Tick-Borne Diseases in Humans in the U.S.

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Outline

- Vectors and diseases
- Incidence and distribution
- Emerging issues and concerns
- Challenges and opportunities
- Priorities for prevention and control

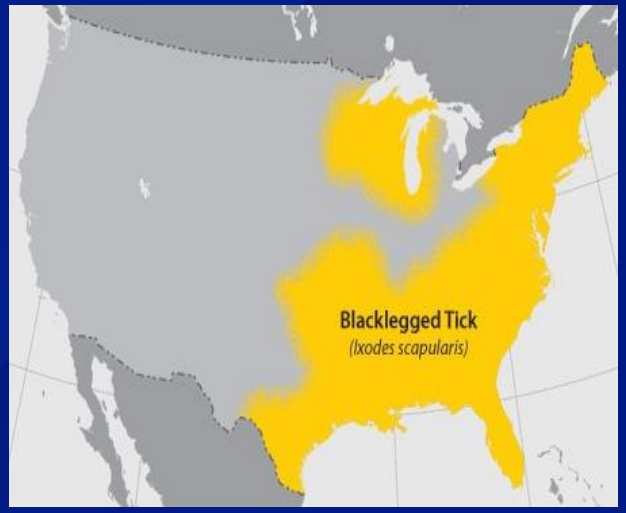
Vectors and Diseases

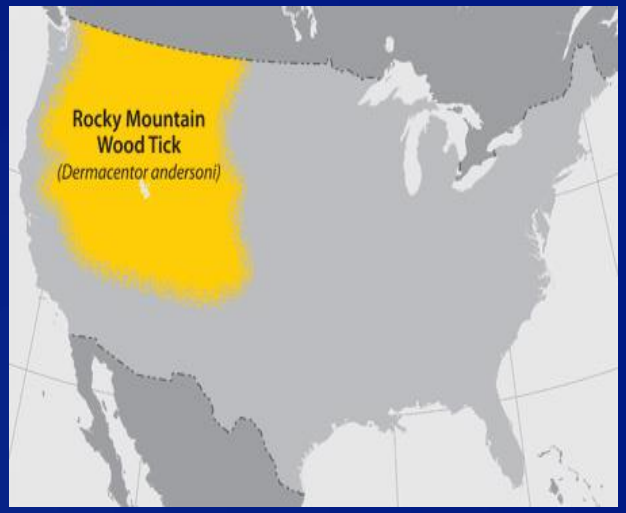
Important U.S. Tick Vector Species (human health)

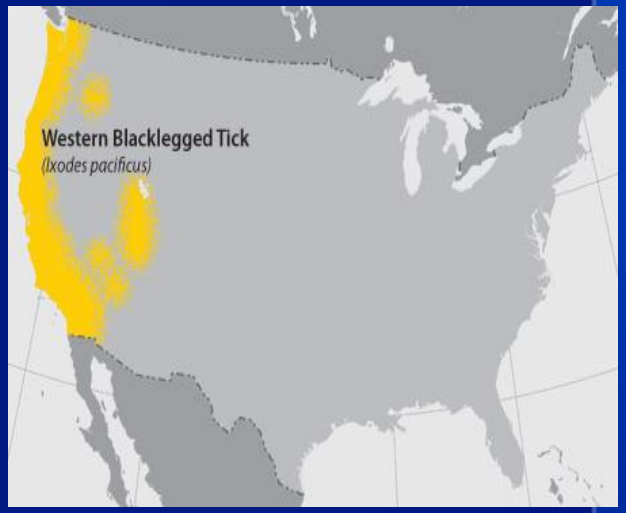
- American dog tick - *Dermacentor variabilis*
- Blacklegged tick - *Ixodes scapularis*
- Brown dog tick - *Rhipicephalus sanguineus*
- Gulf Coast tick - *Amblyomma maculatum*
- Lone star tick - *Amblyomma americanum*
- Rocky Mountain wood tick - *Dermacentor andersoni*
- Western blacklegged tick - *Ixodes pacificus*
- Soft ticks – primarily *Ornithodoros hermsi*

http://www.cdc.gov/ticks/geographic_distribution.html

Distribution Maps of Key Vector Species



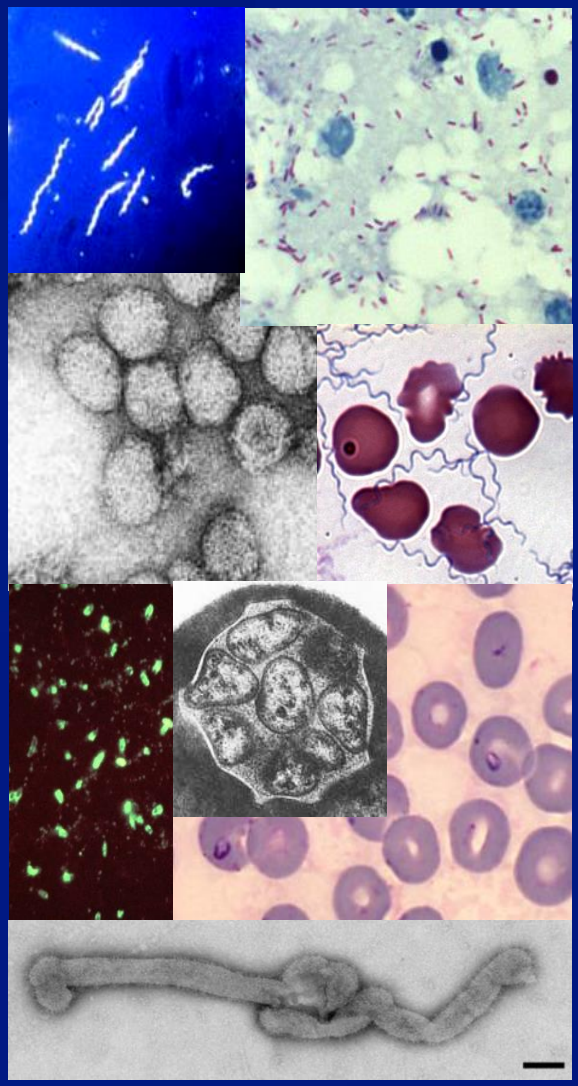




http://www.cdc.gov/ticks/geographic_distribution.html

Tick-borne Diseases in the U.S.

- Anaplasmosis*
- Babesiosis*
- Lyme disease (*Borrelia burgdorferi*)*
- *Borrelia miyamotoi* infection
- Other novel *Borrelia* spp
- Bourbon virus
- Colorado Tick Fever
- Ehrlichiosis (including *E. muris*-like agent)*
- Heartland virus infection
- Southern Tick-Associated Rash Illness
- Spotted Fever Group Rickettsia*
- Tick-borne relapsing fever
- Powassan virus infection*
- Tularemia*



Note: Green text denotes recently identified pathogens

*reportable to CDC

Incidence and Distribution

Tick-borne Diseases in the U.S., 2013

Disease/agent	Reported cases*
Lyme disease	36,307
Spotted Fever Rickettsiosis	3,359
Anaplasma phagocytophilum	2,782
Babesia	1,792
Ehrlichia chaffeensis	1,518
Anaplasma or *Ehrlichia* – undetermined/other	251
Tularemia	203
Powassan virus	15

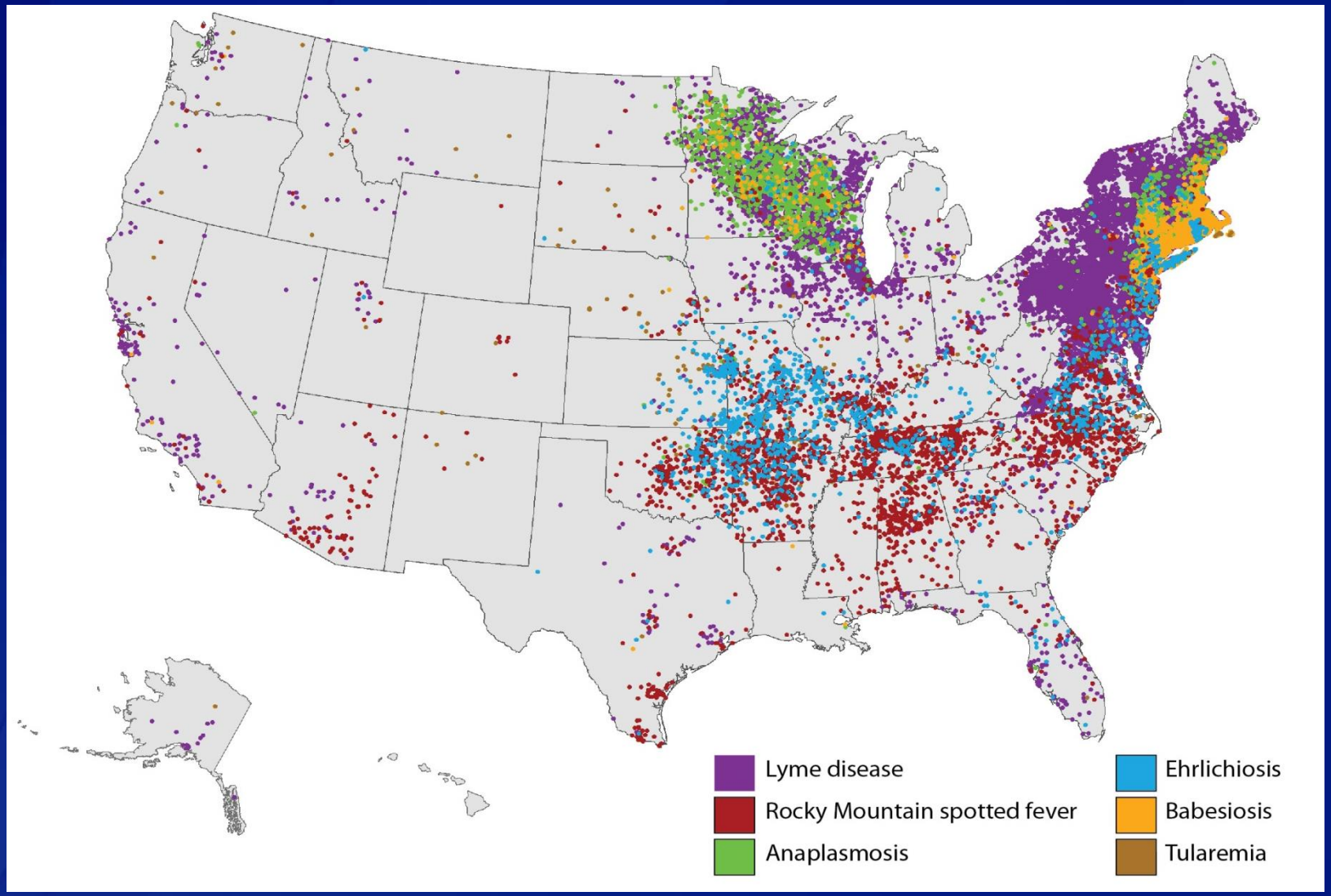
*total reported cases – confirmed and probable

Top 10 Notifiable Diseases in the United States, 2013

Disease	Case numbers
1. Chlamydia	1,401,906
2. Gonorrhea	333,004
3. Syphillis	56,471
4. Salmonellosis	50,634
5. Lyme disease	36,307*
6. HIV/AIDS (new diagnoses)	34,969
7. Pertussis	28,639
8. Invasive Pneumococcal disease	17,193
9. Giardiasis	15,106
10. Shigellosis	12,729

*Total number of cases estimated at close to 300,000 per year

Distribution of Key Tickborne Diseases, 2013

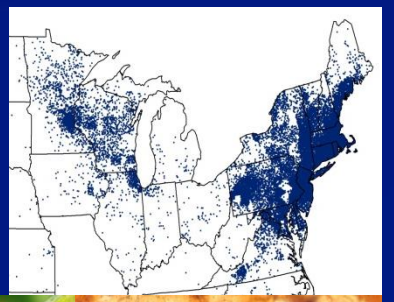


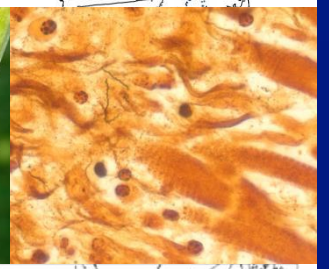
Each dot represents one case reported according to county of residence and not necessarily where the disease was acquired. In 2013, no cases were reported from Hawaii. In Alaska, there were 14 travel-related cases of Lyme disease and one case of tularemia. Babesia was reportable in only 28 states.

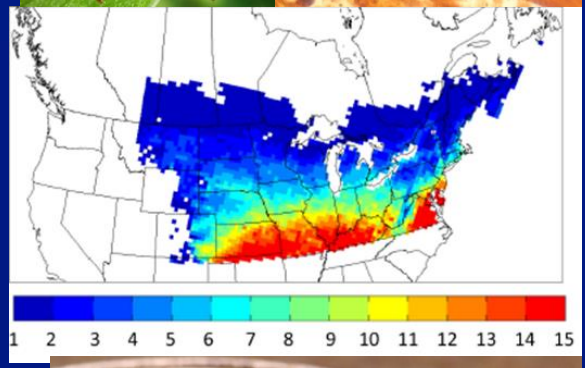
Emerging Issues and Concerns

Emerging Issues and Concerns

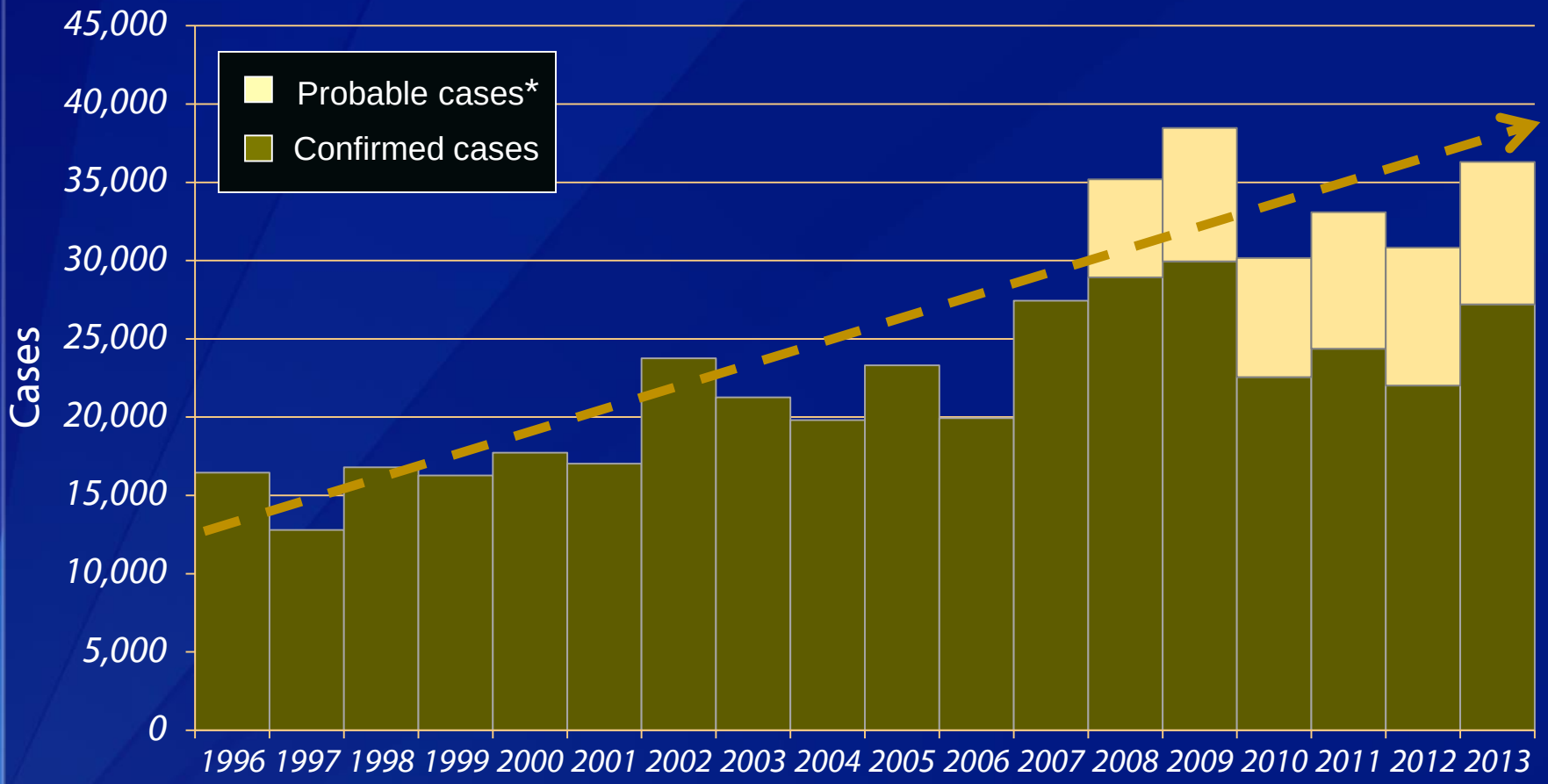
- Expanding incidence and distribution
- A warming climate
- Novel and emerging pathogens





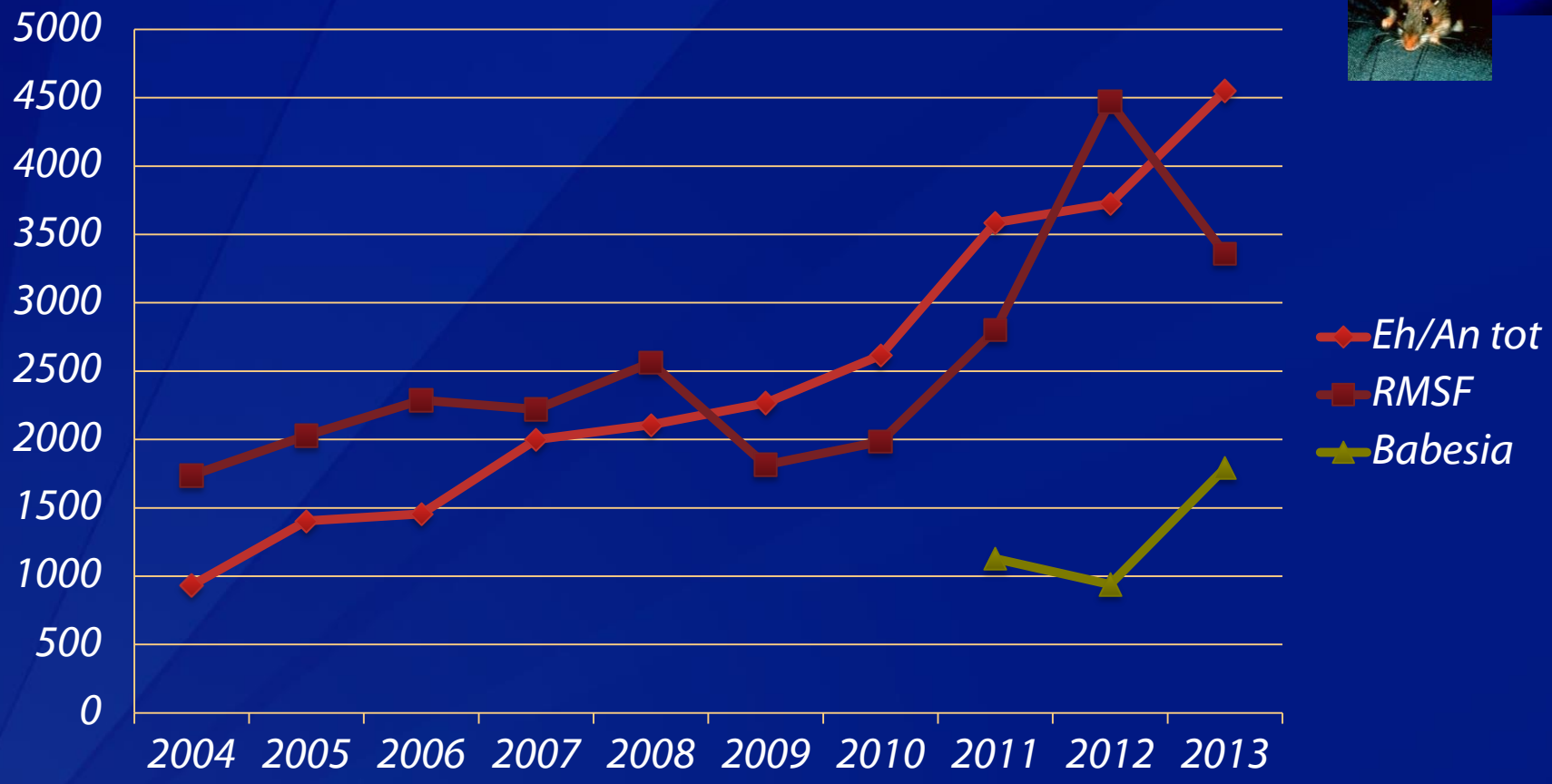


Reported Cases of Lyme Disease by Year, United States, 1996-2013



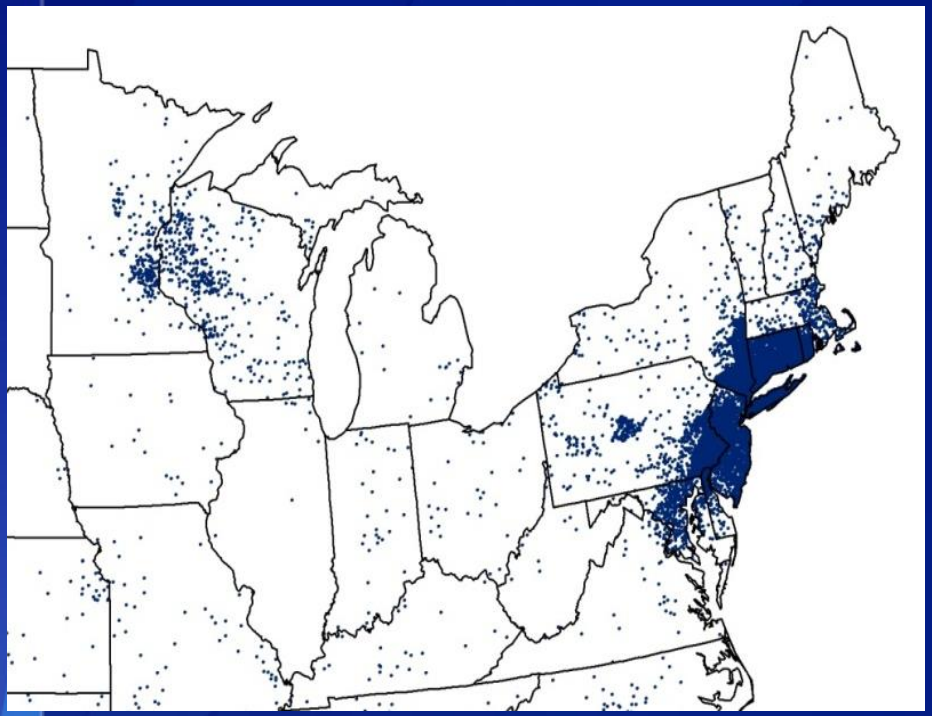
*National Surveillance case definition revised in 2008 to include probable cases; details at http://www.cdc.gov/ncphi/disss/nndss/casedef/lyme_disease_2008.htm

Tick-borne Diseases in the United States, 2004-2013

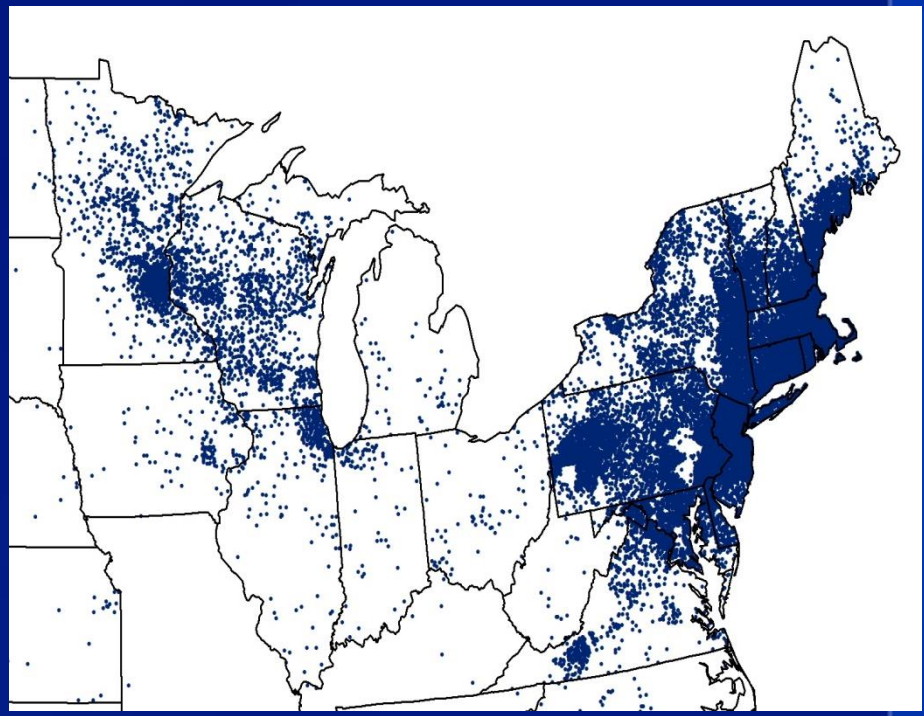


*Includes HGA, HME, and other or unspecified ehrlichiosis
‡Babesiosis became nationally notifiable in 2010

Lyme Disease U.S. Case Distribution – 18 year Trend



1996



2013

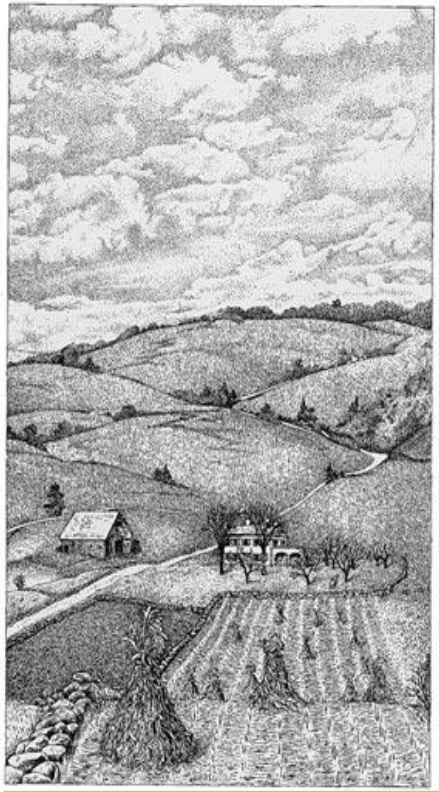
http://www.cdc.gov/lyme/stats/maps/interactiveMaps.html

Reportable Cases of Vector-Borne Diseases in the U.S., 2013

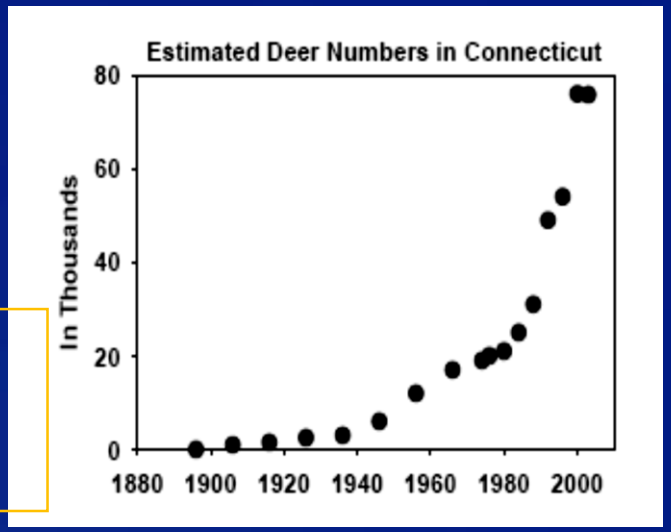
Diseases	2013 Reported Cases	Median (range) 2004-2013
Tick-borne		
Lyme disease	36,307	30,495 (19,804-38,468)
Anaplasmosis/ Ehrlichiosis	4,551	2,187 (875-4,551)
Spotted Fever Rickettsioses	3,359	2,255 (1,713-4,470)
Babesiosis	1,792	1,128 (940-1,792)
Tularemia	203	136 (93-203)
Powassan virus disease	15	7 (1-16)
Mosquito-borne		
West Nile virus infection	2,469	1,913 (712-5,673)
Malaria	1,594	1,484 (1,255-1,773)
Dengue	843	624 (254-843)
California serogroup viruses	112	78 (55-137)
St. Louis encephalitis	1	10 (1-13)
Eastern Equine Encephalitis	8	7 (4-21)
Flea-borne		
Plague	4	4 (2-17)

Dengue and malaria cases are primarily imported. Babesiosis and Dengue have only been notifiable since 2011 and 2009, respectively. Median and range values encompass cases reported from 2011 to 2013 for Babesiosis and 2010 to 2013 for dengue.

Tick-borne Disease Emergence – Re-emergence in the U.S.



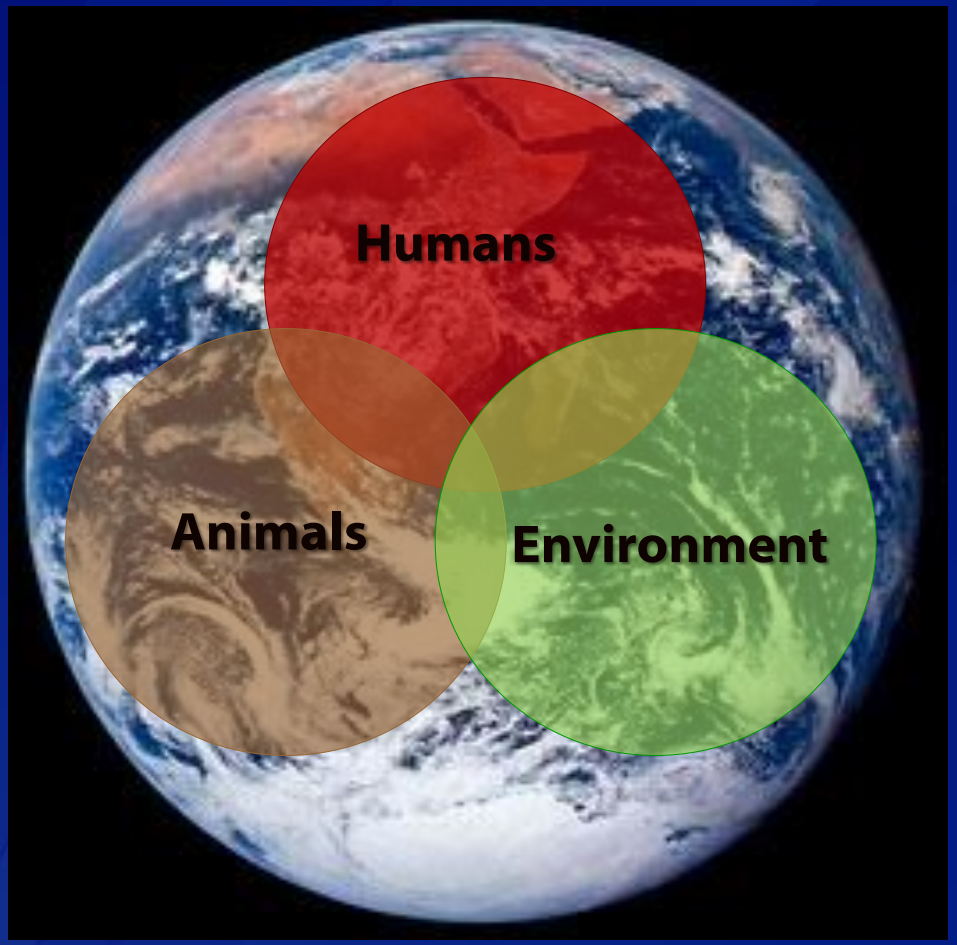
Source:
Bald hills: New England before the trees returned. From *Thoreau's Country.*
American Scientist Online
http://www.amercanscientist.org



- Reforestation
- Overabundant deer
- Expansion of suburbia into wooded areas
- Abundant habitat around homes for Lyme reservoir hosts
- Increased numbers of ticks
- Increased exposure opportunities in people
- Climate change

Source: K. Stafford, CT Agricultural Experiment Station

Emerging infectious diseases through a One Health Lens



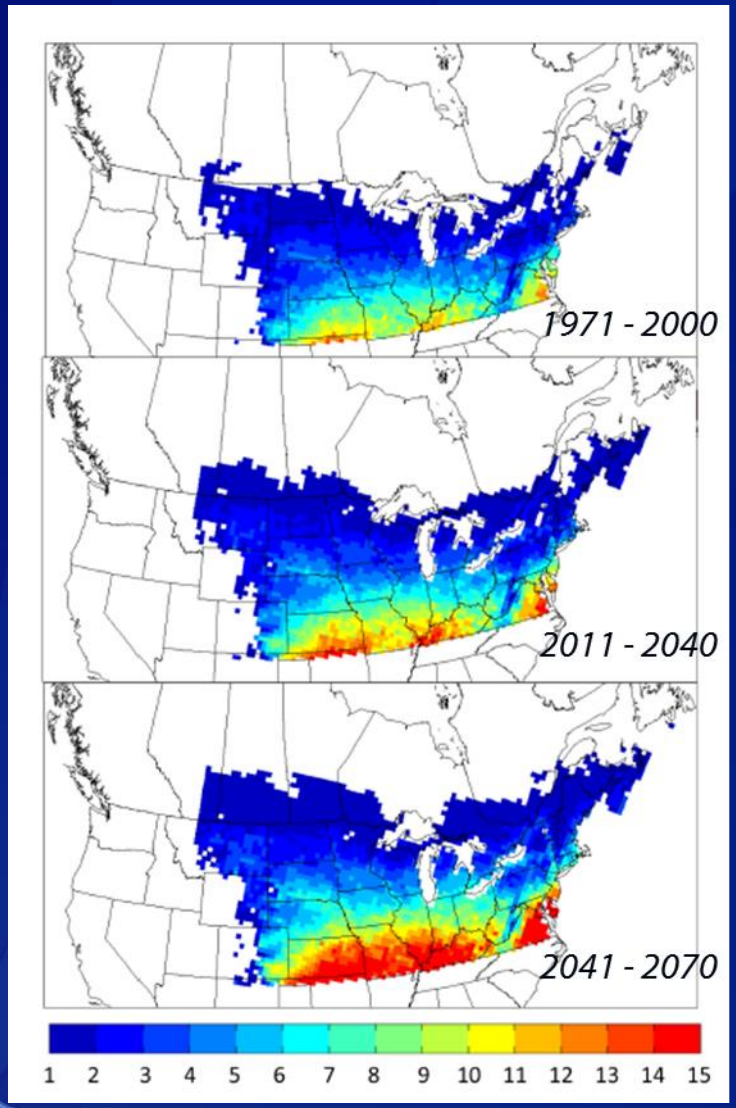
Changes in climate lead to changes in the environment, which result in changes in the incidence and distribution of diseases that have environmental linkages

Climate, Weather, and Lyme Disease

- Climate (primarily minimum temperature) defines the limit of northern distribution
- Warmer temperatures may increase the reproductive capacity of ticks, leading to larger populations and greater risk for disease transmission to humans
- Higher moisture levels allow ticks to survive in warmer environments
- Temperature and moisture affect the feeding behavior of ticks
- Temperature (measured by cumulative growing degree days) affects seasonality of disease

Brownstein, J. S., T. R. Holford, and D. Fish. 2003. Environ Health Persp 111: 1152-1157
Eisen, L., R. J. Eisen, and R. S. Lane. 2002. Med Vet Entomol 16: 235-244
Yuval, B., and A. Spielman. 1990. J Med Entomol 27: 196-201
Moore, S. M., R. J. Eisen, A. Monaghan, and P. Mead. 2014. Am J Trop Med Hyg 90: 486-496

Climate, Weather, and Lyme Disease



Estimated Effects of Projected Climate Change on the Basic Reproductive Number of the Lyme Disease Vector *Ixodes scapularis*

Nicholas H. Ogden, Milka Radojević, Xiaotian Wu, Venkata R. Duvvuri, Patrick A. Leighton, and Jianhong Wu

http://dx.doi.org/10.1289/ehp.1307799

Conclusion:

Climate warming may have co-driven Lyme disease emergence in northeastern North America, and in the future may drive substantial disease spread into new geographic regions, and increase tick-borne disease risk where climate is currently suitable.

Climate Change and Lyme Disease – A More likely Outcome: Changes in Seasonality

Am. J. Trop. Med. Hyg., 90(3), 2014, pp. 486–496
doi:10.4269/ajtmh.13-0180

Meteorological Influences on the Seasonality of Lyme Disease in the United States

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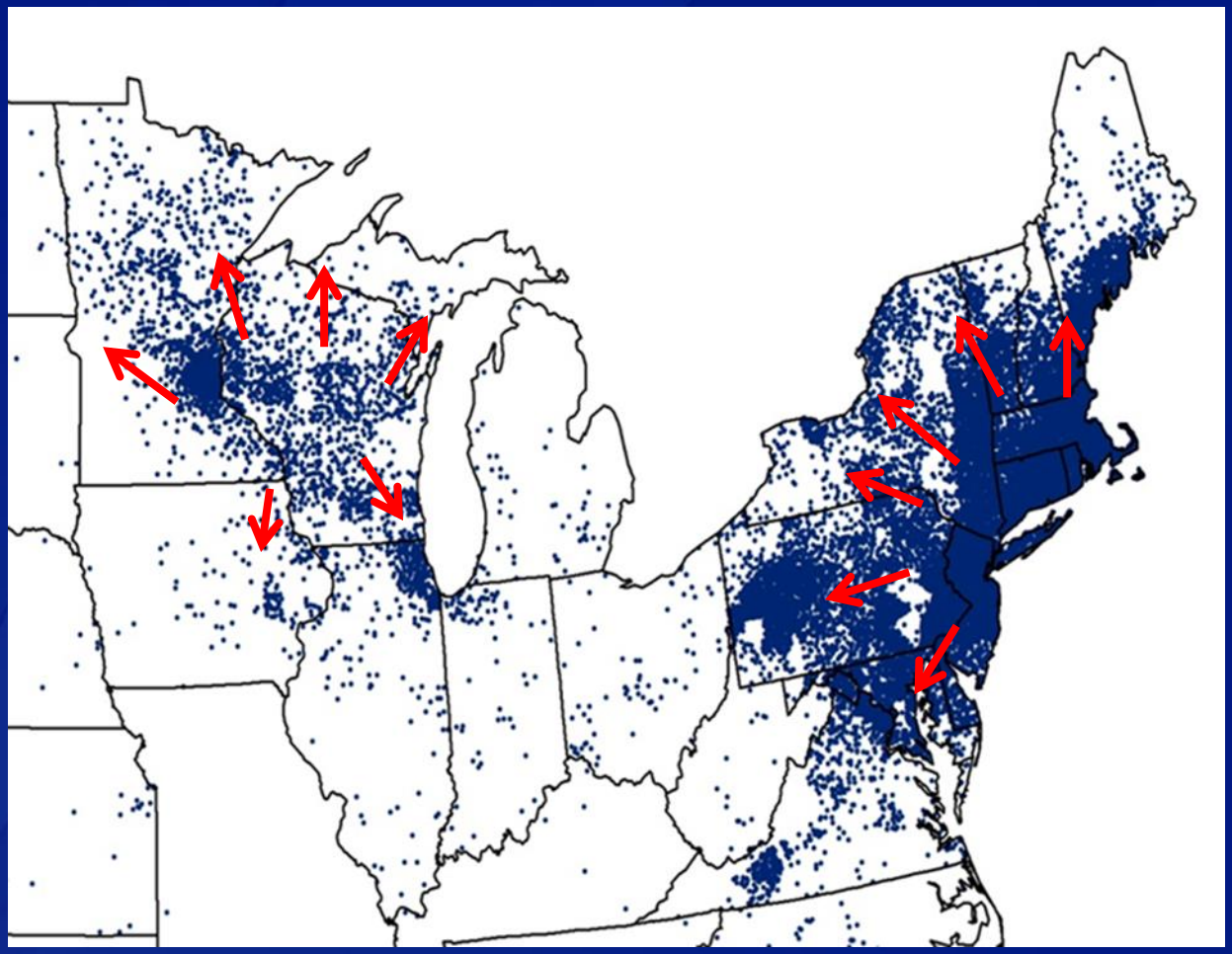
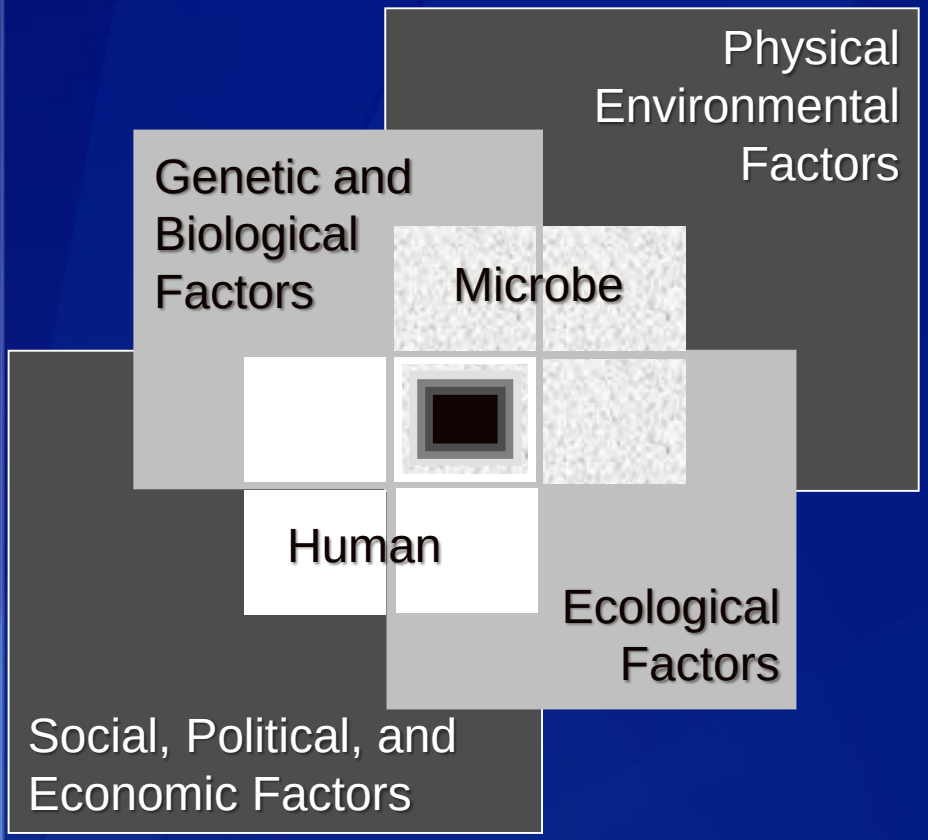
Abstract. Lyme disease (*Borrelia burgdorferi* infection) is the most common vector-transmitted disease in the United States. The majority of human Lyme disease (LD) cases occur in the summer months, but the timing of the peak occurrence varies geographically and from year to year. We calculated the beginning, peak, end, and duration of the main LD season in 12 highly endemic states from 1992 to 2007 and then examined the association between the timing of these seasonal variables and several meteorological variables. An earlier beginning to the LD season was positively associated with higher cumulative growing degree days through Week 20, lower cumulative precipitation, a lower saturation deficit, and proximity to the Atlantic coast. The timing of the peak and duration of the LD season were also associated with cumulative growing degree days, saturation deficit, and cumulative precipitation, but no meteorological predictors adequately explained the timing of the end of the LD season.

Reported Cases of Lyme Disease in the United States – 2013



1 dot placed randomly within county of residence for each confirmed case

Drivers for Disease Emergence



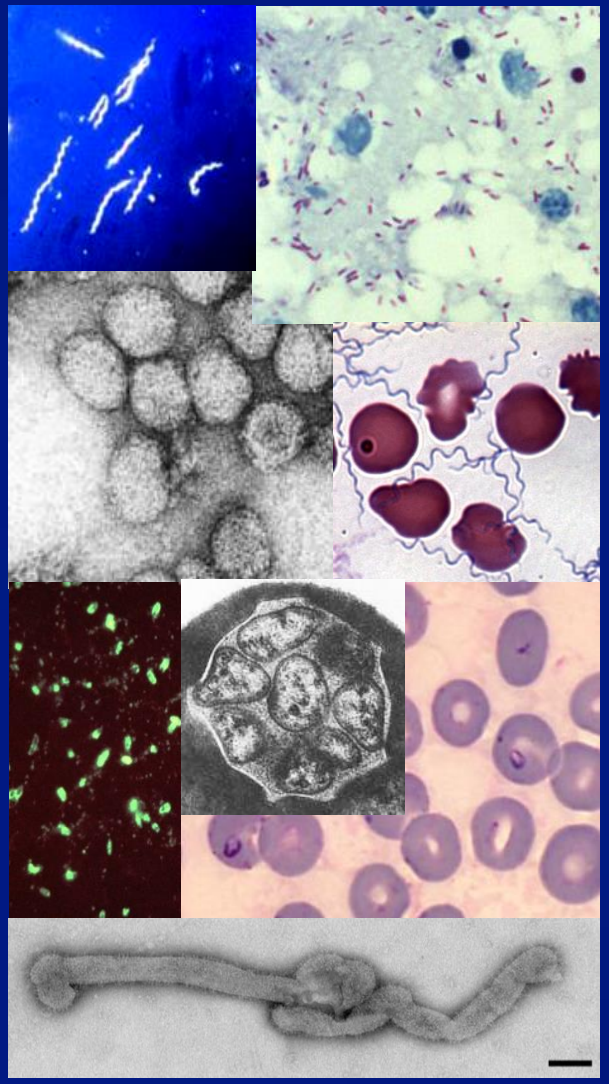
Convergence Model for Emerging Diseases

- Climate and weather
- Changing ecosystems
- Economic development and land use
- Microbial adaptation and change
- Human susceptibility to infection
- Human demographics and behavior
- Technology and industry
- International travel and commerce
- Breakdown of public health measures
- Poverty and social inequality
- War and famine
- Lack of political will
- Intent to harm

Source: Institute of Medicine 2003 report – Microbial Threats to Health

Novel and emerging pathogens and conditions

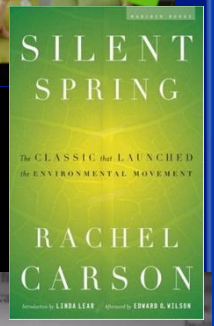
- Babesiosis in the NE and upper MW
- Borrelia miyamotoi across the northern U.S.
- Powassan virus in the NE and upper MW
- Heartland virus in Missouri and Tennessee
- Bourbon virus (*Thogotovirus*) in Kansas
- Novel Lyme Borrelia sp. in upper MW

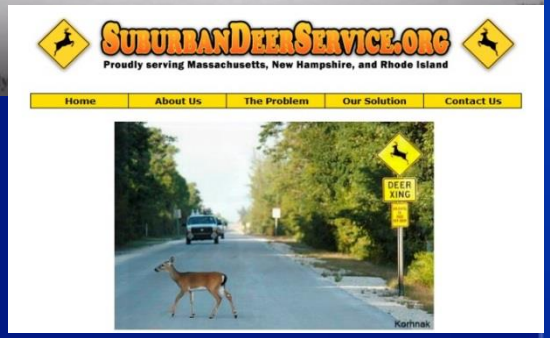


Challenges and Opportunities

Lyme Disease in the U.S. – Current State of Affairs

- The case numbers are higher than they have ever been
- The geographic case distribution is more extensive than ever in the past
- There is significant polarization among key stakeholders
- There is currently no *'magic bullet'* that is effective for disease prevention and control





Other Concerns

- Fewer scientists specializing in TBDs
- Less research being conducted on TBDs
- Stagnant federal budgets
- Less general interest and awareness in the academic community
- Tick control is largely seen as a responsibility of individual homeowners with limited public support or participation

Priorities for Prevention and Control

Lyme Disease – CDC Strategic Priorities

- Strengthening national surveillance and understanding disease burden
- Identifying and validating effective prevention and control practices
- Improving early and accurate diagnosis and treatment
- Building effective collaborations with key prevention partners

CDC Lyme Disease Prevention Activities – Lessons Learned…

- There are many tools available for killing ticks
- Killing ticks in your own yard doesn't necessarily equate to reducing risk of illness
- Tick control responsibility should be shared between homeowners and local communities
- The best solutions will probably be IPM* methods, evaluated across a variety of local settings

*Integrated Pest Management

Conclusions

- Tick-borne diseases in humans are increasing in numbers and distribution in the U.S.
- There are numerous research questions still to be answered.
- Prevention and control requires validated tools and methods (diagnosis, treatment, and interventions), and effective collaboration.
- Local solutions are likely to be the best solutions, AND the responsibility should be shared between homeowners and their local communities.
- A integrated understanding of climate, ecology, and epidemiology is critical for predicting and averting epidemics of Lyme and other tick-borne diseases

Thank you for your attention!

Questions?

The findings and conclusions in this report have not been formally disseminated by the Centers for Disease Control and Prevention and should not be construed to represent any agency determination or policy