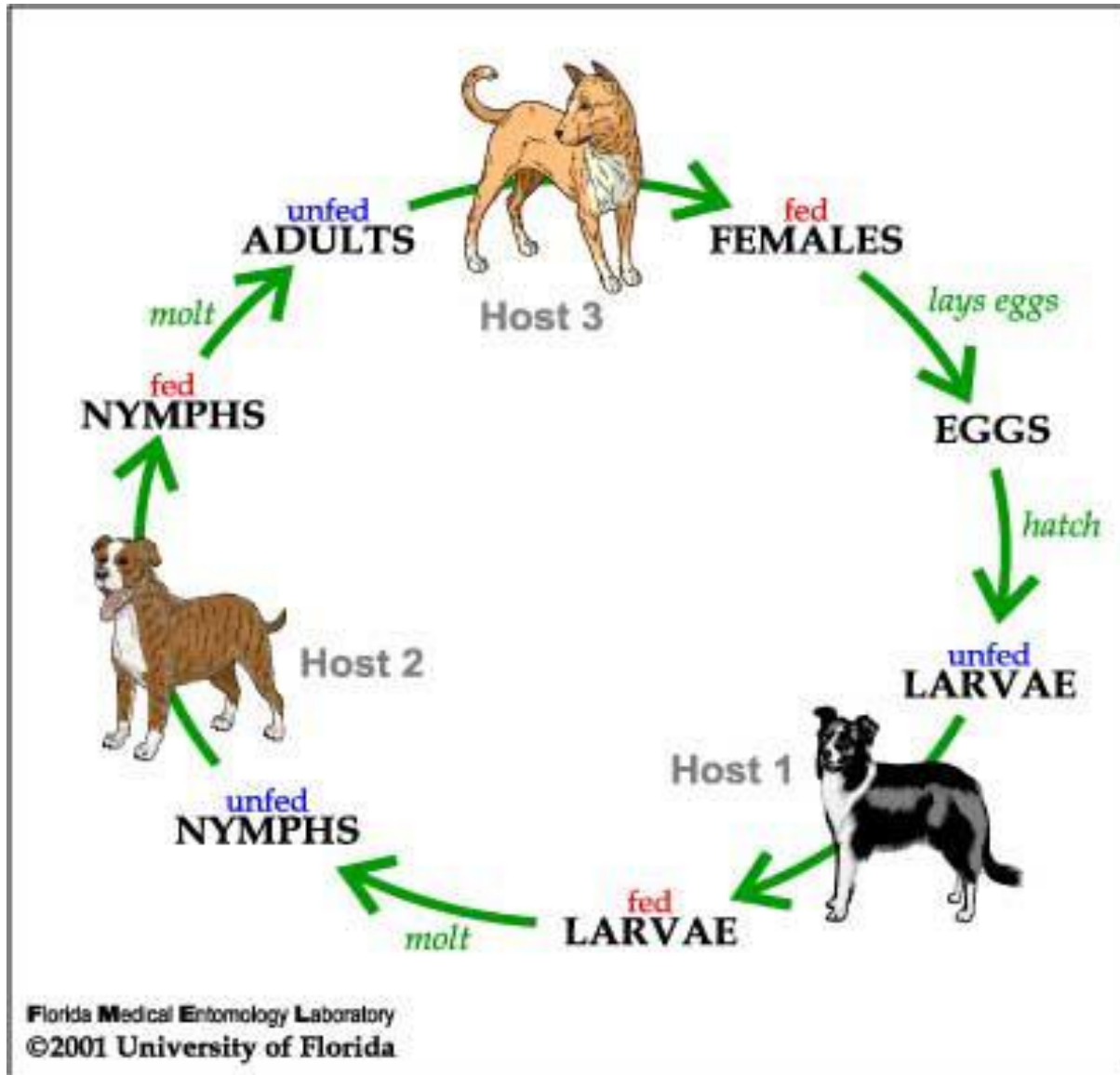
Dermacentor variabilis Life Cycle

Note: The life cycle of a 3-host tick may take 1-2 years depending on whether or not the tick can find a suitable host between life stages.



(Dept. of Medical Entomology, Purdue University)

Rhipicephalus sanguineus Life Cycle



(University of Florida)

Signs & Symptoms

- Fever
- Headache
- Nausea
- Vomiting
- Abdominal pain
- Muscle pain
- Lack of appetite
- Conjunctivitis
- Rash
 - Some type of rash occurs in 90% of individuals diagnosed
 - Classically occurs 2-5 days after fever onset
 - Petechial rash- severe disease



Petechial Rash (CDC)

Methods

Spotted Fever Rickettsiosis

Methods

- Conducted literature review and collected retrospective data on *Dermacentor variabilis* and *Rhipicephalus sanguineus* vector locations
 - Primary data for 2000-2012 obtained from Dr. Michael Dryden of KSU-CVM
 - Additional data from Brillhart, 1993, White&Mock, 1991
 - Determined counties where *D. variabilis* & *R. sanguineus* ticks were reported
- Created maps depicting these counties using ArcMap 10.1 software

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Methods- Epidemiologic Study

- Included only confirmed and probable cases
- Confirmed case:
 - Clinically compatible case that is laboratory confirmed
 - Laboratory confirmed:
 - Fourfold change in IgG titers
 - Detection of bacteria by PCR assay
 - Spotted fever group antigen in biopsy
 - Isolation of bacteria in cell culture
- Probable case:
 - Clinically compatible case and supportive laboratory results
 - Laboratory supportive:
 - Serologic evidence of elevated IgG or IgM antibody to *Rickettsia* bacteria

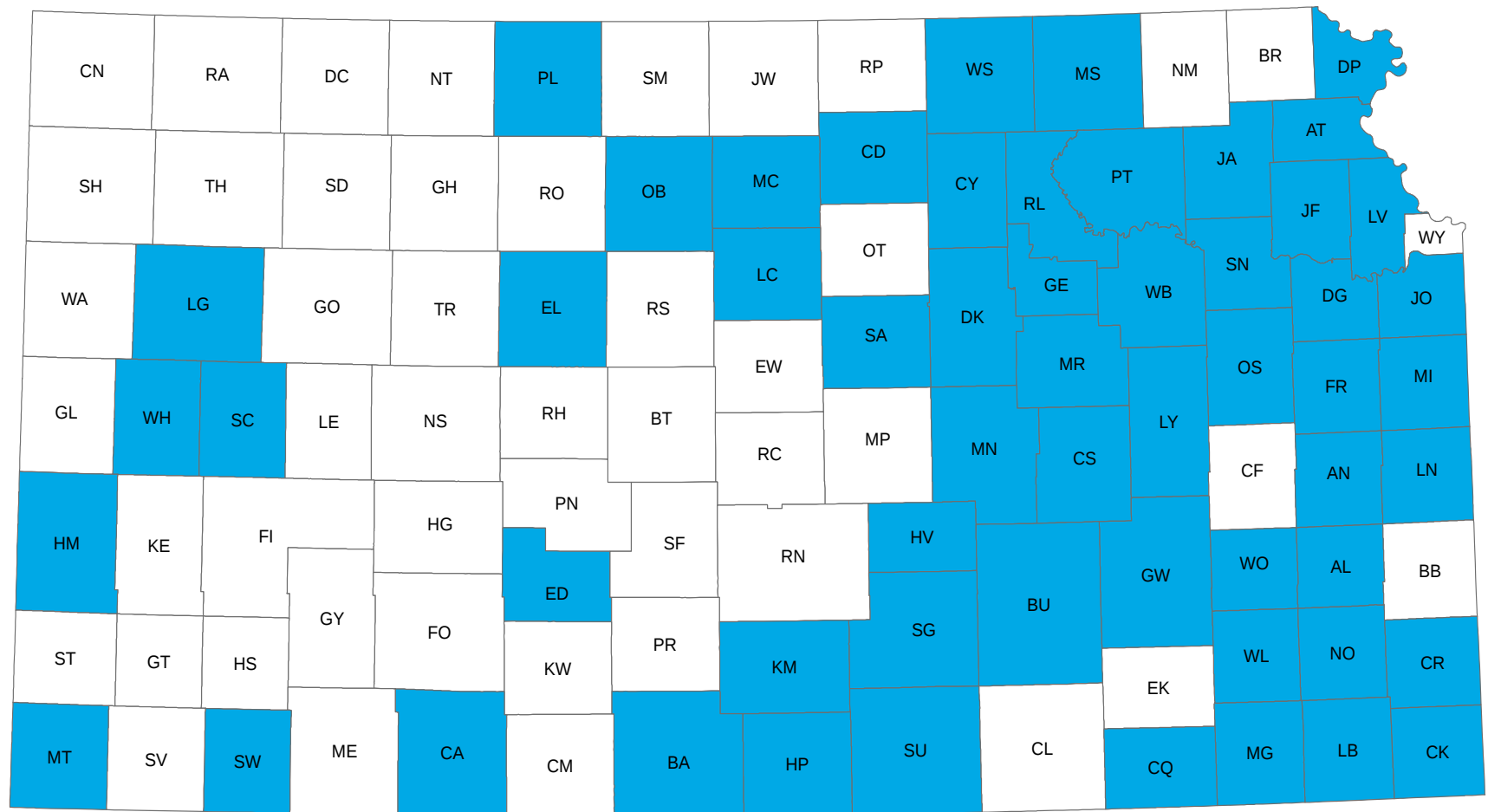
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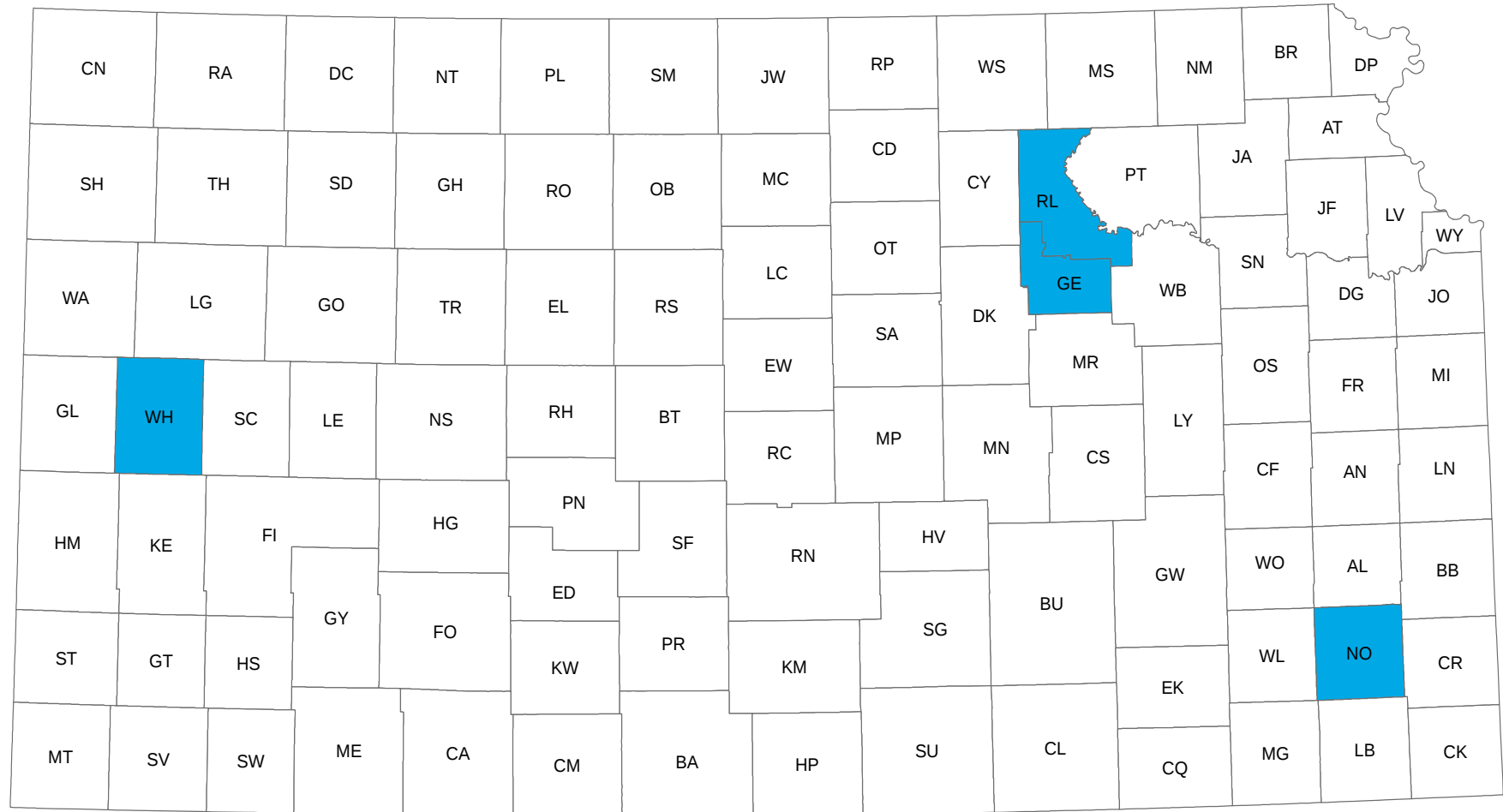
Spotted Fever Rickettsiosis

Map of Counties in Kansas where *Dermacentor variabilis* ticks were found



 Counties with *D. variabilis*

Map of Counties in Kansas where *Rhipicephalus sanguineus* ticks were found

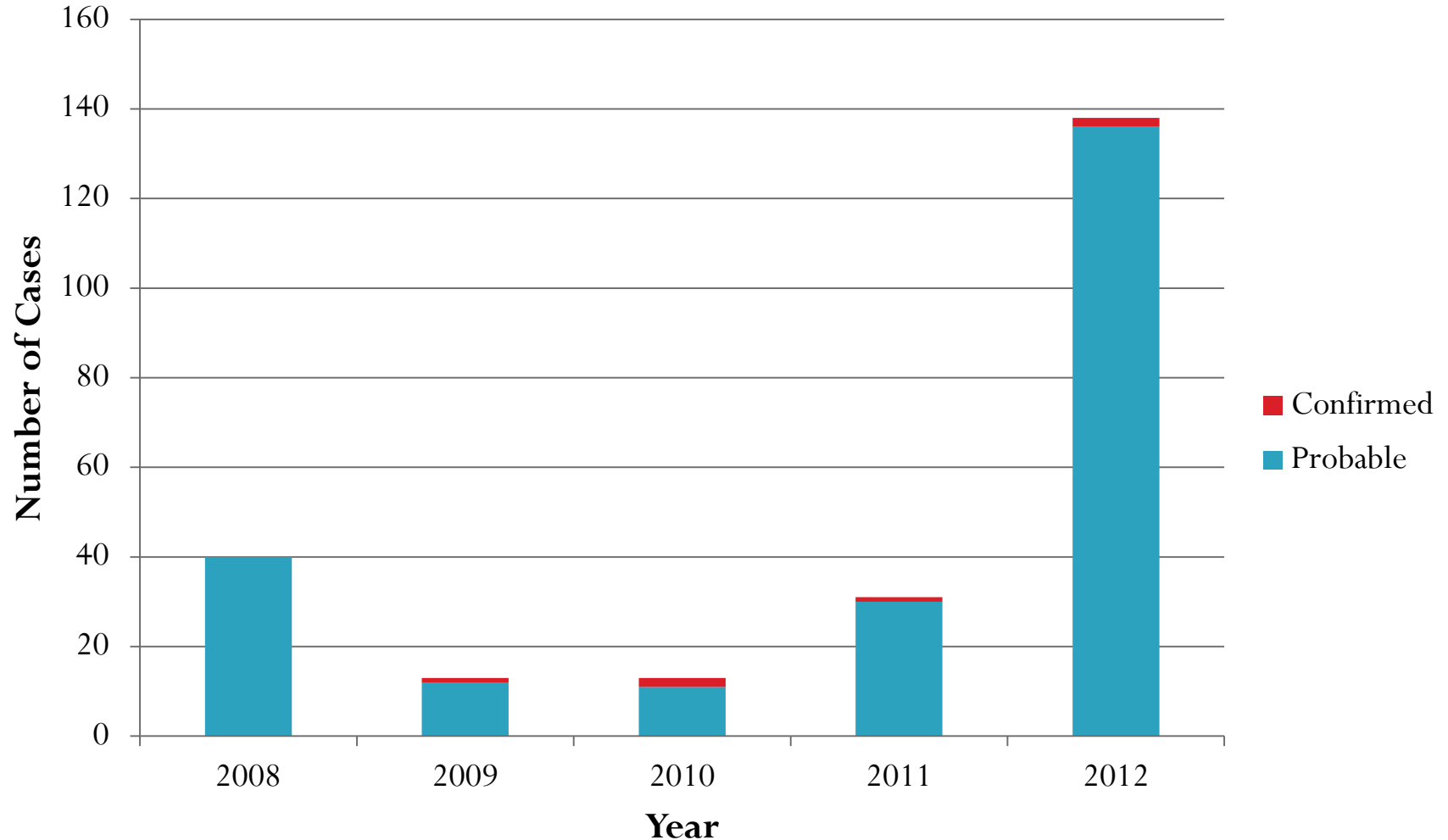


Counties with *R. sanguineus*

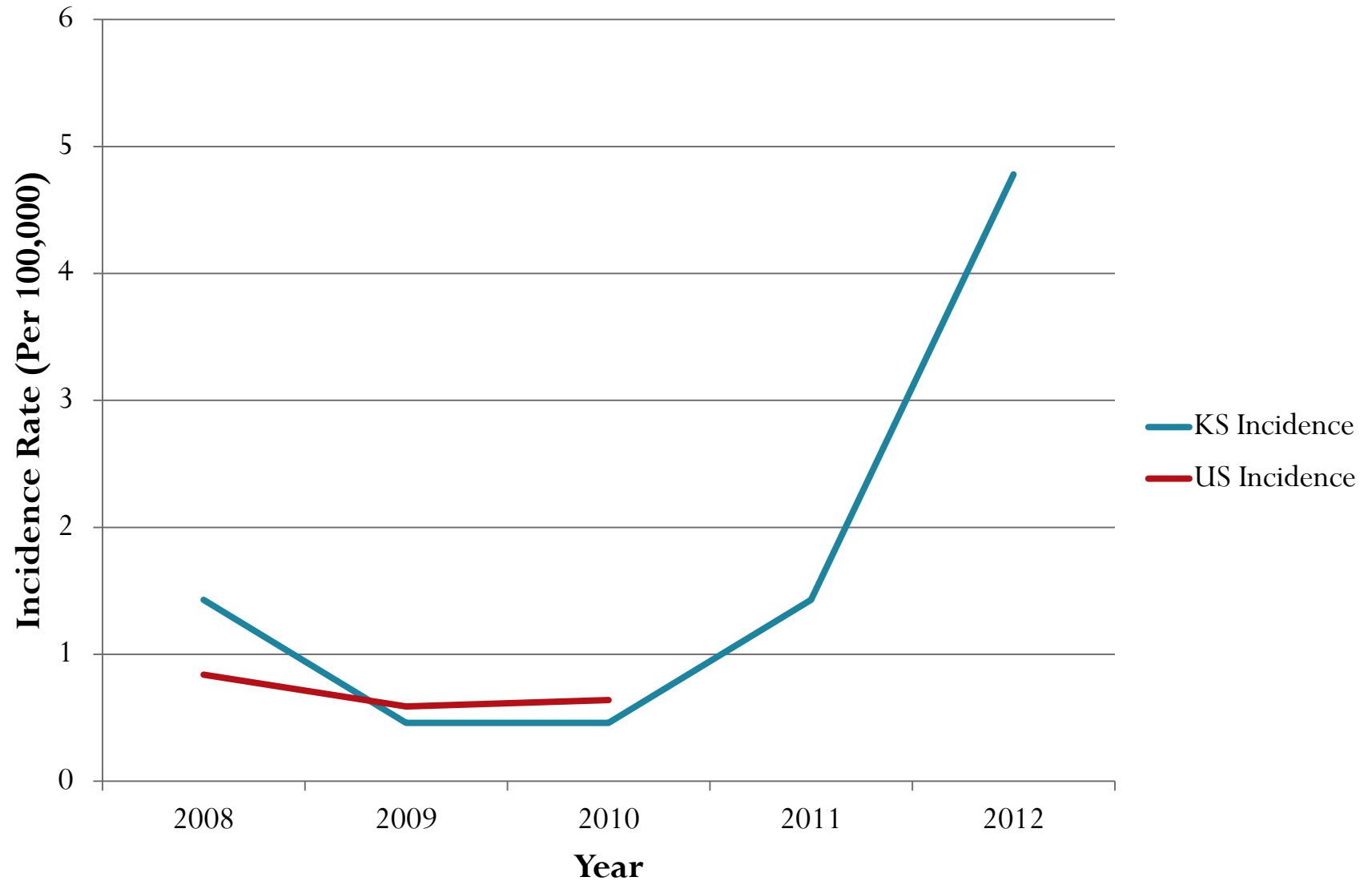
Results

- Total number of cases, 2008-2012
 - 235 cases
- Largest number of cases in 2012
 - 136 cases
- Probable and Confirmed cases
 - 6 (2.55%) confirmed
 - 229 (97.45%) probable

Number of Confirmed and Probable Cases of Spotted Fever Rickettsiosis Reported in Kansas, 2008-2012



United States and Kansas Incidence of Spotted Fever Rickettsiosis, 2008-2012

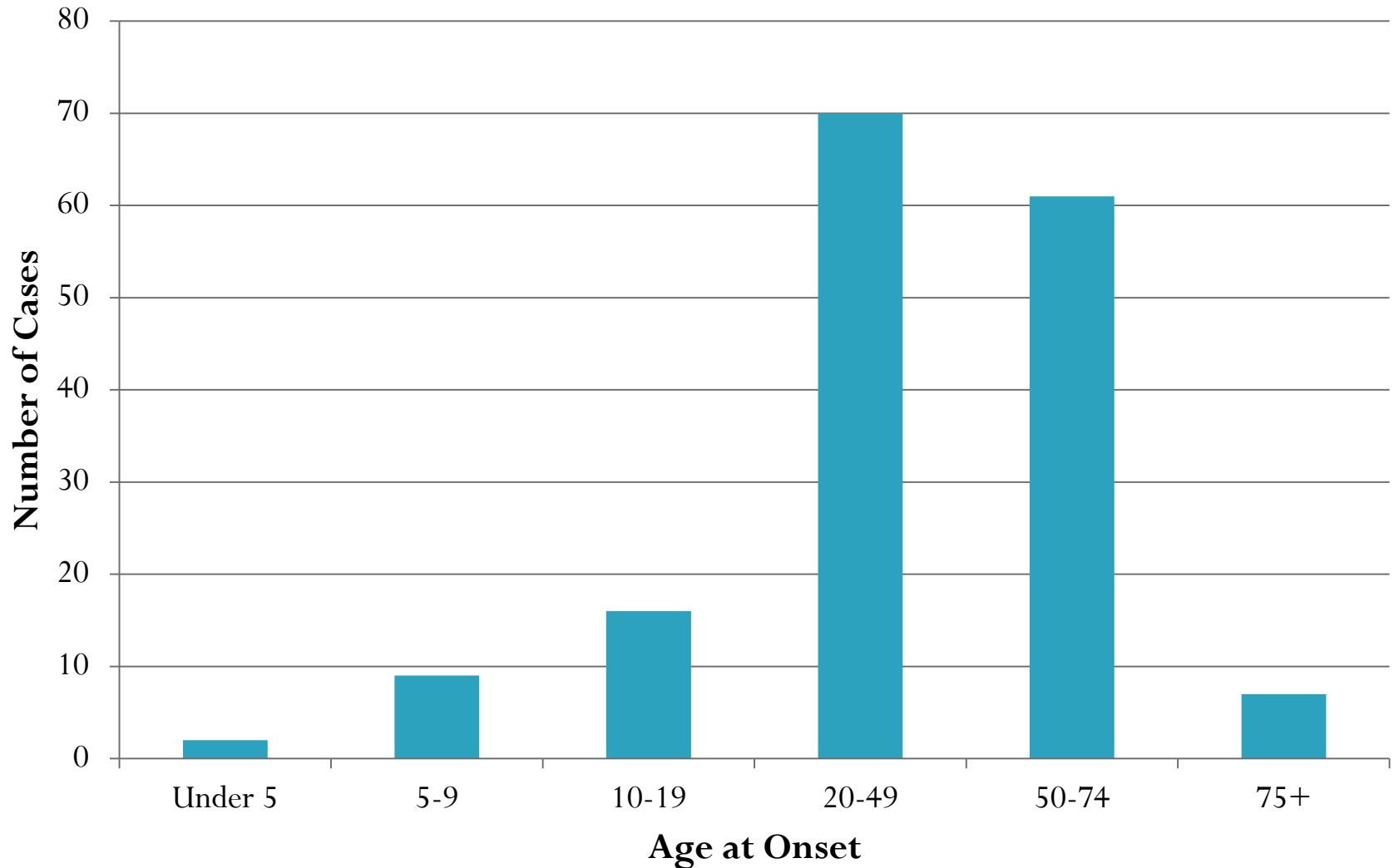


Results

- More male (63%) than female (37%) cases
- Ethnicity
 - Non-Hispanic/Latino (74%)
- Race
 - Majority are white

Race	Number of Cases	Percentage of Cases	Percentage in Kansas
White	189	80.43	87.40
Black/ African American	1	0.43	6.10
American Indian/ Alaskan Native	1	0.43	1.20
White; American Indian/ Alaskan Native	1	0.43	----
Asian	1	0.43	2.50
Unknown	42	17.87	----

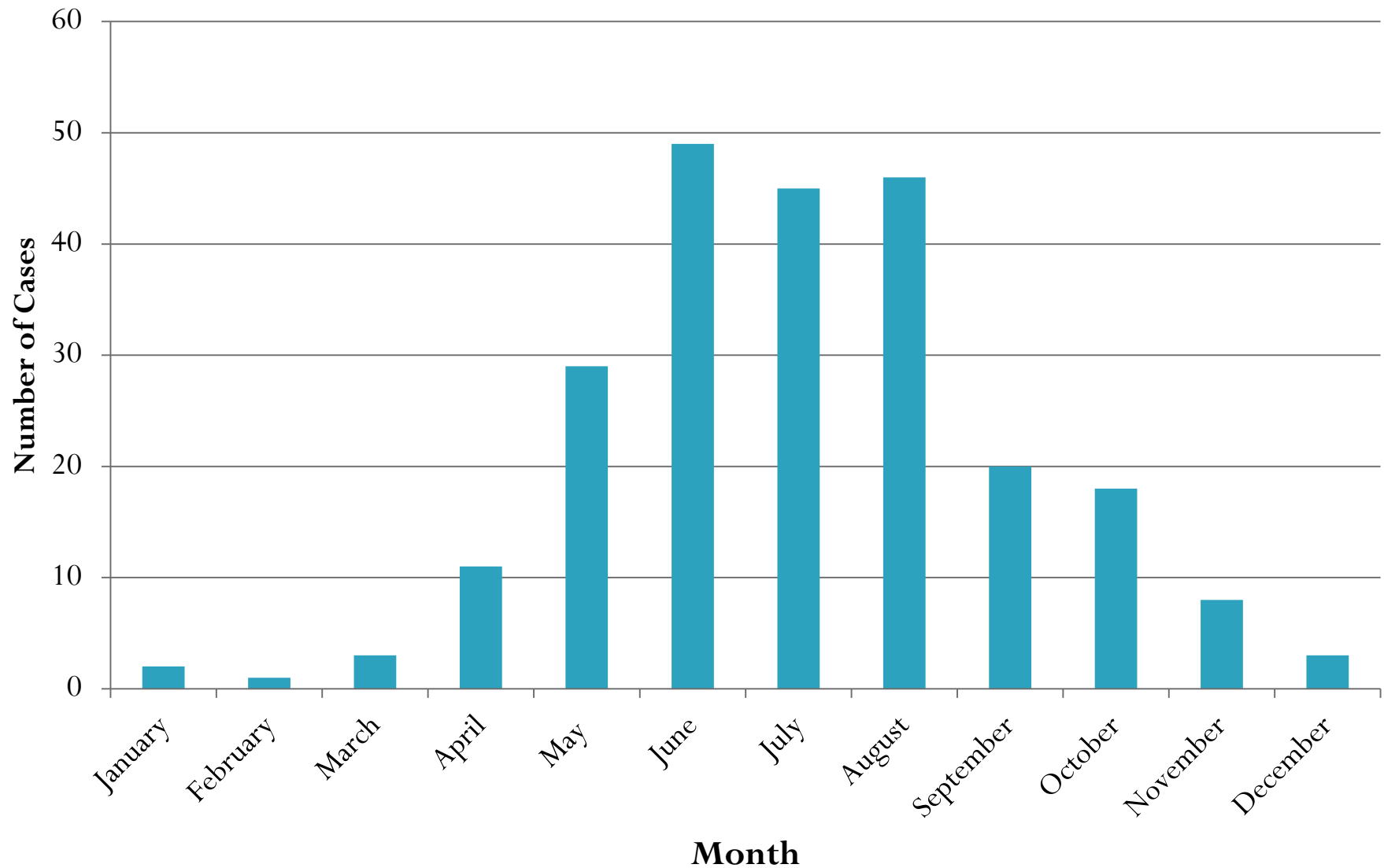
Number of Cases of Spotted Fever Rickettsiosis Reported in Kansas by Age, 2008-2012 (n=165)



Clinical Manifestations of Spotted Fever Rickettsiosis

Symptoms	# Cases	Total Known	Percentage
Fever	225	228	98.7
Myalgia	172	214	80.4
Headache	162	211	76.8
Rash	97	209	46.4
Elevated Hepatic Transaminases	31	133	23.3
Anemia	28	160	17.5
Leukopenia	25	150	16.7
Thrombocytopenia	24	145	16.6
Eschar	4	205	2.0

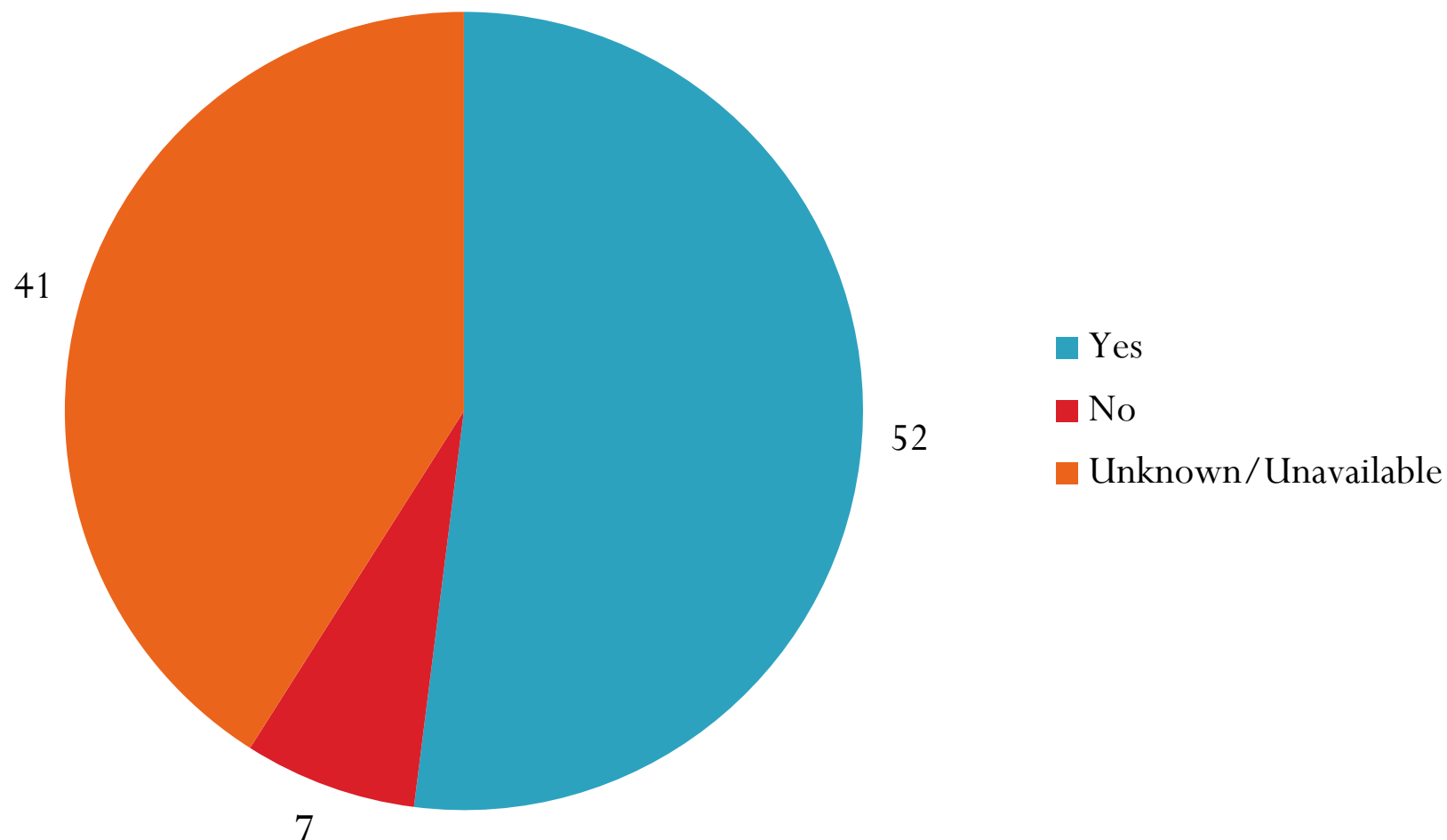
Number of Cases of Spotted Fever Rickettsiosis by Month, 2008-2012



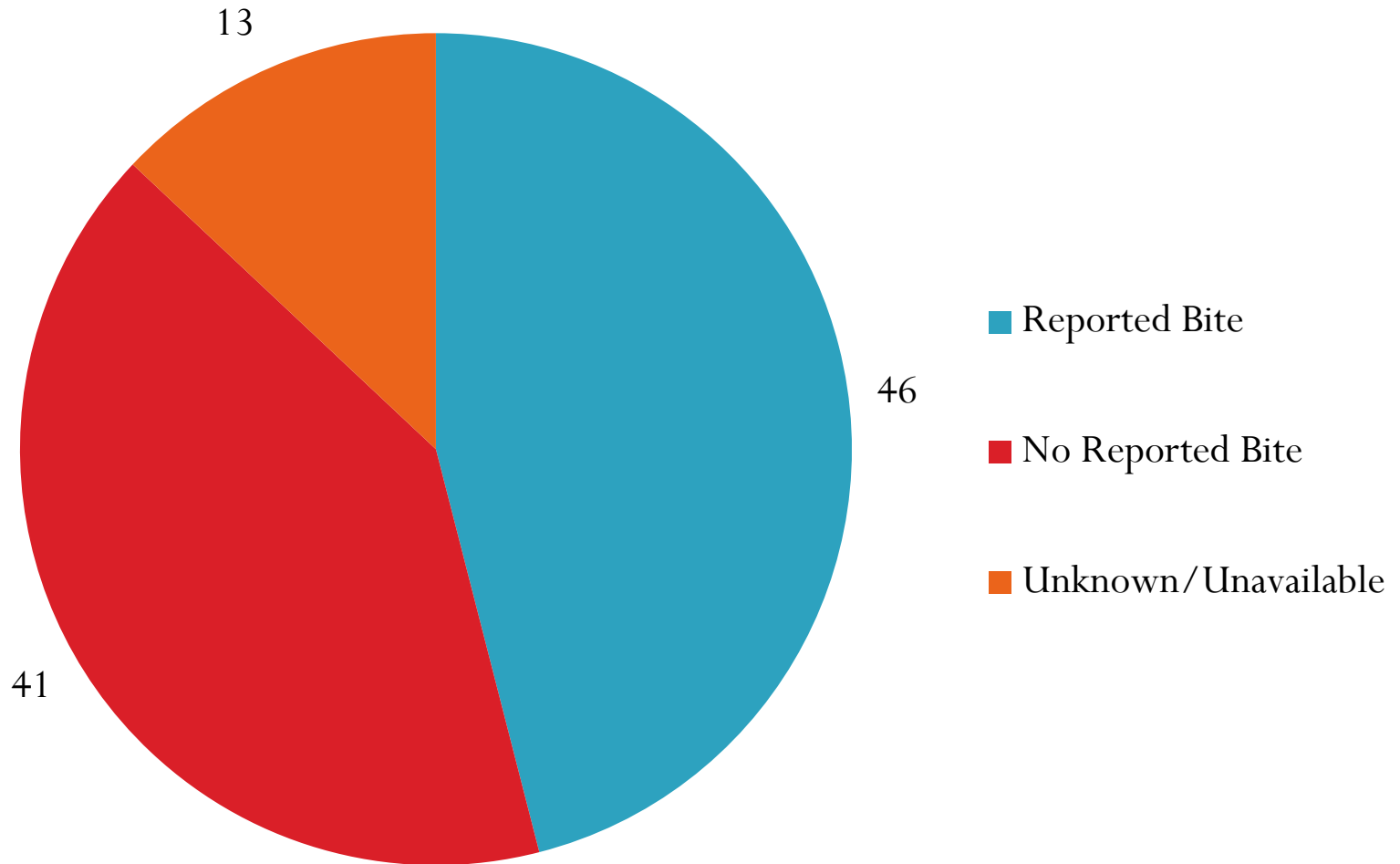
Results

- For the 235 total cases
 - 140 cases reported exposure in Kansas
 - 22 cases reported out of state exposure
 - 73 cases either did not report place of exposure or their place of exposure is unknown

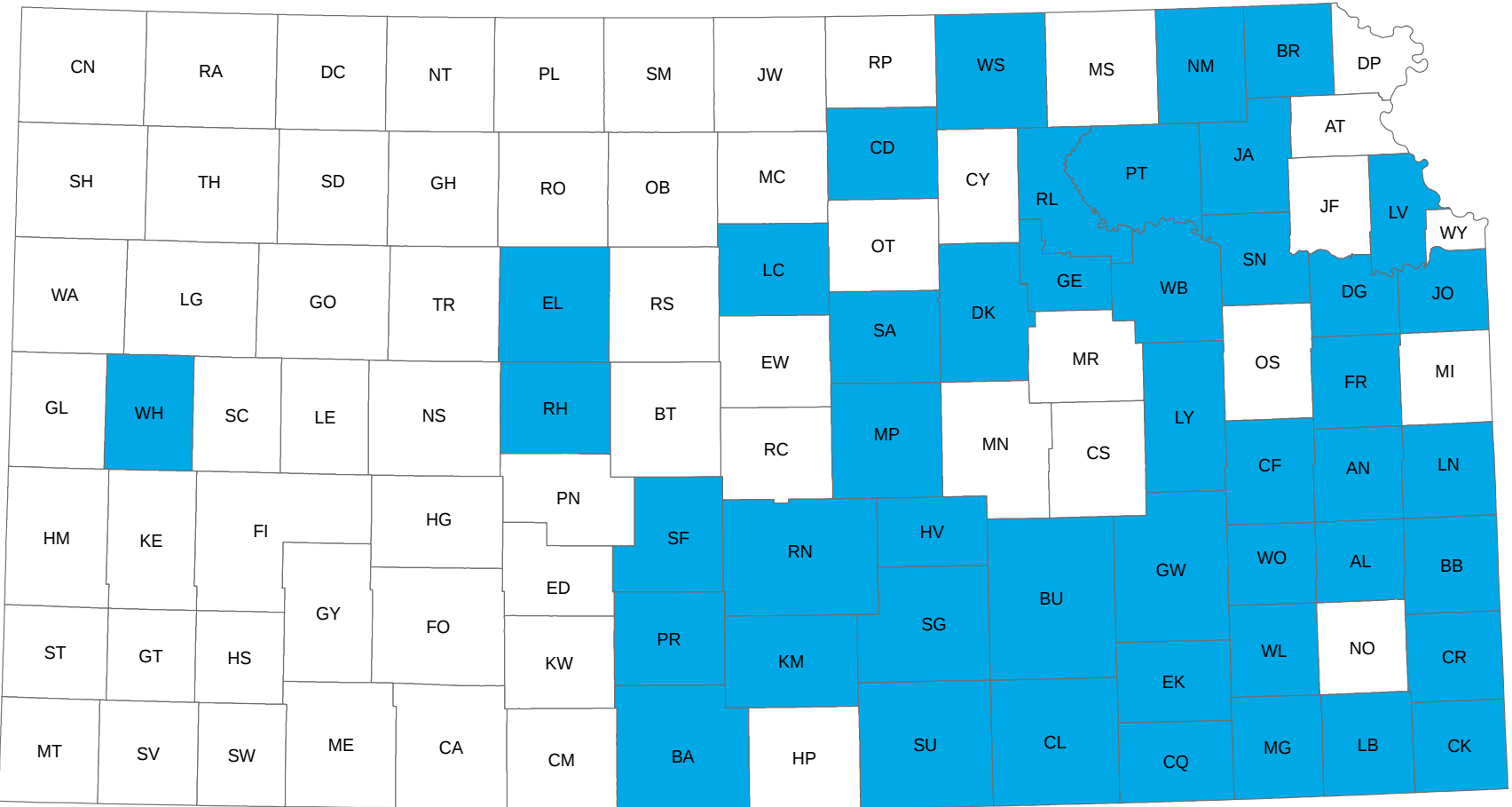
Percentages of Exposures for Spotted Fever Rickettsiosis Cases, 2008-2012



Percentages of Tick Bite History for Spotted Fever Rickettsiosis Cases, 2008-2012



Counties in Kansas where reported exposures occurred for individuals with probable or confirmed cases of Spotted Fever Rickettsiosis, 2008-2012



Counties of Exposure for Confirmed or Probable Cases

Discussion

Spotted Fever Rickettsiosis

Discussion

- Significant increase in probable cases in 2012
 - 134 cases
 - 464% increase from previous 4 year average of probable cases
- Increase due to:
 - Change in surveillance procedures
 - Increase in monitoring local health departments investigation
 - Change in surveillance systems
 - KS-EDSS → EpiTrax
 - Easier to review cases based on specific variables
 - Better report functionality
 - Testing

Discussion

- 2008 to 2012 majority of cases are probable, not confirmed
 - Lack of laboratory testing needed for a confirmatory classification
 - Acute and convalescent serology

Discussion

- Higher the incidence in Kansas than the United States
- *R. sanguineus* is not the primary tick vector in Kansas
- *D. variabilis* most likely is primary vector
- Compared to the U.S.
 - CDC cites increase in incidence in U.S. from 2000 to 2010
 - Attributed to *R. sanguineus*

Discussion

- More adult cases reported than young and elderly cases
 - Rural occupations
 - Increased exposures
- Seasonality:
 - Most cases are seen between April and October
 - Ticks are more active and seeking a blood meal
 - Greater outdoor activity

Discussion

- Exposures
 - More than half reported tick habitat exposure (52%)
 - 41% unknown
 - Recall ability
 - Vague definition of exposure
 - Unable to be interviewed
- Tick bite
 - Less than half reported a tick bite (46%)
 - More likely to visit health care provider if bitten/ill
 - More likely to be tested
 - 13% unknown
 - Clear answer (Y/N)
 - Greater recall
 - 41% reported no bite
 - Nymphs are small and easily overlooked

Public Health Implications

- Increase in cases
 - Improved surveillance due to reviewed cases
- Greater awareness of tick vector location
- Prevention efforts targeted to specific groups

Overall Study Limitations

- Passive Surveillance
 - Tick data
- Under-reporting
 - KDHE relies on clinicians, local health departments, laboratories, and hospitals for disease reporting
- Incomplete Data
 - Ability of local health department to follow up
 - Patients recall ability

Recommendations

- Extension agents
 - Maintain more accurate and comprehensive records on tick species distribution in Kansas
- KDHE
 - Provide training and assistance to local health department during an investigation of tick-borne diseases
- Health Departments
 - Provide more information to health care providers on the appropriate confirmatory tests to order for tick-borne disease
- Education
 - Preventative measures

Acknowledgements

- Mrs. Sheri Tubach
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- Wayne and Alice Coleman
- Josh Oden

Thank You!

Questions?

