

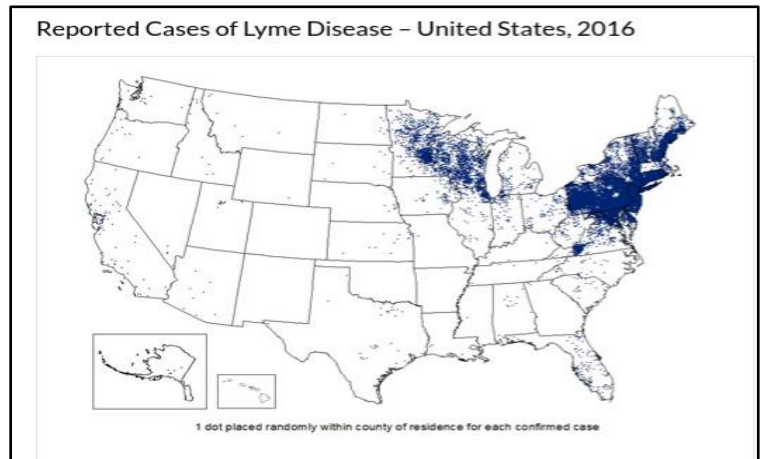


### Level 3: Lyme Disease Prevalence in the Northeast United States

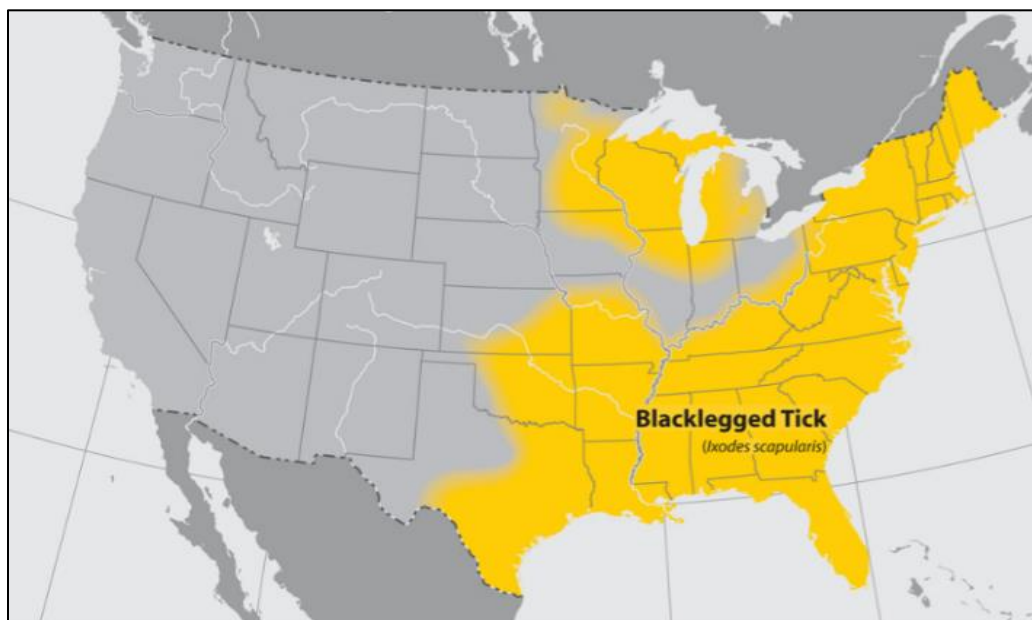
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#### ❖ **Background Information:**

Since the early 1980s, Lyme disease has been a growing concern for residents of the Northeastern United States. The Center for Disease Control now estimates that as many as 300,000 Americans are diagnosed annually with Lyme disease, which causes fever, exhaustion, joint pain/stiffness, headaches, forgetfulness, facial paralysis and more (CDC 2015). It is the number one tick transmitted disease within the country and the sixth most common reported notifiable disease annually. One third of the reported cases of Lyme occur within New York State.



The black-legged tick (*Ixodes scapularis*) is the primary vector of the bacterium that causes Lyme disease, which is called *Borrelia burgdorferi*. In the northeast United States, black legged ticks that transmit Lyme disease are increasing their range and thus increasing the likelihood of spreading the disease. Most humans are infected through the bites of immature ticks called nymphs. Nymphs are tiny (less than 2 mm) and difficult to see; they feed during the



spring and summer months. Adult ticks can also transmit Lyme disease bacteria, but they are much larger and are more likely to be discovered and removed before they have had time to transmit the bacteria.

Figure 2: Black legged tick range within the United States

## Symptoms of Lyme Disease

Several symptoms may result from infection with Lyme. These may include the following depending on the stage of infection.

Early symptoms (3 to 30 days after infection):

- Nausea, fever, chills, headache, fatigue, muscle and joint aches, swollen lymph nodes.
- Erythema Migrans (EM) rash: Occurs in 70 to 80 percent of infected people. Rash expands to a size of around 30 cm diameter between 3 and 30 days after initial bite. Rash tends to have a classic “bullseye” appearance.

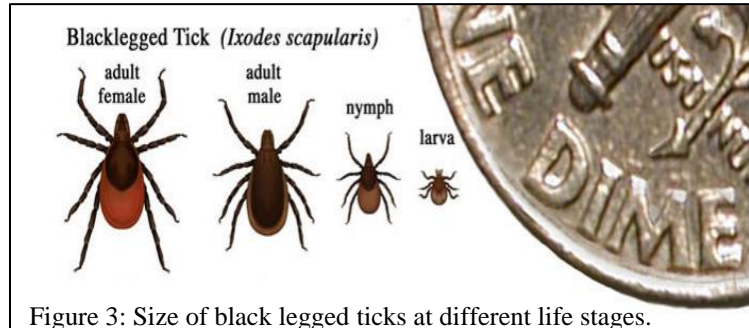


Figure 3: Size of black legged ticks at different life stages.

Late symptoms (days to months after infection):

- Neck stiffness, arthritis associated with joint swelling and stiffness, facial palsy.
- Problems with short term memory, other nervous system problems.



Figure 4: Classic Erythema Migrans “bullseye” rash.

## Diagnosis and Testing

The CDC recommends a two-step testing process to diagnose individuals that have been bitten by a tick and/or present the above symptoms. Positive results of blood tests involving Enzyme Immunoassay, followed by IgM Western Blots are used to confirm Lyme infections and are reported to the CDC.

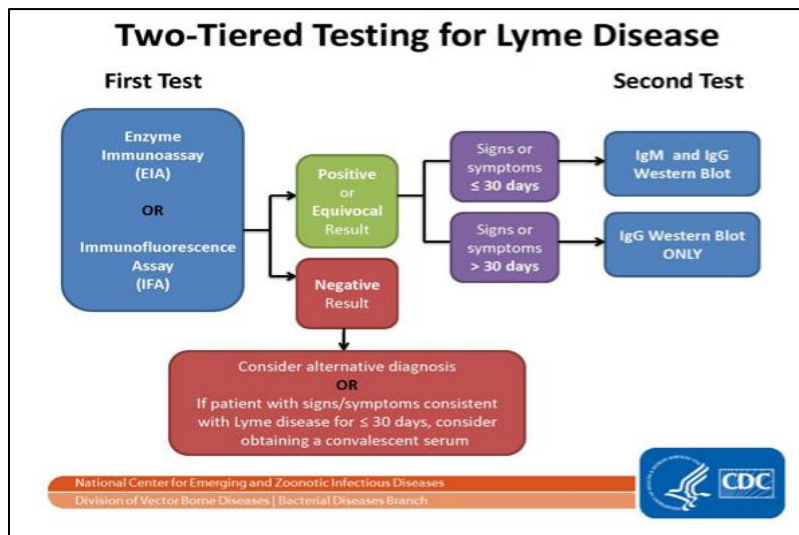


Figure 5: Two-step testing process for Lyme disease.

## Lyme Disease and the CDC

Lyme disease has been a nationally notifiable condition within the United States since 1991. Reports of Lyme disease are collected and verified by state and local health departments in accordance with their legal mandate and surveillance practices. Reportable cases of Lyme are shared with CDC through the [National Notifiable Diseases Surveillance System \(NNDSS\)](#).



The NNDSS helps the United States public health system monitor, control and prevent 120 diseases nationwide. The CDC has compiled a dataset of reported Lyme disease infection rates to help facilitate scientists investigating of the prevalence and spread of the disease over time.

❖ **Dataset Variables:**

**State Averages Sheet**

- State: State in the Northeast where Lyme disease was reported (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont)
- Yearly average cases/county (2000-2016): the average number of cases per county for each state in each year. County averages are used to allow for comparison between states of different sizes and populations.
- State total: average cases per county for each state over all years
- Total average cases/county: the average cases per county in each year of all the counties in the Northeast states
- Total reported cases: total number of cases in each year for all the Northeast states

**Individual State Sheets**

- State: focal state in the Northeast (New York, Connecticut, Massachusetts, New Jersey, Pennsylvania)
- County: name of individual county where Lyme disease was reported within the state
- Lyme disease cases reported by year (2000-2016): cases reported in the county in each year
- Average: average cases reported in the county over all years
- <State Name> Total: average cases per county in each year for the focal state (this is the same data as presented in the State Averages sheet)

❖ **Dataset Timeframe:**

- This dataset provides the number of reported cases of Lyme within the Northeast United States by county over the years of 2000-2016. [Link county maps of the United States](#)

❖ **Data Collection Methods**

Clinically, the best marker of contracting Lyme is the erythema migrans (EM) rash occurring in approximately 70% of patients. The data compiled by the CDC spanning years 2000-2008 used “confirmed” Lyme cases, which included presentation of rash combined with the following laboratory evidence of infection criteria:

- Isolation of *Borrelia burgdorferi* from a clinical specimen, **OR**
- Demonstration of diagnostic immunoglobulin M or immunoglobulin G antibodies to *B. burgdorferi* in serum or cerebrospinal fluid (CSF). A two-test approach using a sensitive



enzyme immunoassay or immunofluorescence antibody followed by Western blot was recommended.

Data from 2008 to 2016 allowed reporting of “confirmed” and “probable” cases. Probable case classification permits inclusion of cases where the physician suspects Lyme because the following criteria are met:

- A case of EM where there is no known exposure (as defined below) and no laboratory evidence of infection (see above), **OR**
- A case with laboratory evidence of infection but no clinical information available (e.g. a laboratory report).

Exposure is defined as having been in wooded, brushy, or grassy areas (potential tick habitats) within 30 days before the onset of EM in a county in which Lyme disease is found. A confirmed tick bite is not required.

❖ **Source of Dataset:** Center for Disease Control (<https://www.cdc.gov/lyme/stats/index.html>)

❖ **Inquiry Idea Starters:**

*Here are some sample questions you could ask using these data. These are just suggestions, and we hope you’ll come up with many interesting questions of your own!*

- Has the prevalence of Lyme disease changed since 2000 in the Northeast?
- Do states differ in their prevalence of Lyme disease, or in the pattern of Lyme disease cases over time?
- In Dutchess County, NY, how has the prevalence of Lyme disease changed over time? How does this compare with the rest of New York?

❖ **Additional Resources:**

- **Independent student inquiry:**  
Clickable state map of LD, from 1990 - 2016  
[https://www.lymediseaseassociation.org/LDA\\_Apps/content/Maps/index.html#](https://www.lymediseaseassociation.org/LDA_Apps/content/Maps/index.html#)
- **CDC Lyme disease cartoon:**  
[www.cdc.gov/lyme/resources/toolkit/DontletTicksbitemeComicFS\\_508.pdf](http://www.cdc.gov/lyme/resources/toolkit/DontletTicksbitemeComicFS_508.pdf)

**Cary Institute resources:**

- [The Tick Project](http://www.tickproject.org) : project website [www.tickproject.org](http://www.tickproject.org)
- Hudson Data Jam data set “Lyme Disease Connections”:  
[www.caryinstitute.org/students/hudson-data-jam-competition/data-jam-data-sets/level-3-black-legged-ticks-cary-institute](http://www.caryinstitute.org/students/hudson-data-jam-competition/data-jam-data-sets/level-3-black-legged-ticks-cary-institute)

**Articles:**

- [Forest Ecology Shapes Lyme disease risk in the eastern US](#)
- The Citizen Scientist: [Lyme Disease](#)
- The New York Times: [Lyme disease worst enemy? It might be foxes.](#)



- The New York Times: [With a tick boom it's not just Lyme disease you have to fear.](#)  
**Center for Disease Control**
- Lyme disease frequently asked questions: <https://www.cdc.gov/lyme/faq/index.html>

**Extensions:**

**Additional Data sets:** Instructors may choose to extend data analysis with students and incorporate additional data sets into lesson. In addition to the Cary Institute Data Jam Dataset mentioned in the above section, the following data set contains information regarding black-legged tick nymph counts, density, and bacterial strain infection rates across New York State by county for years 2008 - 2017: [health.data.ny.gov/Health/Deer-Tick-Surveillance-Nymphs-May-to-Sept-excludin/kibp-u2ip/data](http://health.data.ny.gov/Health/Deer-Tick-Surveillance-Nymphs-May-to-Sept-excludin/kibp-u2ip/data) (NY.gov :Deer Tick Surveillance: Nymphs (May to Sept) excluding Powassan virus: Beginning 2008 )

**Reference:**

- 1 Centers for Disease Control and Prevention. Recommendations for test performance and interpretation from the Second National Conference on Serologic Diagnosis of Lyme Disease. *MMWR Morb Mortal Wkly Rep* 1995; 44:590–1.
- 2 Center for Disease Control and Prevention. <https://www.cdc.gov/lyme/index.html>