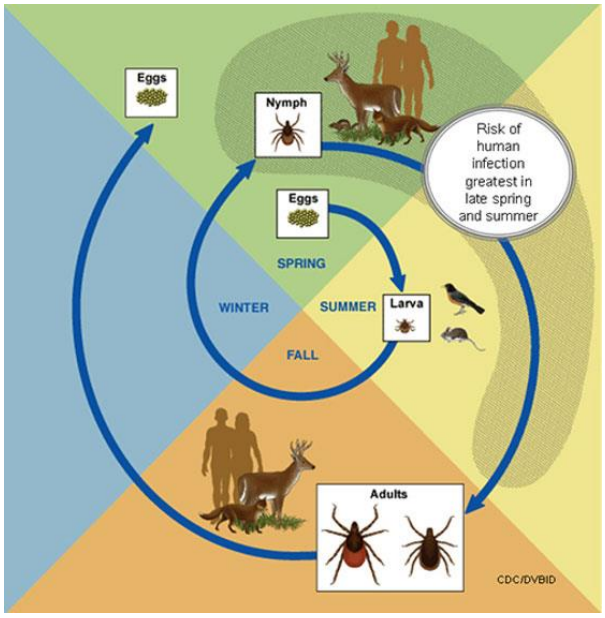
Ticks, Global Warming; Is There a Correlation?

"Careful of the grass, there may be ticks!" A phrase all of us have heard before as kids as we've explored nature and all of its critters and life. For many, ticks are an insect that we know can cause disease, but that tends to be the extent of our knowledge. For some, ticks may have become the reason as to why their lives have been altered forever. In any case, ticks are a species that have become a more prevalent topic in more recent years, and many scientists believe this to be the case because of the changing climates. Or, in other words, the warming conditions of certain environments around the US and the world. However, in this article, the main location of tick populations that will be discussed is the United States. Before we dive into the correlation of climate change and tick growth rates, let's start off with some background on the tick as well as Lyme Disease, the common disease that may be contracted from a tick bite (CDC).

Ticks are blood-feeding parasites, in which there are two main types: Ixodidae (hard ticks) and Argasidae (soft ticks). Hard ticks lay about 1,000 to 10,000 ticks each time, and have the ability to transmit Lyme Disease, because as they burrow their mouthparts into the skin, they inject saliva into an organism's bloodstream. Soft ticks have a similar rate of laying eggs, however they have the ability to spread a different disease known as Tick-borne Relapsing Fever (TBRF) which causes recurring fevers with headaches as well as body aches. TBRF cases are mainly found around mountains with higher altitudes. The popular time for TBRF to be caught by humans is from summer-time into September. TBRF will not be as heavily focused on, and the rest of this paper will focus on Lyme Disease and hard ticks.

Lyme Disease is contracted from hard ticks infected with the bacteria *Borrelia burgdorferi.* This vector-borne disease, a disease that is contracted from a blood-feeding

organism, is transmitted via a blacklegged tick biting the skin of a human. According to the CDC, nymph ticks (the stage before adult ticks) are common during the months of April through July. Nymph ticks are smaller in size compared to adult ticks, and are therefore more difficult to detect. In fact, many humans who are bitten by a nymph tick are unaware of this, allowing the bacteria from the possibly-infected tick to infect the human's blood. So, how do ticks become infected with this bacteria in the first place? Research has shown that these ticks are typically infected when feeding on other wildlife, usually rodents. However, Lyme Disease can be avoided by promptly removing ticks from the skin. The longer they are left on the skin, there is a greater chance of becoming infected.



If someone were to become infected with a lyme disease-carrying tick, what would these symptoms look like? From the 3rd to 30th day after the tick bit, a rash known as *Erythema migrans rash* will appear. The rash tends to look like a ring of irritation surrounding a red center of irritated skin and is often referred to as a "bulls eye" rash. Later on, many days and possibly months after the untreated bite, symptoms such as swollen knees and/or Facial Palsy may occur. However, Lyme Disease can be assessed in a multitude of ways: signs and symptoms are recorded, environmental/geographic history is needed, other possible illnesses are taken into account with similar symptoms, and lab testing occurs. The lab testing consists of a two-step blood test. These tests are designed to detect antibodies to the bacteria. Sometimes, patients in the early stages of infection may not show signs of these antibodies yet. Finally, there is always

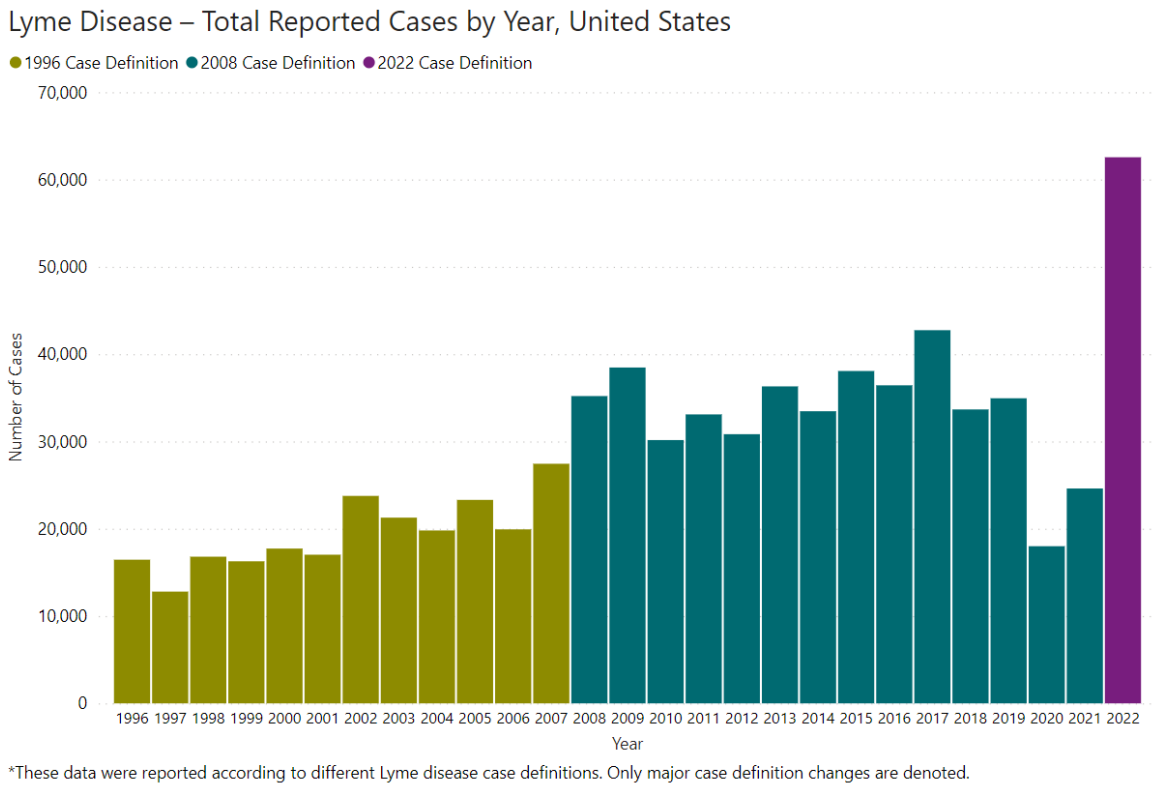
the possibility of a false positive result, in which the patient has a similar disease with different antibodies.

Lyme Disease is treatable, if diagnosed early. People who notice they have been bit early on can take oral antibiotic treatment from their doctor that should help to fight off the disease. However, there is a 10% chance that people who have been treated are diagnosed with Post Treatment Lyme Disease Syndrome. This is when symptoms last longer than 6 months, and unfortunately the reason for this is largely unknown by scientists. However, some scientists believe it is an auto-immune response to the bacteria their bodies are trying to fight off. There has been no proven treatment for this syndrome; oral antibiotic treatment has taken away the infection, yet symptoms of fatigue, pain, and possibly cognitive impairment linger.

Ticks may seem to many like a distant problem that has no reason to become a priority when going camping, or simply running up a grassy hill. However, there has started to become an increasing amount of research on the effects of climate change and the population density of ticks. This article will review evidence from mainly the US to showcase certain aspects of climate change as probable reasons as to why there is a steady increase in the population rates of ticks in the US. To begin, an important aspect of climate change is global warming, or the slight warming of the globe each year due to an increase in greenhouse gasses. These greenhouse gasses reflect light back into the surface of the planet which ultimately leads to higher temperatures. These higher temperatures tend to make more areas hospitable for vector-borne disease to percolate. This is because ticks prefer a warmer climate to live and raise their eggs. Typically, it takes ticks many years in order for their population to grow. However, increasing

temperatures shortens maturation time of ticks, allowing these tick populations to grow much quicker than before. Additionally, warmer winters allow more ticks to live through this season, increasing their life span and possibly their population's lifespan. A comparison to note is that mosquitos, which produce another vector-borne disease known as malaria, are much more responsive to changes in temperature. They are defined as r-selected species, or species in which their maturation stage is extremely short, and their offspring are produced in large numbers. Ticks, on the other hand, take more time to reach maturation, which are defined as k-selected species. However, ticks could become more r-selected if their maturation is shortened due to the increasing temperatures from global warming.

The CDC has provided statistics that the number of cases of Lyme Disease from the year 1992 to 2021 has steadily increased over time. In 1992, there were roughly 10,000 total cases of Lyme Disease. In 2019, it was estimated that around 35,000 people had been infected with this disease, and up until the Covid virus, cases were increasing each year and almost reaching 40,000 cases per year. In 2021, it was estimated that the total number of cases was somewhere around 25,000. It is important to keep in mind that this was during the peak of the Covid-19 pandemic, so it would make sense that in 2021, there were not as many cases as the years prior.



Tick populations tend to be the greatest in New England, the mid-Atlantic states and the upper Midwest. Mid-Atlantic coasts are perfect homes for ticks, due to the soil moisture and humidity of the air. With rising temperatures, sea levels are likely to rise on the coasts, changing the soil moisture levels and humidity, which may make coasts even more tempting for ticks (Talbot). In addition to this, certain environments in the country and around the world may see a decrease in their tick populations as temperatures increase due to droughts, causing humidity and soil moisture to decrease drastically. This idea is hinting at a potential outcome for the populations of ticks that are no longer able to survive in the dry conditions: genetic drift. Due to the natural disasters such as droughts, populations are killed until only a small amount of the population is left. This is known as the bottleneck effect, which decreases the amount of alleles present in the gene pool, making the ticks more susceptible to changes in their environment from there on out.

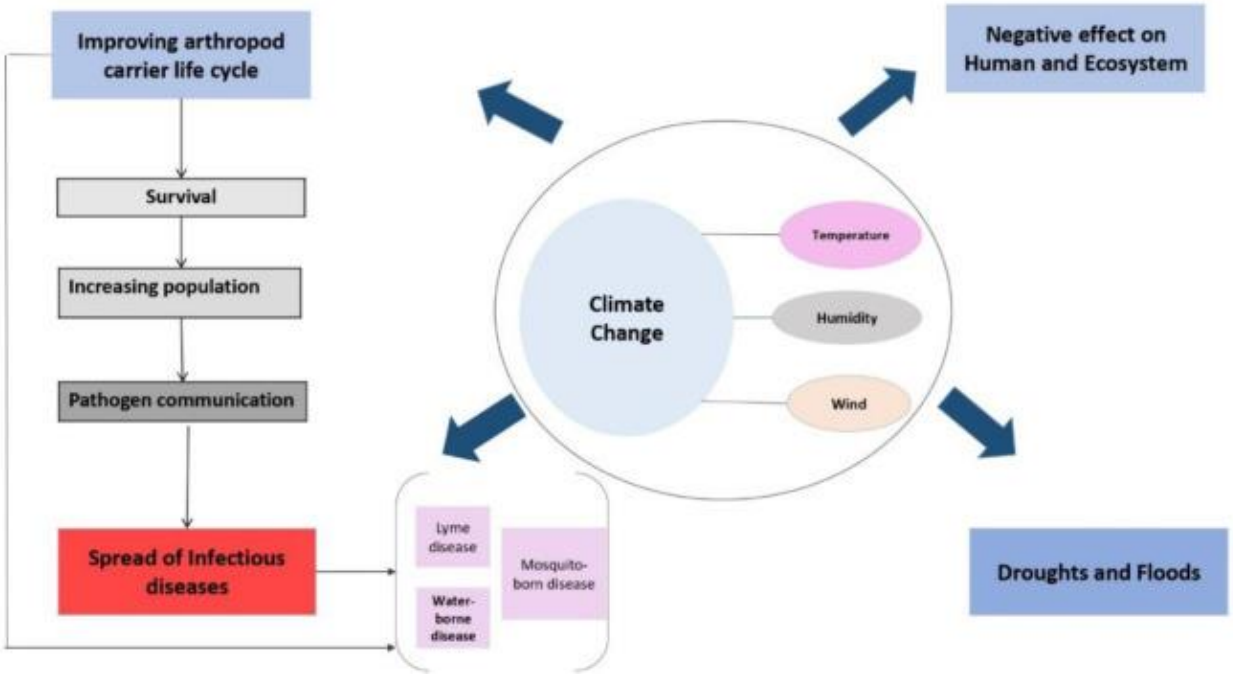
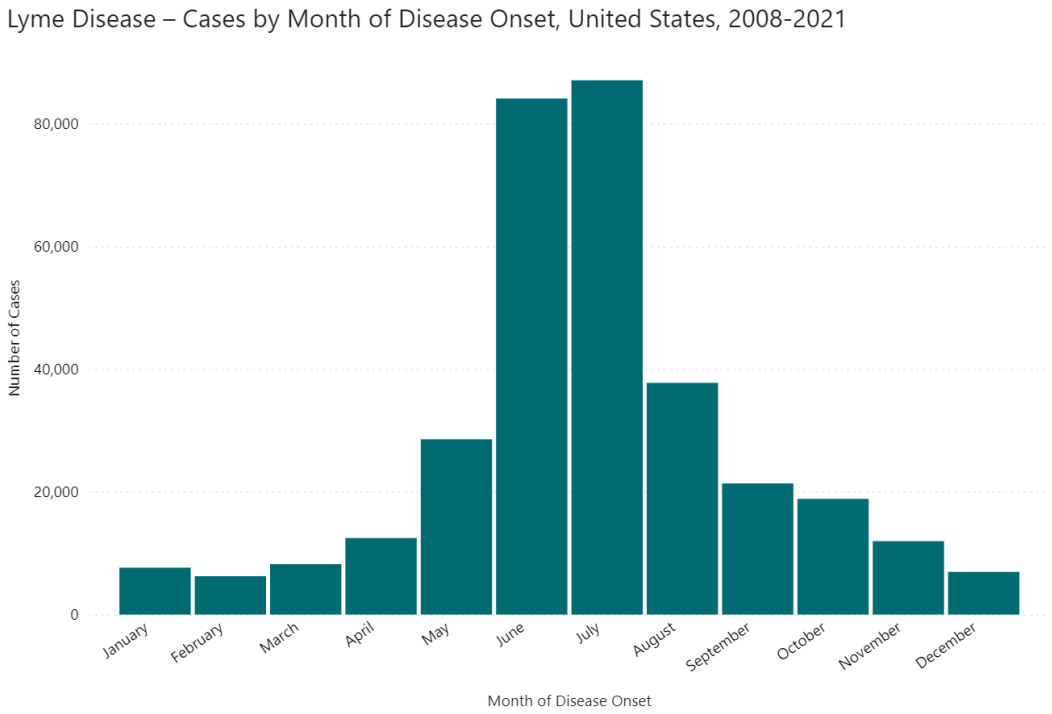


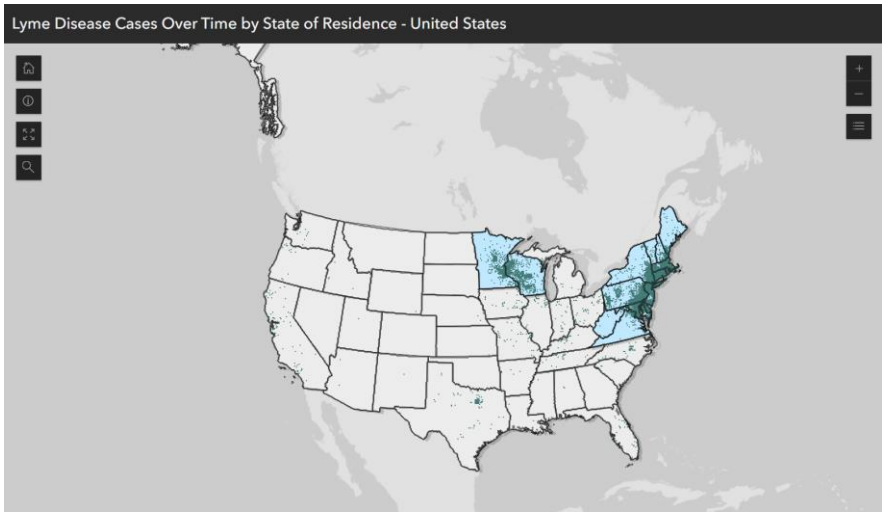
Diagram from The Washington State Pest Management Association

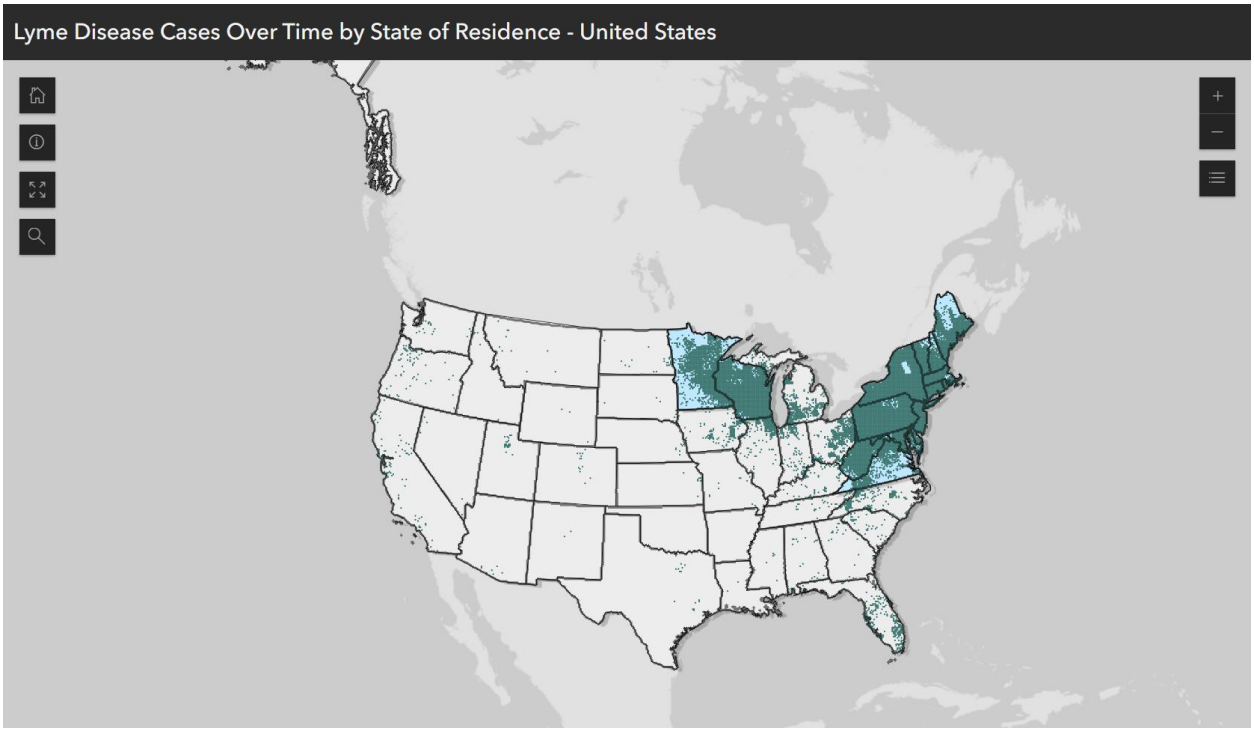
Henceforth, as this model depicts, an increase in temperature leads to greater humidity and wind, which can increase the likelihood of floods and droughts. This change in climate also has negative impacts on human health as well as the many organisms occupying those environments too. Parasitic disease limits one's socioeconomic status in society, especially in the tropics and subtropics areas in the world. Those affected by these diseases are forced to change their lives and if not treated, become too sick to attend their professions and take part in their day-to-day life. This shows just one way that human ecosystems are impacted, not just physically but also socially. It is also important to note that climate change is not the only impact on tick distribution. Along with climate change, habitat destruction, land use, pesticide application, and the host density also impact tick populations. Hard ticks are also not the only creature that spreads these vector-borne diseases, fleas, mites, mosquitos, and lice do so as well.

Some final graphs to include that allude to a connection between warming environments and tick population density:



During the months of June and July, the collective (from all years combined) number of cases was around 80,000 from 2008 to 2021 in the US alone. These months encompass the season of summer, which should be noted. These warmer conditions, as stated before, are more hospitable for ticks to produce offspring.





The first map was developed in 2001, and shows the cases of Lyme Disease on the US map. The map below that one is from 2021. This comparison between the two shows a significant increase in cases from 2001 to 2021 along the East Coast/Mid-Atlantic and Wisconsin, Michigan, and Minnesota. “It is expected that the increase in the number of ticks is due to the fact that winters are generally much warmer than previous years” (NCBI). As argued earlier, many researchers and data has been drawn to support the idea that global warming and climate change in general has led to a vast increase in tick populations, meaning Lyme Disease cases are bound to increase over time.

In summary, ticks are a vector species that have the ability to transmit infectious diseases such as Lyme Disease. Lyme Disease, if untreated, can lead to serious health risks for humans, including Facial Palsy, swollen joints, etc. Lyme Disease can be treated, however, if found early and taken care of in a professional setting. Lyme Disease cases have been increasing over the past years, and many researchers believe this is because of the warming environments around the

world from climate change. One aspect of climate change is global warming, which has led to droughts, flooding from rising sea levels, and other natural disasters. These natural disasters have made certain environments for ticks more or less hospitable. In many states within the Mid-Atlantic region, the impact from increased soil moisture and humidity has led to a drastic rise in tick populations from the early 2000s to the present. This is because ticks need warm temperatures to raise their eggs, and the moisture and humidity from the soil and air add to the perfect conditions to raise their babies. In other locations such as states in the midwest, their environments are suffering from droughts. These droughts have led to many ticks unable to live or produce offspring due to the dry conditions. Even though the temperatures are warm, which is what ticks need, the extremity of the dry air has led those environments to become inhospitable. Nevertheless, as temperatures continue to rise, winters will become warmer meaning ticks will be able to mature in a shorter amount of time. This has already helped populations of ticks, since they will not need as much time in their lifespan to mature and continue their cycle of a tick. While science has become increasingly well versed on the topic of Lyme Disease, and doctors can offer remedies to fight the bacterias, it's crucial to understand that there is still a much greater chance than ever before of contracting a vector-borne disease. This is due to the fact that tick population densities are becoming more present in warming environments than ever before.

References

Centers for Disease Control and Prevention. (n.d.-a). *Treatment and intervention for lyme disease*. Centers for Disease Control and Prevention. http://www.cdc.gov/lyme/treatment/index.html

Centers for Disease Control and Prevention. (n.d.-b). *Where ticks live*. Centers for Disease Control and Prevention. https://www.cdc.gov/ticks/about/where-ticks-live.html

Edelson, P. J., Harold, R., Ackelsberg, J., Duchin, J. S., Lawrence, S. J., Manabe, Y. C., Zahn, M., & LaRocque, R. C. (2022, September 1). *Climate change and the epidemiology of infectious diseases in the United States*. OUP Academic. https://doi.org/10.1093/cid/ciac697

Environmental Protection Agency. (2021, April). *Climate Change Indicators: Lyme Disease*. EPA. http://www.epa.gov/climate-indicators/climate-change-indicators-lyme-disease

Gabriele-Rivet, V., Arsenault, J., Badcock, J., Cheng, A., Edsall, J., Goltz, J., Kennedy, J., Lindsay, L. R., Pelcat, Y., & Ogden, N. H. (n.d.). *Different ecological niches for ticks of public health significance in Canada*. PLOS ONE. https://doi.org/10.1371/journal.pone.0131282

Journal, B., & says, A. M. G. (2015, July 1). *Mid-Atlantic becomes tick central as species from north, South Converge - Talbot Spy*. The Talbot Spy. https://talbotspy.org/mid-atlantic-becomes-tick-central-as-species-from-north-south-converge/

Khan Academy. (n.d.). *Genetic drift (article) | natural selection*. Khan Academy. http://www.khanacademy.org/science/ap-biology/natural-selection/population-genetics/a/genetic-drift-founder-bottleneck#:~:text=Genetic%20drift%20can%20have%20major,a%20colony%20(founder%20effect)

Wilke Cohen Lyme Disease Project. Institute for Systems Biology. (2019, November 26). https://isbscience.org/lyme/