No Time for Lyme: Public Health Approaches to Lyme Disease in Vermont

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No Time for Lyme: Public Health Approaches to Lyme Disease in Vermont

A Senior Honors Thesis
by
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A Bachelor of Arts in the Individually Designed Major in
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Abstract

In this thesis I examined past, present and future public health approaches to Lyme disease in Vermont to identify ways in which the state can improve prevention. Within these research questions, areas of inquiry focused on education and awareness, preventative strategies, diagnosis and treatment of Lyme disease. This topic is highly significant because the number of cases of Lyme disease has been increasing considerably in the past ten years throughout Vermont, and many experts believe there is a serious potential for the number of cases to continue to increase in the future. If undiagnosed and/or not promptly treated, Lyme disease can lead to serious health complications.

In undertaking this research, scholarly literature on Lyme disease prevention at the state and national level was reviewed. Next, grey literature on the Vermont Department of Health website was compared with the CDC website and the website of other surrounding states with a high prevalence of Lyme disease. Finally, eight interviews were conducted with experts in the field of public health and medicine, including one clinical Lyme disease specialist. Information from all of these sources was compared for similarities and differences to see how Vermont fares against national standards for Lyme disease prevention, as well as the best practices of other states.

In my research, I found that there was a large degree of consonance between the scholarly literature, the CDC website, other states’ websites and the Vermont Department of Health website, as well as the responses of my interviewees. Interviewees as well as scholarly and grey literature agreed that education and awareness should be at the forefront of any public health campaign against Lyme disease. The one small difference between the scholarly literature and the Vermont website and the interview responses was that the scholarly literature stressed the importance of educating the public not only on preventative behaviors, but persuasively educating them on the relevant efficacy of those preventative behaviors. In comparing the CDC website and Vermont’s, the CDC website offers information on post-treatment Lyme disease, in addition to the diagnostic, treatment and prevention information also available on the Vermont Department of Health website. In comparing with the websites of other states, the Vermont Department of Health site has a more well designed, “user friendly” appearance, yet their educational resources are limited in comparison with those available on Connecticut’s. No state’s health website in regards to Lyme disease excels in all areas of educational resources, aesthetics, and usability. According to my interviewees, one of the main problems in Vermont is that there is an overall low level of awareness of Lyme disease compared with surrounding states affected by Lyme disease. In part, this is because Lyme disease came to Vermont later than in surrounding states. In comparing interview responses with the scholarly literature, both agreed that efforts to prevent Lyme disease shouldn’t focus on human vaccination, host removal, or tick surveillance. For the most part, mirroring the scholarly literature, interviewees agreed that human vaccination, tick surveillance, and host removal were not viable or feasible options for Lyme disease prevention in Vermont. However, targeting large mammals with bait boxes, landscape management and disease surveillance were viewed by the interviewees as important secondary techniques to be used in conjunction with public education. Beyond that, my
research shows that, increasing education amongst at-risk groups as well as among political
and medical communities, addressing budgetary constraints by increasing collaboration
amongst state and governmental organizations and increasing electronic communication
could all help to improve Lyme disease prevention in Vermont. The need remains to find an
evaluation tool to examine what educational tools are currently working, and what
demographics are using which news outlets in order to prioritize our educational tools and
public service announcements to be fiscally effective. Furthermore, within the above
mentioned secondary techniques, I argue that consideration should be given to using natural
alternatives to synthetic acaricides and reducing certain invasive species.

According to my interviewees and comparing with best practices recommended in the
scholarly literature and by the CDC, overall Vermont is currently doing a reasonably
effective job at marshaling sound Lyme disease public health prevention measures. Vermont
offers educational resources on their department of health website, as well as preventative
behavioral strategies. Vermont is also implementing sound landscape management best
practices to reduce tick habitat, and is meeting basic Lyme disease case reporting standards.
However, by increasing education and awareness, further targeting at-risk groups, using bait
boxes for large mammals, reducing invasive species, improving diagnostics and treatment
options for those infected with Lyme disease, and increasing education and awareness
amongst political and medical communities, Vermont can better prevent cases of Lyme
disease from increasing throughout the state in the coming years.
# Table of Contents

1. **Introduction**
   - Project Description
   - Historical Impact of Lyme Disease in Vermont
   - Significance
   - Research Questions
   - Original Hypothesis
   - Thesis Statement

2. **Background: Lyme Disease Basics**
   - Pathogen and Transmission
   - Tick Habitat
   - Symptoms of Lyme Disease
   - Diagnosis and Testing
   - Treatment of Lyme Disease
   - Conclusion
   - Organization of Thesis

3. **Methodology**
   - Scholarly and Grey Literature Search Methods
   - Research Subjects and Field Sites
   - Interview Questions
   - Protection of Human Subjects
   - Analysis of Data
   - Dissemination of Results

4. **Prevention Through Education and Awareness: A Starting Point**
   - Significance
   - Results of My Research
   - Baseline Public Awareness of Lyme Disease in Vermont
   - Scholarly and Professional Assessment of the Need for Education
   - Current Educational Tools and Preventative Strategies of Vermont
   - Discussion: Comparison with Surrounding States
   - Challenges to Education and Awareness
   - Conclusion

5. **Prevention By Targeting At-Risk Groups: Age, Occupation, and Behavior**
   - Identifying At-Risk Groups
Discussion: How the Vermont Department of Health Reaches the Public and How to Improve Their Strategy
Conclusion

   Significance
   History of the Lyme Disease Vaccine
   Concerns Surrounding the Vaccine
   Results of My Research
   Study Participant Views on the Human Vaccine for Lyme Disease
   Discussion and Conclusion

7. Prevention by Targeting Host Populations: An Innovative New Idea
   Targeting Large Mammals: Four Poster Bait Boxes
   Targeting Small Mammals: Bait Boxes
   Host Removal
   Discussion and Conclusion

   Safety of and Alternatives to Synthetic Acaricides
   Efficacy and Risks Associated with DEET as Well as Alternatives
   Landscape Management
     Landscape Management Practices of Vermont
   Surveillance
   Discussion and Conclusion

9. How Vermont Can Better Help Those Infected with Lyme Disease
   Significance
   Post-treatment Lyme Disease Syndrome
   Results of My Research
   Legislative Applications
   Physician Awareness and Post-treatment Lyme Disease Syndrome
   Discussion and Conclusion

10. Conclusion
    Summary of Results
    Implications
      Scholarly Implications
      Practical and Social Implications
    Limitations of the Study
    Areas for Further Research
    Recommendations
    Concluding Note

References
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I would like to thank Professor Jeanne Shea, and all of the interview participants for allowing me to conduct this community based research project. I am grateful to Jeanne Shea for helping me to design this research project and for guiding me through the research process. I have gained critical knowledge about the research process, including both its challenges and its potential benefits. By partnering with the interview participants, I was able to learn about the continued issue of Lyme disease in Vermont, what the state is doing to address this disease, and what the future of prevention and treatment looks like. I hope that my findings will be useful to the Vermont Department of Health as they continue working to improve their approach to the prevention and treatment of Lyme disease throughout the state.
1. Introduction

Project Description

This thesis is an investigation of the emergence and re-emergence of Lyme disease in Vermont. The research questions focus on what has Vermont done in the past, what is Vermont currently doing, and what can Vermont do differently in terms of education, awareness, preventative strategies, diagnostics, and treatment strategies to better prevent cases of Lyme disease. It will examine the efficacy of preventative strategies, educational resources, and treatments for Lyme diseases in Vermont. Attention will be given to what preventative strategies, educational resources, and treatments contribute to the prevention, reduction, and control of Lyme disease. By examining the efficacy of preventative strategies, educational resources and treatment options, changes may be made to improve public health interventions in Vermont and slow the spread of Lyme disease. For instance, alternative, culturally appropriate interventions may be added, or amended to stop or slow the spread of Lyme disease. Through ethnographic research, interviews with officials at the Vermont Department of Health, as well as with experts at the University of Vermont, Middlebury College, and clinicians, I aim to understand how Lyme disease is being spread in Vermont, what kinds of prevention techniques are currently being practiced, and how we can better slow and prevent the spread of this disease in Vermont.

Historical Impact of Lyme disease in Vermont

Lyme Disease first appeared on the scene in 1975 when children began to fall ill with unusual cases of rheumatoid arthritis in Lyme, Connecticut and two neighboring towns. Researchers looked into contamination in the water supply, air, or other pathogenic causes. Many of the children reported living or playing near wooded areas, and so the researchers began to
look at deer and ticks as possible causes of the phenomena. The majority of children fell ill in the peak summer months, and many reported a skin rash as well as having a tick bite. Researchers began to describe this new disease as Lyme disease. It wasn’t until 1981 that researchers Alan Barbour and Dr. Burgdorfer at the National Institute of Allergy and Infectious Diseases, studying the spirochete bacteria were able to connect the spiral shaped bacteria with both the rash (erythema migrans) and Lyme disease. The spirochete was named Borrelia Burgdorferi in honor of Dr. Burgdorfer (National Institute of Allergy and Infectious Diseases).

Since 1975, Lyme disease has become the most commonly reported vector-born disease in the US with the greatest prevalence occurring in the Northeast and Upper Midwest. Before 2005, only a small number of cases of Lyme disease were reported to the Vermont Department of Health (VDH) annually. Since then, the number of cases has been on the rise. According to the Vermont Department of Health, the number of cases has increased from 50 cases in 2004 to 890 in 2013. Figure 1 shows the incidence of Lyme disease in 2013 for Vermont as well as the confirmed vs. probable cases. The figure shows that the vast majority of cases occurring in Vermont are in state. The increase in cases could be due to actual increasing prevalence of disease, increase in surveillance and reporting, or both. Additionally, it is difficult to compare rates of Lyme disease with other states, as we may not use the same surveillance or reporting methods. This could mean that states with higher numbers of reported cases could have more awareness and reporting of Lyme disease. Any case of Lyme disease, either confirmed or probable is reported to the Vermont Department of Health by either a lab or a physician, as it is mandated under state law. It is important to note that Lyme disease surveillance systems can be inexact because of disease under-reporting and misclassification. Not every case gets reported to the state and some cases that are reported could be due to another cause. Not surprisingly, 80%
of cases in 2013 were reported to the Vermont Department of Health between June and September, corresponding to peak nymph activity, which I will discuss in the following section (Vermont Department of Health).

Figure 2 shows that there has been a huge increase in the number of cases reported in Vermont between 2005 and 2011. In addition, this figure highlights the fact that the majority of cases have indigenous roots to Vermont.

Finally, Figure 3 shows that the majority of cases are occurring among Vermonters between the ages of 0-19 and 50-69. This is an interesting point, as we will look at demographics as an area for preventative strategies in later chapters (Lyme Disease Surveillance Report 2011).

Figure 1. This image was taken directly from the Vermont Department of Health Website (2013)
Figure 2. This image was taken from the Lyme Disease Surveillance Report for 2011, provided by the Vermont Department of Health (2011)

Figure 3. Confirmed cases of Lyme disease by age and gender, Vermont, 2013

Figure 3. This image was taken from the Lyme Disease Surveillance Report for 2013, as provided by the Vermont Department of Health (2013)
Significance

This thesis aims to contribute to the public health literature on Lyme disease by focusing on the little-studied state of Vermont and by drawing in scholarship on Lyme disease from other disciplines, such as medical anthropology, medical sociology, social psychology of health, epidemiology, public health policy, and zoonotics in animal health science. Drawing together the scholarly and grey literature from a number of disciplines will help us to better understand what interventions and educational tools are being used to prevent transmission of Lyme disease and to learn what further could be done to further decrease probability of transmission in Vermont.

Expansion around the world has led to an increase in zoonotic diseases, or infectious diseases that spread from animals to humans, like Lyme disease. We are a technologically driven society in a globalized world in which one can travel to another country in a number of hours. The increase in ease of transportation has also led to the increased spread of diseases around the world. Therefore, it is more important than ever to examine how and why infectious diseases are endemic, emerging, and reemerging in the United States.

Lyme disease, an endemic zoonotic disease throughout the US is no exception to the rule and is increasing in prevalence in states throughout the US. Lyme disease, first discovered in Lyme, Connecticut has spread throughout the US and has a significant impact on the Northeastern States, especially in Vermont. Cases of Lyme disease were rare in the beginning and started increasing in prevalence within the past 15 years. Cases have risen from 60 in 2003 to 890 cases in 2013 (671 confirmed, 219 probable) (CDC 2015). In 2011 Vermont had the second highest incidence of Lyme disease in the U.S. with 75% of cases originating in state. Such a staggering increase has public health officials searching for answers as to how to better protect
Vermonters against this endemic disease. I will thus examine the preventative strategies, educational resources, and treatments available to determine how to better stop or slow the spread of Lyme disease in Vermont. I have chosen to look at Vermont as a case study as Lyme disease is endemic to Vermont and surrounding states. This research project will therefore examine how Vermont can improve public health efforts to stop the spread of Lyme disease. My research ultimately seeks to find existing best practices, as well as new solutions and educational tools that will allow the state of Vermont to better address the problem of transmission of Lyme disease. Communicating to the lay educated public about a science-heavy topic can often be challenging and may alienate certain sectors of the population from receiving and comprehending available data and information. I therefore examined the Vermont Department of Health website in detail, looking at aesthetics, usability, and available resources to determine how they can improve their website to more effectively communicate with the lay educated public.

It is also worth noting the significant role that climate change may have on the prevalence of Lyme disease throughout the state of Vermont, as well as throughout the country and surrounding areas. Although this is not a topic I explore in depth in my thesis, it is worth mentioning due to the serious impact changing temperatures can have on the impact and spread of Lyme disease. Both scholarly and grey literature share the view that changing temperatures will expand areas in Northern U.S. that are habitable to I. scapularis ticks.

Scholarly and grey literature examining the relationship between climate change and I. scapularis tick prevalence indicates that changing temperatures will shift populations of ticks Northward throughout the US and into Canada. According to authors Brownstein, Holford, and Fish (2005), there will be a significant movement of ticks into Canada, with increases in suitable
habitats rising by 213% by 2080’s (38). This study also indicated that prevalence of ticks would likely decrease in southern U.S. and increase in the central U.S. The grey literature, obtained from the Natural Resource Defense Council (2009), echoed findings in the scholarly literature, emphasizing that changing temperatures may cause ticks to move northward in the US and increase in prevalence throughout Canada. The movement of tick populations in the future indicates that Lyme disease education and prevention strategies may need to be applied to these new areas.

Overall, the scholarly and grey literature suggest that changing temperatures will shift suitable tick habit northward. According to the literature, climate change will likely cause tick populations to become more prevalent in the northern states of the U.S (Natural Resource Defense Council 2009), as well as in parts of Canada (Brownstein, Holford, and Fish 2005: 38), indicating a need to increase education and prevention strategies for Lyme disease in these areas.

**Research Questions**

My research questions include: what has Vermont done in the past, and what is Vermont currently doing to address Lyme disease in order to stop or slow the spread of this disease, and how can Vermont better prevent cases of Lyme disease? Within both of these questions, I looked at education and awareness, other preventative strategies, diagnoses, and treatment of Lyme disease. The focus of this research paper therefore was to gain a better understanding of past and current preventative strategies as well as identify areas in which Vermont can improve prevention, diagnoses, and treatment of Lyme disease.

**Original Hypothesis**
Prior to conducting research on the topic of Lyme disease in Vermont, it is hypothesized that there are certain at-risk groups, such as hunters and hikers, which are not being targeted with educational resources and awareness training by the Vermont department of health. It is thought that this lack of education and awareness for at-risk groups increases their risk of exposure to Lyme disease. Furthermore, it is believed that increasing surveillance of ticks and manufacturing a human vaccine for Lyme disease would be two ways to better protect Vermonter against this disease. Finally, standardizing diagnostics and treatment courses may serve to better identify and treat those suffering from Lyme disease.

**Thesis Statement**

In my research, I found that there was a large degree of consonance between the scholarly literature, the CDC website, other states’ websites and the Vermont Department of Health website, as well as the responses of my interviewees. Interviewees as well as scholarly and grey literature agreed that education and awareness should be at the forefront of any public health campaign against Lyme disease. The one small difference between the scholarly literature and the Vermont website and the interview responses was that the scholarly literature stressed the importance of educating the public not only on preventative behaviors, but persuasively educating them on the relevant efficacy of those preventative behaviors. In comparing the CDC website and Vermont’s, the CDC website offers information on post-treatment Lyme disease, in addition to the diagnostic, treatment and prevention information also available on the Vermont Department of Health website. In comparing with the websites of other states, the Vermont Department of Health site has a more well designed, “user friendly” appearance, yet their educational resources are limited in comparison with those available on Connecticut’s. No state’s health website in regards to Lyme disease excels in all areas of educational resources, aesthetics,
and usability. According to my interviewees, one of the main problems in Vermont is that there is an overall low level of awareness of Lyme disease compared with surrounding states also affected by Lyme disease. In part, this is because Lyme disease came to Vermont later than in surrounding states. In comparing interview responses with the scholarly literature, both agreed that efforts to prevent Lyme disease shouldn’t focus on human vaccination, host removal, or tick surveillance. For the most part, mirroring the scholarly literature, interviewees agreed that human vaccination, tick surveillance, and host removal were not viable or feasible options for Lyme disease prevention in Vermont. However, targeting large mammals with bait boxes, landscape management and disease surveillance were viewed by the interviewees as important secondary techniques to be used in conjunction with public education. Beyond that, my research shows that, increasing education amongst at-risk groups as well as among political and medical communities, addressing budgetary constraints by increasing collaboration amongst state and governmental organizations and increasing electronic communication could all help to improve Lyme disease prevention in Vermont. The need remains to find an evaluation tool to examine what educational tools are currently working, and what demographics are using which news outlets in order to prioritize our educational tools and public service announcements to be fiscally effective. Furthermore, within the above mentioned secondary techniques, I argue that consideration should be given to using natural alternatives to synthetic acaricides and reducing certain invasive species. According to my interviewees and comparing with best practices recommended in the scholarly literature and by the CDC, overall Vermont is currently doing a reasonably effective job at marshaling sound Lyme disease public health prevention measures. Vermont offers educational resources on their department of health website, as well as preventative behavioral strategies. Vermont is also implementing sound landscape management
best practices to reduce tick habitat, and is meeting basic Lyme disease case reporting standards. However, by increasing education and awareness, further targeting at-risk groups, using bait boxes for large mammals, reducing invasive species, improving diagnostics and treatment options for those infected with Lyme disease, and increasing education and awareness amongst political and medical communities, Vermont can better prevent cases of Lyme disease from increasing throughout the state in the coming years.
2. Background: Lyme Disease Basics

The purpose of this chapter is to give readers background information on Lyme disease and I. Scapularis ticks as they relate to existing and proposed preventative strategies in subsequent chapters. This chapter will focus on the bacteria, or pathogen, that causes Lyme disease, how the disease is transmitted, what types of ticks can carry and transmit the bacteria, as well as characteristics of tick habitat. This chapter will also discuss common signs and symptoms of Lyme disease, the diagnostic and treatment process, as well as discuss the pros and cons of tick testing. The goal of this chapter is to provide readers with necessary background information about the basics of Lyme disease as well as the ticks that transmit this disease as such topics are related to educational strategies focused on preventative behaviors, the Lyme disease vaccine, targeting host populations, landscape management practices, as well as diagnosing and treating cases of Lyme disease. The majority of information in this chapter is taken from the book, *Ecology and Environmental Management of Lyme Disease* by Howard S. Ginsberg (1993), and the CDC (2015). Ginsberg is a research ecologist with a Ph.D. who specializes in vector borne diseases. Although his book was published in 1993, the information I gather from it focuses on areas of Lyme disease that are timeless, such as information about Borrelia burgdorferi structure, and transmission, as well as basic information about tick habitat.

**Pathogen and Transmission**

In order to understand how Lyme disease is spread and how to prevent it, as will be discussed in subsequent chapters, it is critical to understand what type of pathogen causes Lyme disease and how it spreads from host to tick to humans. Lyme disease is caused by the spirochete, or spherical shaped bacteria, called Borrelia burgdorferi (of the genus Borrelia) that is transferred from tick into human upon the bite of a tick (Ginsberg 1993: 11). There are six
genera of spirochete bacteria that cause an array of diseases from Syphilis to Yaws. Spirochetes have mobility and burrow into the body in a corkscrew rotation (Virology online). Brock writes, “spirochetes are long and slender bacteria, usually only a fraction of a micron in diameter but 5 to 250 microns long. They are tightly coiled, and so look like miniature springs or telephone cords” (Brock et al 1994: 7). According to Brock et al, spirochetes represent an unusual group of bacteria due to their arrangement of axil filaments, which are similar to bacterial flagella. These filaments allow the spirochetes to move by rotating in place (Brock et al 1994: 7).

It is important to distinguish which type of tick will be discussed throughout this thesis, as this affects the preventative strategies discussed in later chapters. Ticks, not to be confused with insects, are most closely related to mites, spiders, scorpions, and harvestmen. In the US, there are currently around 80 species, and about 865 recognized species worldwide. Only 12 out of the 80 species are a threat to humans or animals in the US (Ginsberg 1993: 17). The ticks discussed in this thesis are those in the Ixodidae family, or hard ticks. The tick that this thesis focuses on is Ixodes scapularis, the blacklegged, or deer tick, as this is the species that most commonly infects humans in the Northeastern US. I. Scapularis is responsible for transmitting Lyme disease, human babesiosis and human granulocytic anaplasmosis (HGA).

It is necessary to understand the different life stages of ticks, as ticks can be more “dangerous” in certain life stages due to their small size, which can affect preventative strategies, which will be discussed in chapter 4. According to Ginsberg (1993), ticks are rarely born carrying the Borrelia bacteria (36). Rather, they become infected usually upon their first blood meal. To better understand how ticks become infected with Borrelia bacteria, we must look at the life stages of Ixodes (black legged) ticks. According to Ginsberg, There are four main life stages: egg, larval, nymph and adult. Eggs are normally laid in leaf litter on the forest floor where they
hatch into small 6 legged larvae within about one month. It is in the larval stage that ticks have their first blood meal, usually lasting between 3 and 5 days. Once they have fed, they fall off of the host (usually a small mammal such as the white footed mouse) and molt into a larger 8 legged nymph. Molting from the larval to nymph stage takes about 35 days. Nymphs then feed on another host for about four to five days. The nymphs then fall to the forest floor again, molting into adult ticks, which takes about 42 days. Adult ticks feed on larger mammals, usually white tailed deer. Overall, in the field, this process takes about 2 years and ticks in Northern states usually live between five and six years (Ginsberg 1993: 17). Although transviral transmission of second-generation ticks infected with Borrelia burgdorferi is possible, it is very rare. One study examined the prevalence of Borrelia burgdorferi present in unfed larval nymphs and found 2/274 infected (meaning the female had passed on Borrelia burgdorferi transvirally to 2 of the 274 eggs), which is an infection rate of about 1% (Ginsberg 1993: 49). Transviral transmission is inefficient and does not represent a major concern to public health efforts in addressing the transmission of this bacteria. Rather, the cycle of transmission between host and ticks represents the main problem and should be a focus of preventative strategies.
Figure 4. Larva, nymph, adult male and female Ixodes scapularis from the *Tick Management Handbook*, by Kirby C. Stafford (2004)

Figure 5. This diagram shows the life cycle of ticks and the corresponding seasonality of when ticks are active according to their life cycle stage. This image was taken directly from the CDC website (2014)

It is important to understand the life cycle of ticks and how it relates to preventative strategies, such as checking your body for ticks after being outside during certain times in the year, which will be discussed in chapter 4. According to Ginsberg (1993), larva hatch around
midsummer, between July and early August (31). Larvae either molt into nymphs following their first feeding or remain in an engorged state in the duff layer of the soil over the winter and molt into nymphs in the early spring. Therefore, nymphs are most active in the early spring, between May to early July. Adult ticks are thus most active mid-October through mid-November. According to Ginsberg (1993), “appearance of nymphs each year prior to larvae allows for efficient transmission of Lyme disease spirochete B burgdorferi to the next generation” (Ginsberg 1993: 31). Nymphs transfer the spirochetes to susceptible reservoir hosts. Larvae, which are essentially spirochete free then acquire burgdorferi from reservoir competent hosts and retain the spirochetes during the molting process (Ginsberg 1993: 31). Therefore, the differences in peak activity allow the continuation of transmission of Borrelia bacteria between host and tick as it cycles through the host, nymph, and larval stages of a tick’s life cycle.

It is important to examine which animal populations represent competent hosts for the Borrelia bacteria, as targeting host populations will be discussed as a possible preventative strategy in chapter 7. Ixodes ticks feed on a variety of host animals including small mammals such as the white-footed mouse, grey squirrels, birds, and woodchucks. Adult ticks tend to attach
to larger hosts such as deer and cattle. In areas where Lyme disease is endemic, studies have shows that 70-80% of white-footed mice are infected with Borrelia bacteria (Ginsberg, 1993: 49). Host immune system, host preference by ticks, and host abundance all affect the number of ticks that become infected.

![Tick Closeup](image1.png)

**Figure 7.** Above shows an unfed vs. engorged female I scapularis tick. This photo was taken from the *Tick Management Handbook*, by Kirby C. Stafford (2004)

![Tick on Finger](image2.png)

**Figure 8.** This photograph shows a nymph on the fingernail and an adult female on the finger. This photograph highlights the small size of nymphs, which makes them incredibly hard to find on one’s body, making it more likely that they are able to attach for a longer period of time than an adult would be. This photo was taken from the *Tick Management Handbook*, by Kirby C. Stafford (2004)
It is important to understand how ticks pass the Borrelia bacteria to humans, as this will be discussed in chapter 6 when human vaccines for Lyme disease are considered as a preventative method. According to Ginsberg (1993), after ingestion of blood from their first blood meal as larva, spirochetes passed from infected host into larval ticks replicate in the gut, penetrate the epithelium, the basal lamina and enter the hemolymph (21). Spirochetes then invade the salivary glands, which allows for the spirochetes to be passed via tick saliva into host tissue. The duration of attachment to host is critical for infection with the spirochetes to occur (Ginsberg, 1993: 21). One study showed that “white footed mice failed to become infected if nymphal ticks were removed within 24 hours, 50% became infected if ticks were removed within 48 hours, and almost all became infected if ticks were removed after 72 hours or more” (Ginsberg, 1993: 45). This emphasizes the point that prompt identification and removal of a tick is critical in order to avoid infection with Borrelia bacteria. Prompt identification and proper removal will be discussed later on in chapter 5.

During the feeding process, ticks secrete large amounts of saliva, “… containing a variety of antihemostatic, anti-inflammatory, and immunosuppressive properties. Active immunosuppressive chemicals, including prostaglandin E2 (PGE2), block macrophage activation, and neutrophil activity and may inhibit T-cell activation, all early precursors in the cascade of cellular events leading to antibody production and antigen processing. Thus, salivary components injected by these ticks may promote infection of the host by Lyme disease spirochetes. By deactivating macrophages, PGE2 may serve to protect B burgdorferi during its initial phase of adaptation in the skin of infected hosts. Moreover, temporary protection through localized immune suppression may provide saliva-injected spirochetes with an ability to escape into tissues less exposed to the host’s humoral immune system” (Ginsberg, 1993: 47).

Ginsberg (1993) emphasizes that the transmission of spirochetes from ticks to host is a complicated process and one that involves suppressing the host’s immune system in order to give spirochete bacteria the greatest chance at survival within the host (47).
In order to understand how to prevent Lyme disease, which will be discussed in depth in chapters 4 and 8, it is necessary to explore all of the possible ways that one can become infected with the bacteria. The CDC has provided a list of ways that one can become infected with Lyme disease. However, the main pathway for transmission is from the bite of a blacklegged tick. The CDC (2015) notes that there is no evidence to suggest person-to-person transmission is possible for Lyme disease. In addition, there are some complications that can arise if someone who is pregnant becomes infected, such as placental infection and stillbirth. However, there are currently no reports of Lyme disease being transferred via breast milk. To date, no blood transfusions have led to no cases of Lyme disease, however the CDC (2015) cautions that individuals being treated for Lyme disease with antibiotics should not donate blood as the bacteria can live in stored blood. Once someone has completed treatment for Lyme disease, they may be considered for blood donation. Animals cannot spread Lyme disease directly to their owners, but can bring infectious ticks into homes. The CDC (2015) also notes that you cannot get Lyme disease from eating venison or squirrel meat. However, hunting for such animals and cleaning them could increase your risk of coming into contact with infectious ticks. Finally, the CDC (2015) clearly states that Lyme disease is not transmissible through, ‘air, food, water, or from the bites of mosquitoes, flies, fleas, or lice’.

**Tick Habitat**

It is important to understand what constitutes tick habitat as this relates to preventative strategies discussed in chapter 4 and landscape management best practices discussed in chapter 8. According to Ginsberg (1993), “topography, vegetation structure, time of day affect the abundance of host seeking ticks and affect the degree of risk of human exposure to infected ticks” (49). In order to better protect one’s self from Lyme disease, it is necessary to understand
what tick habitat looks like and what makes a habitat particularly favorable for the blacklegged ticks. One of the main factors that affects prevalence of ticks is the abundance of competent hosts. In forested areas with large populations of white footed mice, small rodents, or white tailed deer, you are likely to find a great population of ticks simply because of the prevalence of competent hosts. Host populations have to be able to sustain tick populations. Ticks often reside in woodland edges, areas with high shrubbery, places that they are able to stay cool and moist in. Dry, sunny areas are inhospitable to the ticks as they are at risk for drying out (Ginsberg, 1993: 57). Creating environments around your home or schools that are inhospitable to ticks is a form of prevention and will be discussed later in chapter 8.

### Symptoms of Lyme Disease

It is necessary to understand the symptoms of Lyme disease as well as the myriad of complications that can arise from this disease, as this will be discussed in depth in chapter 9. Between 3 and 30 days after becoming infected from the bite of a blacklegged tick, infected individuals will enter the early-localized stage, which is often characterized by the red, expanding rash called erythema migrans (EM). Only about 70-80% of infected persons will get this rash, which is often why cases of Lyme disease go unreported or undiagnosed (CDC 2015). Some individuals will get a small bump or redness at the site of the tick bite that will normally go away within a few days. The rash usually appears around the site of the tick bite around day 7 post bite and can expand up to 12 inches. The rash often resembles a bull’s eye. The rash is often warm to the touch but is not usually itchy or painful. The early-localized stage is also characterized by fatigue, chills, fever, headache, muscle and joint aches, and swollen lymph nodes (CDC 2015).
Figures 9 and 10. The figure on the left shows the bull’s eye rash known as erythema migrans that appears on 70-80% of cases of Lyme disease. The image on the left shows a patient with Bell’s palsy that can results as a complication from Lyme disease. Both pictures were taken from the CDC website (2015)

If left untreated, the bacterial infection can spread to other parts of the body such as,

“EM lesions in other areas of the body, facial or Bell’s palsy (loss of muscle tone on one or both sides of the face), severe headaches and neck stiffness due to meningitis (inflammation of the spinal cord), pain and swelling in the large joints (such as knees), shooting pains that may interfere with sleep, heart palpitations and dizziness due to changes in heartbeat”. (CDC 2015)

Interestingly, the CDC (2015) suggests that many of these symptoms can resolve on their own without treatment with antibiotics in a number of weeks to months. However, untreated Lyme disease can result in a number of serious complications. For instance, 60% of patients who failed to receive treatment will experience intermittent bouts of arthritis with serious joint pain and swelling (CDC 2015). The knees are the joints most often affected. According to the CDC (2015), “arthritis caused by Lyme disease manifests differently than other causes of arthritis and must be distinguished from arthralgia (pain, but not swelling, in joints)”
The side effects of Lyme disease are serious and be debilitating. It is important to have a basic understanding of complications of Lyme disease, as these will be discussed in chapter 9. The CDC (2015) notes that around 5% of untreated patients often develop chronic neurological problems months to years after infection. Symptoms include, “shooting pains, numbness or tingling in the hands or feet, and problems with short term memory” (CDC 2015).

Lyme Carditis is another complication that can arise due to infection with Lyme disease and occurs when Borrelia bacteria enter into the tissue of the heart. The spirochetes interfere with normal electrical signaling between the upper and lower chambers of the heart, disrupting the heart beat rhythms in what is known as a “heart block”. Heart blocks can be mild, medium, or severe and can progress rapidly. Symptoms of a heart block include, “light-headedness, fainting, shortness of breath, heart palpitations, or chest pain” (CDC 2015). Patients with Lyme Carditis typically have additional symptoms such as fever, body aches, and erythema migrans, typical of any Lyme disease patient. Between 2001-2010, around 1% of Lyme disease patients developed Lyme carditis and were treated with antibiotics for 14-21 days. Symptoms typically resolved within 1-6 weeks. Antibiotic treatment for Lyme carditis patients was either oral or intravenous depending on the severity of the symptoms, and some patients required a temporary pacemaker (CDC 2015). There were three deaths reported due to Lyme carditis in 2013. It is estimated that
between 4 and 10% of patients with untreated Lyme disease will develop Lyme carditis, but some have estimated that as many as 30% of untreated Lyme disease patients will develop asymptomatic Lyme carditis (Airley et al 2008: 279).

Figure 12. This figure shows the block between the upper and lower chambers, disrupting the normal rhythms of heartbeat in a patient with Lyme Carditis. This image was taken from the CDC’s website (2015)

Lyme Disease Diagnosis and Testing

It is imperative to have a basic understanding of how to test for and diagnose Lyme disease as this process and the controversy of ambiguous diagnostics will be discussed in Chapter 9 when we examine how to better help those infected with Lyme disease. The diagnosis of Lyme disease is complicated, especially with the absence of standard tests that are accepted and conducted by every lab. Labs and medical offices have recommended tests by the CDC, which they should follow. However, the diagnostic process for Lyme disease does not always yield clear, definitive results, which makes defining cases of Lyme disease challenging, as will be discussed further in chapter 9. The main way that Lyme disease is diagnosed is based on signs, symptoms, and a history of exposure to infected blacklegged ticks (CDC 2015). Laboratory blood tests are the main way to diagnose Lyme disease cases and are effective when
used correctly and using validated methods (CDC 2015). Although there is no “standard” method to diagnose Lyme disease, the CDC (2015) recommends a two-step diagnostic process that tests that blood for antibodies against the Lyme disease bacteria.

According to the CDC (2015), the first step in the testing process is done by performing an EIA (enzyme immunoassay), or an IFA (indirect immunofluorescence assay, although this test is done more rarely than the EIA). The EIA tests for antibodies to the Lyme disease bacteria. The EIA is very sensitive and therefore it is possible for someone who is not infected with Lyme disease to test positive – a “false positive”, or for someone to test indeterminate. A false positive could indicate that someone is suffering from another disease such as, “tick-borne relapsing fever, syphilis, anaplasmosis, leptospirosis, lupus, bacterial endocarditis, infection with helicobacter pylori, Epstein Barr virus, or Treponema denticola” (a bacterial infection of the gums) (CDC 2015). Those who test positive, or indeterminate, therefore should undergo a second test, which is often the Western blot test. The Western blot test is more specific than the EIA and tests for both IgG and IgM antibodies that would be present if someone was infected with Lyme disease. IgM antibodies would appear within the first four weeks of infection (CDC 2015). IgG, as well as IgM antibodies would be present in someone after four weeks of initial infection. Therefore, testing someone 4-6 weeks after infection for presence of both IgM and IgG antibodies would indicate active infection. There must be at least 5 bands present for IgG antibodies on the Western blot to indicate that someone is infected with Lyme disease. The ambiguity of having 3 or four lines present on a Western blot and how physician’s “choose” to interpret this can make the diagnostics process both challenging and murky (CDC 2015).

Treatment of Lyme disease
Understanding best practices surrounding treatment of Lyme disease is imperative as differing courses of treatment and their efficacy will be discussed in chapter 9. The most common and effective treatment for Lyme disease is a standard course of antibiotics. Patients who are treated appropriately with antibiotics in the early stages of Lyme disease usually recover quickly and completely. Oral antibiotics used include doxycycline, amoxicillin, or cefuroxime axetil. Patients suffering from neurological or cardiac complications may be put on intravenous antibiotics such as ceftriaxone or penicillin (CDC). According to a study, “doxycycline is relatively contraindicated during pregnancy or lactation and in children <8 years of age. Antibiotics recommended for children are amoxicillin, cefuroxime axetil, or, if the patient is \( \geq 8 \) years of age, doxycycline” (Wormser et al 2006: 1090).

People who have removed a tick from their body and/or received antibiotic prophylaxis should be monitored for up to 30 days for the development of Lyme disease symptoms, especially looking for an expanding rash at the site of the tick bite. People who develop symptoms after removing a tick for their body should seek medical attention to be tested for tick born infection and receive corresponding treatment (Wormser et al 2006: 1091).

**Conclusion**

Lyme disease is caused by the pathogen Borrelia burgdorferi, a bacteria carried by infected I. Scapularis ticks most prevalent in the Northeastern States. Infection occurs by the bite of an infected tick and transmission is most common only if the tick has been attached for more than 36 hours. It is critical to understand that there are four life stages of I. Scapularis ticks, with nymphal ticks posing the greatest threat to humans as their small size make them incredibly difficult to identify on one’s body. This relates to educating the public on when and how to
properly check one’s body after being outside in the spring, summer and fall months, which will be discussed in chapter 4. Additionally, it is important to be aware that the spring, summer and fall months are the times of year in which ticks are most active, with spring being the season for peak nymphal activity, as well being aware of what constitutes tick habitat. Identifying and reducing tick habitat as a preventative measure and landscape management practices will be discussed further in chapter 8. Having an understanding of which animal populations are competent hosts for Borrelia bacteria is also important and will be discussed further in chapter 7 as we look at targeting host populations as a preventative method. Furthermore, Lyme disease can be difficult to diagnose due to challenges with the diagnostics process, which will be discussed further in chapter 9. In addition, there are serious complications that can arise if Lyme disease goes untreated or is improperly treated which will also be discussed further in chapter 9.
3. Methodology

In undertaking this research, scholarly literature on Lyme disease prevention at the state and national level was reviewed. Grey literature on the Vermont Department of Health website was compared with the CDC website and the website of other surrounding states with a high prevalence of Lyme disease. Finally, eight interviews were conducted with experts in the field of public health and medicine, including one clinical Lyme disease specialist. Information from all of these sources was compared for similarities and differences to see how Vermont fares against national standards for Lyme disease prevention, as well as the best practices of other states.

Scholarly and Grey Literature Search Methods

A review of existing literature was conducted examining medical sociology, medical anthropology, environmental studies, epidemiology, public health policy, and animal health science databases and related search engines to gain further knowledge about Lyme disease. I focused on education, behavior, and prevention techniques in the context of Lyme Disease in Vermont. I used search engines such as AnthroSource, JStor, Academic Search Premier, Google Scholar, and Web of Science. Some of the search terms I used include “Lyme disease, Lyme disease prevention, behavioral preventative strategies in Lyme disease, Lyme disease spread, Lyme disease vaccine, Lyme disease treatment, post-treatment Lyme disease, health and Lyme disease, Lyme disease exposure, Lyme disease risk, Lyme disease occupational exposure, Lyme disease landscape management, tick habitat, tick prevention, tick removal, Borrelia burgdorferi, Borrelia burgdorferi prevention, Borrelia burgdorferi treatment”, and more. Data was collected and compared. Grey and scholarly sources were compared for similarities and differences. Grey
and scholarly sources were also compared and contrasted to interviews, which are discussed in the following paragraph.

**Research Subjects and Field Sites**

Eight participants for this research project were contacted via email or phone based on available contact information online. Convenience sampling was used in order to talk with as many university/college professors and employees at the Vermont Department of Health as possible. Interviews were conducted in person or over the phone and were recorded on both an iPhone 5c and a MacBook Pro. I tried to identify professionals that worked nearby to my own school as well as professionals around the country that appeared (as stated in information given online) to have some knowledge of animal science, Lyme disease, public health, or zoonotic diseases. I searched the Internet for professionals and contacted them via email or phone. Those that responded positively were invited to participate. All but one that initially responded agreed to participate. Subjects interviewed include a Professor of Biology from Middlebury College, Professor David Allen / a Professor of Chemistry and Biochemistry from Middlebury College, Professor Bob Cluss / an Infectious Disease Epidemiologist of the Vermont Department of Health, Dr. Bloom / as well as an Epidemiologist, Ms. Green of the Vermont Department of Health / a medical doctor specializing in infectious diseases who has published scholarly research papers on clinical Lyme disease treatment, Dr. Johan Bakken / the University of Vermont Extension professor, George Cook / a professor of medical laboratory and radiation sciences, Professor Brown / and a professor in the Department of Animal Science at the University of Vermont, Professor John Barlow. Interviews were conducted in a public setting,
usually the office or workspace of the participant, or over the phone. For convenience, I have listed my interview participants below.

<table>
<thead>
<tr>
<th>Name of Research Participant</th>
<th>Title</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>Bob Cluss</td>
<td>Professor of Chemistry and Biochemistry</td>
<td>Middlebury College</td>
</tr>
<tr>
<td>David Allen</td>
<td>Professor of Biology</td>
<td>Middlebury College</td>
</tr>
<tr>
<td>Dr. Bloom</td>
<td>Infectious Disease Epidemiologist</td>
<td>Vermont Department of Health</td>
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<tr>
<td>Dr. Johan Bakken</td>
<td>Medical doctor specializing in infectious diseases</td>
<td>St. Luke’s Hospital in Duluth, MN</td>
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<tr>
<td>George Cook</td>
<td>University of Vermont Extension Professor</td>
<td>University of Vermont</td>
</tr>
<tr>
<td>John Barlow</td>
<td>Professor in the Department of Animal Science</td>
<td>University of Vermont</td>
</tr>
<tr>
<td>Ms. Green</td>
<td>Epidemiologist</td>
<td>Vermont Department of Health</td>
</tr>
<tr>
<td>Professor Brown</td>
<td>Professor of medical laboratory and radiation sciences</td>
<td>University of Vermont,</td>
</tr>
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Interview Questions

Interview questions were developed focusing on disease risk and transmission, prevention and education, as well as regulation and guidelines for Lyme disease. Within each of these categories, questions became more detailed, asking specifics about Lyme disease transmission, risks to Vermonters, past and present preventative strategies, as well as ways in which Vermont could improve upon preventing cases of Lyme disease.

Zoonotic disease, risk, and transmission:

In your experience, what are the biggest factors that contribute to Lyme Disease and its transmission in Vermont today?

Follow up: What human populations are most at risk and why?

Which animals in the state are most at risk of carrying and or transferring Lyme Disease? How is the situation handled when an animal is diagnosed with or identified as a potential carrier of Lyme disease?

Is human-to-human transmission via the vector a possibility or concern for Lyme disease?

Do the risk factors for the spread and transmission of Lyme disease differ today from what they were in the past?

What risks does Lyme disease pose if someone becomes infected? What risks does Lyme disease pose if someone becomes infected and is unable to, or fails to receive treatment?

Prevention and education:

What preventative strategies exist currently and in the past in Vermont addressing Lyme disease?

Follow up: What are the most important things that are currently being done in the state to keep animals and humans safe from Lyme disease transmission?

How, if at all, are any of these things you’ve just discussed different from the situation at Vermont in the past?

Are there areas in Lyme disease prevention that could be improved upon?
Have there been any recent (or if no recent ones, then past) outbreaks of Lyme disease in Vermont? If so, what, and how did the state address them? How did we do, and how could we have done a better job?

**Is there any type of monitoring system that exists to track the spread of Lyme disease or animals that could be carriers for these diseases?**

Follow up: Are certain animal populations that are known to carry Lyme disease tracked? If so, how? What is done with such information?

Under what circumstances are animals quarantined or have to be euthanized to prevent disease spread?

Are there preventative strategies that exist for people who were exposed or that lived close to an animal that was diagnosed with Lyme disease?

**What role does environmental and behavioral management play?**

What role does inoculation play?

Does any of this vary by season?

**In what ways do you go about educating the public about Lyme disease facing Vermonters?**

Follow up: How can we improve upon educational tools?

How can we better communicate with the public about Lyme disease?

Which kinds of zoonoses do public outreach efforts tend to be focused on? Is that education tailored at all for particular audiences or risk groups?

There is an advocacy group for Lyme disease in Vermont; do you believe they are effectively spreading information about the disease in a positive and helpful manner? If yes, How so?

**Regulation, written guidelines, monitoring, records, and regional coordination:**

**Does the state have any regulations and/or written guidelines for the prevention of Lyme disease? If so, how can I access a copy?**

Does the state keep records on cases of Lyme disease? If so, are those records accessible?
What kinds of information do they record and who has access to them?

Is there coordination of records and prevention efforts for Lyme disease across states or regions and/or with D.C.?

Is there any way in which any of this could be improved in the state?

**Protection of Human Subjects**

My proposal for research with human subjects was submitted and approved by the UVM Committee on Human Research in the Behavioral and Social Sciences CHRBSS 15-215. I took and passed the IRB tutorial on January 17, 2014. Interviews have been stripped of any identifying information and were kept on both devices, which were password protected. Interviews will be destroyed from both devices upon thesis completion. By agreeing to participate in an interview, the interviewees were giving consent to take part in this research process. Interviewees were informed that pseudonyms would be used, that is, unless interview participants request to be credited by name for their professional opinion, as stipulated by the code of ethics for the American Anthropological Association (2012). Parts in which interviewees wanted to go off the record are not included in the data analyzed within this project.

**Analysis of the Data**

Eight interviews were conducted with experts in public health as described earlier. Interviews were audio recorded on both an Iphone 5s and MacBook Pro through Quicktime Player. Interviews were transcribed and analyzed for similarities and differences in responses. Finally, findings from scholarly and grey literature were compared with findings from the interviews to identify the ways in which Vermont can better address Lyme disease within the context of prevention, education, and treatment. Areas where interview participants agreed and disagreed are highlighted and discussed in the following review.
Dissemination of Results

A copy of this study will be shared with all of the study’s interview participants, the University of Vermont, the Vermont Legislature, The Vermont Department of Health, The Vermont Department of Agriculture, and The Vermont Department of Fish and Wildlife in the hopes that findings from this research project can be used to help improve existing public health efforts to stop and slow the spread of Lyme disease as well as other infectious zoonotic diseases within the state of Vermont. Interviewees will receive an electronic copy of my thesis, sent via an email. The Vermont Department of Health, The Vermont Department of Agriculture, and The Vermont Department of Fish and Wildlife will also receive an email with an electronic copy of my thesis. The University of Vermont’s Honors College will be given both an electronic and hard copy of my thesis.
4. Prevention Through Education and Awareness: A Starting Point

In the following chapter, I will discuss Vermont’s current educational and awareness strategies to address Lyme disease. I will examine their “Be Tick Smart” campaign for areas of improvement and compare their educational resources to those of surrounding states as well as those offered by the CDC. This chapter thus hopes to address the following research questions: What is Vermont currently doing to address Lyme disease, and how can we improve prevention, through education and awareness? There was a large degree of consonance between the scholarly literature and the interviewees; both agreed that education and awareness should be at the forefront of any public health campaign against Lyme disease. However, the scholarly literature differed from interview participants in that it stressed the need to educate the public on the efficacy of preventative behaviors rather than on simply telling the public to practice preventative behaviors. Furthermore, the interviewees stressed that it is imperative that we find a way to evaluate current educational resources and awareness messages in order to identify successful strategies to use in future efforts against Lyme disease, which is something that was not mentioned in the scholarly literature. There were differences amongst interviewees as to the best way to reach the public. Interviewees expressed differing opinions as to the best news outlets with which to reach the public, with preferences ranging from VPR, to newspaper, to television, but with the caveat, that we lack information as to the actual reach of any communication. In examining the grey literature, Vermont’s educational tools and preventative strategies are in line with those offered on the CDC website. The CDC differs in that they offer information on post treatment Lyme disease syndrome, in addition to the diagnostic, treatment and prevention information also available on the Vermont Department of Health website. Vermont’s website was also very similar to other states such as Connecticut, New York, New
Jersey, and New Hampshire. No state website in regards to Lyme disease excels in all areas of educational resources, aesthetics and usability. However, Vermont’s website, with a myriad of resources on tick repellents, prevention, and education, is perhaps the most well-designed and “user friendly” site, which is important in order to effectively communicate scientific information to both a science literate and lay educated audience. Connecticut’s website has the most educational resources, continuing Lyme disease education through high school, which is something that Vermont should consider implementing.

**Significance**

The scholarly literature on Lyme disease prevention identified a positive correlation between awareness of Lyme disease and the practice of preventative behaviors as well as between the awareness of the efficacy of preventative behaviors and practice of preventive strategies. Prevention is often the foundation for protecting against diseases. In order to achieve prevention, the scholarly literature suggests that individuals must first be aware of the disease, as well as its potential risks. One study examined what factors encouraged individuals to protect themselves against Lyme disease. According to the results, “perceived risk of acquiring Lyme disease, knowing anyone with Lyme disease, knowledge about Lyme disease, and believing Lyme disease to be a common problem were significantly associated with prevention practices” (Herrington et al 1998: 2036). This study shows that overall awareness of the disease - whether that manifests in the form of knowing someone with Lyme disease, knowing one’s own risk of getting the disease, or knowledge of overall risk of coming into contact with the disease - is the greatest indicator of one’s willingness to engage in preventive behaviors. According to Herrington et al (1998), “knowledge, attitudes, beliefs, values, and perceived needs and abilities
are pre-disposing factors that motivate an individual to act in a health-directed manner” (2037). Knowledge, attitudes, and beliefs all comprise parts of awareness. This study supports the idea that in order to get individuals to practice prevention, we must first get them to be aware of the problem and to see its relevance to their lives. Vermonters must first become more aware before they can be expected to partake in preventative behaviors.

The relationship between being aware of and concerned about Lyme disease and practicing preventative behaviors is evident in the scholarly literature. Scholarly literature suggests that those who reported being more concerned about ticks and Lyme disease were more likely to practice preventative behaviors. According to Herrington et al (2004), “having seen ticks, being concerned about being bitten, perceiving insect repellent to be effective, having heard about LD, and knowing someone who had LD are the factors most predictive of specific tick-bite preventive behaviors” (135). Interestingly, this study also noted that perceiving tick repellent to be effective was a positive way to get people to use repellant. This suggests that if people perceive preventative behaviors to be effective, they will be more likely to partake in such behaviors. This idea was echoed by Shadick et al (1997), when they noted that, “performance [of a preventative behavior] was related to confidence in finding a tick on oneself and a perception that a precaution's benefit outweighed its inconvenience and would adequately reduce risk for Lyme disease” (273). This suggests that increasing the knowledge amongst Vermonters about the efficacy of personal preventative behaviors, and how well they can actually protect someone against Lyme disease may increase the number of people willing to practice such behaviors. Another study showed similar results, stating that, “prevention programs targeting tick bites and LD should aim at influencing people’s perceptions and increasing their knowledge and perceived efficacy of protective behavior” (Jacqueline et al 2013: 50). This study showed that increasing
motivators such as knowledge of Lyme disease, as well as perceived efficacy of protective behaviors would increase the likelihood of a person performing preventative behaviors to avoid Lyme disease. Finally, a study of high school students in a Lyme endemic area revealed that, “[those] who believed a specific behavior was preventive were 3-6 times more likely than others to practice that behavior” (Cartter et al 1989: 355). This supports the theory that increasing knowledge and awareness surrounding the efficacy of prevention may increase the number of people willing to perform preventative measures and decrease the number incidence rate of Lyme disease.

Therefore, the scholarly literature suggests that there is a need in Vermont to increase awareness surrounding Lyme disease, preventative behaviors, as well as the efficacy of preventative behaviors in order to increase compliance with such prevention strategies.

Results of My Research

In the pages below, I present the results of my research on Lyme disease awareness and education in Vermont, drawing upon the interviews I conducted and references to grey literature from the Vermont Department of Health website. This section begins with interviewee perceptions of basic public awareness of Lyme disease in Vermont. It is followed by an assessment by interview participants and scholarly literature of the need for education and factors in its efficacy. I conclude with a description of Vermont’s current educational tools and preventative strategies as compared with those of the CDC and other states.

Baseline Public Awareness of Lyme Disease in Vermont
Although I could not find information on Vermonters’ level of awareness about Lyme disease in the scholarly or grey literature, I did ask my interview participants about their impression on Vermonters’ overall level of awareness surrounding Lyme disease. All of my interviewees agreed that there seems to be a low level of awareness among Vermonters and consequently low levels of concern and practice of preventative behaviors surrounding Lyme disease. Therefore, increasing awareness should be at the forefront of public health campaigns against Lyme disease in Vermont, and perhaps the best way to increase awareness is through education.

Professor Brown and George Cook agreed that awareness surrounding Lyme disease in Vermont is low among the public, which could indicate that few Vermonters are practicing preventative behaviors – not protecting themselves from Lyme disease. For instance, Brown noted that awareness by the public is one of the main problems facing public health officials in their campaign against Lyme disease. He noted that:

“the public gets nervous when it first shows up, the public gets nervous when there’s a large number of cases but then it slips back to endemic but low level proportions and the public doesn’t pay much attention until someone they know gets it. So I think keeping the public aware of the diseases and what to do to prevent getting the diseases is a constant challenge”.

Brown raises a very important problem here. Although Lyme disease is endemic to the state, it is endemic at a low level, which means it is not always the most common or obvious disease to the public. Many people may live their whole lives in Vermont without knowing someone that becomes infected with the disease, while others may know many people who are infected. In addition, Lyme disease is more common to some areas of Vermont than others, making it more common knowledge in some areas than other. Thus there exists a discrepancy of knowledge surrounding Lyme disease throughout Vermont. However, if we are to improve prevention, we
must increase awareness across Vermont so that Vermonters are able to understand their risk for Lyme disease and know how to protect themselves and their families. Without awareness, there is no need to practice preventative behaviors, and without prevention there is no protection from Lyme disease.

Cook further emphasizes the need for increased awareness by noting, “I think that it’s very important that we do work together to better get the word out such as ‘Hey folks, this is a serious issue and it’s in our neighborhood even if we haven’t personally experienced it yet that we’re aware of.’” The problem with Lyme disease is that all too often, it’s a silent concern. As stated earlier, many people in Vermont may not know anyone with the disease, or may not even know that they themselves have Lyme disease or are living in an at-risk environment, or are participating in an activity that could place them at an increased risk. Ticks are small and often hard to see. Lyme disease is rarely talked about at primary care visits to the doctor or in schools. All of these factors contribute to the idea that there is a serious need for increased awareness surrounding Lyme disease in Vermont. Both interviewees as well as the scholarly literature agree that increasing awareness is essential in order to get people to practice preventative behaviors. The scholarly literature differs in that it specifically notes that educating the public on not only preventative behaviors, but also the efficacy of such behaviors, could increase the likelihood of individually engaging in preventative strategies.

**Scholarly and Professional Assessment of the Need for Education:**

In order to stop or slow the spread of Lyme disease, we must increase awareness among the public about the disease and its risks, and one of the best ways to increase awareness is through education. Scholarly literature as well as interview participants agreed that education should be at the forefront of public health campaigns against Lyme disease and should focus on
preventative behaviors. I will thus begin this section by discussing certain preventative behaviors noted in scholarly literature to be most effective at preventing Lyme disease. The scholarly literature on prevention against Lyme disease focuses on personal protective behaviors as well as examines which are most effective at preventing Lyme disease. Performing tick checks on one’s body as well as avoiding tick habitat seem to be two of the most effective preventive methods according to existing scholarly literature. Above all, scholarly literature suggests that the most effective way to prevent tick bites is simply to avoid tick habitat. When this is not possible, additional precautions should be taken including, “protective clothing and tick repellents, checking the entire body for ticks daily, and prompt removal of attached ticks before transmission of these microorganisms can occur (Wormser et al 2006: 1092). A second study found that tick checks are very effective, however there is a need to, “increase people’s tendency to check their body’s for ticks after being outside. Educating the public about tick checking is crucial” (Gregory A Poland 2001: 720). This study suggests that while tick checking is an effective preventative behavior, perhaps people are not performing said checks enough times throughout the summer or perhaps they are not performing adequate tick checks. This is something that interview participants suggested to include in educational programs about Lyme disease, which will be discussed later in this chapter. Clearly, there is a need to increase Vermonter’s education surrounding when, and how to perform tick checks.

Encouraging Vermonters to perform tick checks within a number of hours of being outside could drastically reduce their risk of becoming infected with Lyme disease, according to the scholarly literature. According to Connally et al (2009), “checking for ticks within 36 hours of spending time in the yard at home was protective against Lyme disease. Bathing within 2 hours after spending time in the yard was also protective. Wearing protective clothing did not
seem to be significantly effective” (204). This study is in line with participant suggestions for tick checks and even specifies that they are most effective if one is able to find and correctly remove a tick within 36 hours. In addition, they note that bathing within 2 hours of being outside can be an effective preventive method. Interestingly, this study did not find that wearing protective clothing was a good preventative method. It would be interesting to examine what types of clothing and how participants in this study were wearing said clothing to evaluate its true efficacy. Also, Jacqueline et al. (2013) noted that, “respondents were more likely to check their skin after being outdoors and remove ticks if necessary, than to wear protective clothing and/or use insect repellent skin products” (225). This suggests that perhaps more emphasis should be placed on educating the public about the efficacy of tick checks, how to do them correctly and when they are most effective.

Returning to the data collected through my interviews, participants were in agreement with the scholarly literature, suggesting that increasing education surrounding behavioral preventative strategies is perhaps one of the most effective ways to prevent Lyme disease. Both officials at the Vermont Department of Health advocated for education as the primary focus of prevention. According to Dr. Bloom, “increasing education is the best way” to prevent cases of Lyme disease. Similarly, Ms. Green noted that, “getting the message out about how to prevent the disease,” is one of the most important things public health campaigns against Lyme disease can do. In addition, she noted that, “prevention and having people do tick checks after you’ve been outside in wooded areas” are critical strategies. Both public health officials agreed that education should be at the forefront of any public health effort to address Lyme disease. Brown supports this assertion, stating that, “I think the preventive strategies involve education”. Professor Cluss also emphasized that, “you have to get out there ahead of the curve. You have to
have effective public education”. The interview participants and scholarly literature agree that it is necessary to create and implement an effective educational program designed to increase awareness and understanding of Lyme disease and how to protect one’s self if we are to better protect Vermonters from becoming infected with this disease.

In further support of the scholarly literature, interview participants agreed that education should focus on personal protective measures such as wearing long pants, using DEET, and checking one’s self for ticks after being outside. However, the participants deviated from the scholarly literature by suggesting that education should also focus on raising awareness among the public about what tick habitat looks like, in what seasons ticks are active, and what time of day ticks are most active.

Personal protective measures suggested by interview participants include tick checks, avoiding tick habitat, wearing long sleeves and pants, treating clothes with permethrin prior to going outside, and using DEET on exposed skin. Participants specifically emphasized the importance of performing tick checks as something that has been shown to be incredibly effective at preventing Lyme disease. According to Ms. Green, the Vermont Department of Health encourages, “prevention and having people do tick checks after you’ve been outside in wooded areas”. Similarly, Dr. Bloom noted that,

“Personal protective measures are the main way to prevent illness: staying out of tick habitat when you can and when you can’t; wearing long sleeves and long pants; wearing clothes treated with permethrin to repel and even kill ticks; using DEET on exposed skin; doing frequent tick checks; checking your clothes when outside and showering after being outside”.

The Vermont Department of Health offers a variety of personal protective measures that can and should be taken to help prevent tick bites and Lyme disease. The suggestions are in line with CDC guidelines and will be reviewed later in this chapter. Not surprisingly, both officials
interviewed from the Vermont Department of Health noted tick checks as one of the best ways to prevent Lyme disease. If you are able to identify a tick on your body and correctly remove it within 24-48 hours, your chances of getting Lyme disease decrease significantly. Dr. Bloom encourages the use of permethrin as well as DEET, two synthetic commercial acaricides that are meant to repel ticks. Interestingly, no participant suggested a natural alternative to synthetic commercially available acaricides that are available for personal use. The health concerns and alternative to such synthetic acaricides are discussed in chapter 8. Although many interview participants noted encouraging tick checks as an effective prevention measure, no one discussed the proper way to perform said checks. Encouraging the public to perform tick checks is clearly essential, however perhaps we should also be increasing education on how to properly check your body for ticks, such as where on the body they are most likely to be, so that people can more thoroughly check such areas.

Ms. Green noted that being in wooded areas puts one at an increased risk for coming into contact with ticks, suggesting that education should also incorporate teaching people about where ticks are most likely to reside and when (time of day and season) they are most likely to be active so that people can avoid those places during certain hours/seasons or take additional precautions to protect themselves. Cluss supports this idea, noting that you have, “to tell people that now’s the time to be outside but now’s the time to be on guard.” Educating the public on when ticks - especially nymphs, which are smaller and harder to see on one’s clothes or body – are most active, can help Vermonters to stay alert when outside so that they can be more wary when walking in tick habitats and be more thorough when checking their bodies after being outdoors.
In conclusion, both the interview participants in this study and the scholarly literature on the topic of preventive behaviors for Lyme disease seem to be in agreement: public health efforts against Lyme disease should focus on increasing awareness through education about Lyme disease, its role in Vermont, and the risks it poses to Vermonters. The scholarly literature differs in that it encourages education on the efficacy of preventative behaviors, and not solely on educating the public on what constitutes a preventative behavior. Furthermore, both the scholarly literature and interview participants agree that the most effective preventative behaviors include tick checks, wearing protective clothing, and using repellant. The interviewees differed from the scholarly literature in that they also suggest incorporating education on what tick habitat looks like as well as when (in terms of season and time of day) ticks are most active.

**Current Educational Tools and Preventative Strategies of Vermont**

Below I have gathered grey literature from the Vermont Department of Health’s website on preventative strategies against Lyme disease as well as educational materials and will compare it to that of the CDC and surrounding states to see if and how Vermont can improve on their prevention and education as well as better tailor their website to communicate effectively to both a scientific and lay educated audience. First, Vermont lists a number of preventative strategies that are similar to those listed by the CDC. The grey literature indicates that information on the CDC and VDH websites on Lyme disease are in similar, with one difference being that the CDC offers information on post-treatment Lyme disease syndrome as well as chorionic Lyme disease, while Vermont does not. Finally, Vermont does an effective job at using simple language and detailed diagrams to communicate complicated scientific ideas to a lay educated audience.
Vermont uses clear and concise language to effectively communicate preventative strategies to a lay educated audience on their department of health website. The following preventative strategies were taken from the Lyme Disease Surveillance Report 2013 on the VDH website. Preventative strategies focus on wearing protective clothing, avoiding tick habitat, using repellant, and checking your body for ticks and removing them if you see any.

Wear light colored clothing with a tight sleeve, so you can spot ticks easily. Wear enclosed shoes, long pants and long sleeves. Tuck pant legs into boots socks and shirt into pants. Apply insect repellant containing DEET or permethrin, following label instructions carefully. Avoid sitting on the ground or stone walls. Do a final, full body tick check at the end of the day, looking for what may seem like more than a new freckle or speck of dirt. Remove tick promptly. Shower soon after coming inside from tick habitat (VDH 2013)

On the Vermont Department of Health website, they have a booklet available that appears to be last updated in 2012. Within the booklet, they break down their behavioral preventative strategies as follows:

**When Outdoors:**
- Avoid high grass and bushy areas as much as possible.
- Wear long pants and long-sleeved shirts to minimize skin exposure to ticks.
- Tuck your pants into your socks to form a barrier to keep ticks out.
- Wear light-colored clothing so you can easily see ticks on your clothing.
- Check for ticks, looking particularly for what may look like nothing more than a new freckle or speck of dirt, and remove ticks promptly.
- Use effective tick repellents on your skin or on your clothing.

**When indoors:**
- Check your body for ticks, and check your children. Pay special attention to the head, armpits, and groin area.
- Remove ticks promptly.
- Showering within a few hours of being outside may also be helpful.
Examine your gear and clothing. Put your clothes in the dryer on high heat for an hour to kill any remaining ticks (VDH 2012)

The preventative strategies against Lyme disease proposed by the CDC mirror those provided by the Vermont Department of Health (see page 50), with one exception being that the CDC encourages you to check your pet for ticks as well as yourself (CDC 2015). Additionally, the CDC specifically states using 0.5% permethrin, so perhaps this is something that the VDH should specifically list in their preventative strategies as well (CDC 2015). Finally, the preventative strategies are provided using language that is simple and not overly scientific. Lay educated audiences should be able to follow such preventative strategies to protect themselves against Lyme disease with ease.

In addition, the Vermont Department of Health discusses how to remove a tick correctly as well as signs and symptoms of Lyme disease. This information is identical to that provided by the CDC and is presented in language that, again, is not overly scientific so that audiences with limited education should be able to read and understand the main points in each section. Interestingly, neither the CDC nor the VDH discuss the emotional side of tick removal. Individuals may experience fear or disgust if they find a tick on themselves or others. Both websites should suggest that such emotional reactions are normal, however, the important thing is to accept the emotional reactions and remove the tick correctly, or find someone who is willing to remove it for you.

Additionally, neither site discusses how to remove a tick if it is in an area that you are not able to effectively reach on your own. Perhaps it is necessary to seek medical attention to remove the tick promptly if you are unable to remove it on your own, or unable to find a friend or family member to help. Finally, neither site talks about checking your body for ticks using a mirror to
reach hard to see areas, such as the back or groin, which is important, as these are common areas for ticks to hide. If you have poor eye-site, seek help to check your body for ticks.

The Vermont Department of Health provides a link to the CDC, where readers can find more information about post treatment Lyme disease syndrome. However, the VDH provides no information on post treatment lyme Disease syndrome nor chronic Lyme Disease, which it are two serious complications which will be discussed further in chapter 9.

Overall, both the CDC website on Lyme disease as well as that of the Vermont Department of health are very similar in terms of preventative strategies, signs and symptoms of Lyme disease, as well as diagnoses and treatment options. First, the preventative strategies on Lyme disease, information on how to remove a tick, as well as signs and symptoms of Lyme disease are the same on both websites, with one exception being that the CDC encourages individuals to check their pets for ticks as well as themselves. The CDC also specifies the use of 0.5% permethrin repellant, while the VDH does not identify a specific concentration of permethrin. Furthermore, the CDC differs in that it offers information on post-treatment Lyme disease, while the VDH does not. Finally, the language used on both sites was simple and concise, which is important so that lay educated audiences can approach these sites without trepidation and gain knowledge and understanding about Lyme disease.

Vermont

According to the grey literature from the VDH website, Vermont is the only state to utilize public service announcements to get the word out into the public about when to be on guard against Lyme disease. Other states may use PSAs, but I was not able to find any PSA
examples on other state department of health websites, indicating one area in which Vermont offers more resources surrounding Lyme disease prevention.

Public Service Announcements

There are three different PSAs in the form of radio spots available to listen to on the Vermont Department of Health’s website targeted at hunters and general public. In the first ad, a hunter states: “apply insect repellants to your skin and wear clothes that have been treated with a chemical that kills ticks”. The character has a thick Vermont accent, probably hoping to appeal to rural or older Vermonters and the spot lasts for 30 seconds. Although the ad is only 30 seconds it does encourage hunters to take precaution against tick bites, which increases awareness and targets an at-risk population (hunters), making this an effective ad.

The second PSA states, “don’t forget to use insect repellant…check yourself and your children carefully for ticks every day and remove ticks promptly”. This PSA is targeted at the general public and lasts 31 seconds. However it does tell people where they can get more information by visiting HealthVermont.gov. This is a good point to add at the end so that people will know where to get more information if they need it.

Finally, a third ad encourages people to, “wear insect repellant when in wooded areas and check your whole body for ticks every day”. This ad, like the second one, encourages people to visit the Vermont Department of Health website to get more information and lasts about 30 seconds. This ad is targeted at the general public.

For me, it is unclear when these ads are played and on what radio stations and during what times. Who is hearing them? Who is their target audience besides hunters (in the first ad) and the general public? Perhaps creating ads that are focused more on at risk groups, such as
children, incoming university students, or hikers would help to raise awareness among such at-risk groups. It is unclear how recent these ads are as well. It would be interesting to know if there have been any responses to these ads, or if the public has reacted differently since hearing these PSAs. Additionally, if these PSAs are only available online, people with no computers or internet (low socioeconomic demographic) will not have access to their messages, suggesting that such ads should be played on radio stations throughout Vermont. Finally, an evaluative tool is needed to examine how effective Vermont strategies like these PSAs are. We need to evaluate how the public is reacting and what information they are taking away from such PSAs.

In addition, the VDH puts on a video contest among high school students, which is a good way to educate younger generations and get them excited to learn about Lyme disease and how to prevent it. The VDH website notes that high school students in Vermont were encouraged to create a 60 second video about Lyme disease and how to prevent it. This is a good way to target younger generations and to raise awareness amongst an at-risk population. Looking at the winners of the competition in 2013, the information in their video was accurate and informative. The video for the 2013 winners can be viewed here:
https://www.youtube.com/watch?v=LV9yW4TdfSU&list=PLk9-Nj2hBiYpsiwZpKJbEt3o26qMyLFX

**Resources for Schools as Provided by the Vermont Department of Health**

In addition to providing examples of PSAs on their website as well as informational videos about Lyme disease created by high school students in Vermont, The Vermont Department of Health offers a number of resources for schools that range from instructions on
choosing a tick repellant to field trip guidelines to educational resources. They start by providing guidelines on how to choose the correct repellant to use against ticks.

Figure 13. This was taken directly from the VDH website (VDH 2015)

This image is designed for the lay educated reader and presents information in a clear and interesting fashion. The colors that they use highlight the titles of each section as well as draw readers’ eyes to the most important information in the diagram. The use of pictures is limited and appropriate as the focus is on repellants, and not on the individuals within the pictures. This diagram also very nicely separates which repellants should be used on skin and which should be used on clothing. There is no ambiguity within this diagram about which repellant to use when and on what (skin or clothing), presenting information in a clear, and concise manner.

In addition, the Vermont Department of Health provides links on their website to resources sent out to schools informing them on how to be tick smart and prevent tick bites. These resources appear to be last updated in 2013. It is unclear whether these materials are sent
out regularly or if they are only sent out upon a school’s request. The following was taken from the PDF designed for schools on the VDH website.

BEFORE THE FIELD TRIP:

If possible, have your child wear a long-sleeved, light colored shirt and long pants. This may be difficult to do when the weather is hot, but it will help keep ticks and mosquitoes away from your child’s skin and ticks will be easier to see on light colored clothing. Socks and shoes are better than sandals as they will leave less exposed skin. Apply a repellent to your child. (see below)

DURING THE FIELD TRIP:

Tuck the pant legs into the socks and tuck the shirt into pants. This will prevent a tick from moving underneath the clothing where it may not be seen. If a student gets a tick on them, he/she should tell an adult to help remove it properly. Children should watch for ticks on each other’s clothes so they can be brushed off before they attach. If the trip involves walking on trails, staying to the middle of the trail will help reduce the chances that a tick could climb from grass and bushes onto your child.

AFTER THE FIELD TRIP:

Tell your child to check themselves for ticks before getting on the return ride from the field trip. At home, conduct a thorough tick check on your child. Favorite places ticks like to go on the body include between the toes, back of the knees, groin, armpits, neck, along the hairline, and behind the ears. A warm soapy shower will wash off any loose ticks. Clothing should be laundered if a repellent was used on it.

(VDH 2015)

Information provided in this handout is presented in a very concise manner. The VDH encourages preventative behaviors to be practiced by children on field trips by encouraging them to wear light colored clothing, as well as using a tick repellant. This handout also encourages children to seek help to remove a tick if they find one on their body and keep clothes tucked into socks. Finally, the importance of checking your child for ticks and bathing them after they were outside is emphasized. Language is simple and clear, with no scientific jargon used, making this an effective way to communicate preventative behavioral strategies to families in Vermont.

Additionally, the Vermont Department of Health offers a letter that was updated in 2014 encouraging schools to create their own tick and mosquito safety procedures. This is a positive way to increase education in schools and does not limit education on Lyme disease to school nurses. As a Vermonter, I was not given any Lyme disease education in school. However, as
someone that was very active in sports as well as outdoors clubs, I feel that it would be beneficial to educate not only nurses, but many faculty members on Lyme disease and preventative strategies. Specifically, it may be beneficial to educate faculty members that run outdoors clubs, gym teachers, sports coaches, and after school leaders as they often bring students outdoors and into or near tick habitat.

Vermont also offers educational materials to be used in schools for grades 3-5 which appear to be factual as well as present information in a manner that fosters creativity and learning. Educational materials on the VDH website include a PowerPoint, instructions and educational materials for the teacher and activity worksheets for the students.

For 3-5 graders the main focus is on the following:

**How to BE TICK SMART:**

- Stay out of areas where ticks live.
- Wear light colored clothing & tuck pants into socks.

  - Repel – Use insect repellents that contain DEET on exposed skin and/or products that contain permethrin on clothing. Repellents with DEET concentrations of 30% or lower for adults and children over 2 months of age provide protection. (Products containing DEET should not be used on children under 2 months of age.)
  
  - Inspect – Check your whole body for ticks every day. Inspect children and pets thoroughly. After returning indoors, take a shower and wash clothing.
  
  - Remove – Carefully remove ticks with a pair of fine point tweezers. Wash the bite with soap and water. Alcohol, gasoline, petroleum jelly, or a hot match should never be used to remove a tick.

(VDH 2015)

The guide comes with helpful visuals about the life cycle and stages of ticks, their actual sizes and how to take care of your lawn to decrease the prevalence of ticks. The guide includes worksheets with a word search, some harder than others, based on grade level. Word searches are a good way to increase vocabulary and knowledge surrounding Lyme disease. There is also a
sheet where students are asked to draw what a tick looks like – good for identification purposes. There was also a crossword puzzle, which seemed to be aimed at younger students. The materials for grade 3-5 seem age appropriate and foster knowledge and understanding surrounding Lyme disease.

Overall, Vermont seems to have a myriad of resources available to the public and schools throughout Vermont. They present information using colors, highlighted text, and pictures in an effective way that draws readers’ attention to the most important information. They also use simple and concise language to communicate about preventative behaviors and tick repellants in a clear and effective manner that could be directed at both the scientific and lay educated community.

**Discussion: Comparison with Surrounding States**

In order to identify ways to stop or slow the spread of Lyme disease, examining how surrounding states address Lyme disease on their department of health websites can illuminate ways in which Vermont can improve its campaign against this disease. For this reason, I have chosen to look at grey literature from Connecticut, New York, and New Jersey, and New Hampshire to examine if and how their departments of health’s websites on Lyme disease differ in resources, aesthetics, and usability compared with Vermont. I chose these states to compare with Vermont because they have all experienced historically high rates of Lyme disease. In this chapter I compare and contrast state strategies in the hopes of identifying ways that Vermont can improve and ways that it is providing better prevention than other states. Overall, the preventative strategies offered on each states’ website do not differ from each other or from those offered by the CDC. The main way these states differ is in their educational resources and
presentation of information. Vermont focuses education on grades 3-5, while Connecticut continues through high school and the other states either have little to no educational resources or have them on some other media tool. In terms of aesthetics, Connecticut, Vermont, and New Hampshire seemed to use the most color and interesting fonts on their department of health websites, which could draw more of the public to their sites. For usability, Vermont and Connecticut present helpful navigational tools on the first page of their website so that readers can easily navigate through the website, which is something that more states should consider doing. New Hampshire and Vermont clearly offer additional resources by providing links to the CDC and other sites, making finding additional factual information quick and easy for readers. Although New Jersey does provide links to the CDC and NIH, they are less accessible than those offered by Vermont and New Hampshire because they are hidden in a brochure. Perhaps considering putting them on the first page of their website would be helpful. Vermont should consider continuing education surrounding Lyme disease and prevention through high school and could use Connecticut as a model. The other states should consider using Vermont, Connecticut, and New Hampshire as models to create user friendly sites that are aesthetically pleasing and offer a plethora of resources about Lyme disease

**Connecticut**

Connecticut remains a state with a high number of cases of Lyme disease and therefore was chosen as a case study for this research project. I examined their preventative strategies and educational resources for Lyme disease as listed on their Department of Health’s website. Connecticut has an effective website on Lyme disease prevention, with its greatest strength being that it provides educational materials and resources for ages ranging from kindergarten to high school.
Preventative strategies:

- Avoid tall grass and over-grown, brushy areas.
- Stay in the middle of the trails when hiking in the woods.
- Wear light-colored clothing so the ticks can be easily seen.
- Wear long pants to provide a better barrier than shorts.
- Tuck pants into socks creates a barrier and ticks will not be able to get to your skin.
- Wear long-sleeved shirts and closed shoes when in tick infested areas.
- Use insect repellent to significantly reduce the chance of tick bites and the transmission of Lyme disease.
- DEET is the primary active ingredient in most tick repellents and is considered the most effective. It must be used as directed on the container.
- Examine yourself, your children, and pets for ticks when returning indoors.
- Remove feeding ticks as soon as possible. Ticks need to feed for 24 hours before transmission occurs.
- When returning indoors, shower using a wash cloth or buff to remove walking ticks on your body. Ticks have a tendency to walk on the body before biting and feeding.
- Talk to your veterinarian to find out how to protect your pets from tick bites.

(Connecticut Department of Health 2014)

Educational Program Surrounding Lyme Disease in Connecticut

**Time for Lyme-School Curriculum Order Form**

A curriculum about tick-borne diseases for grades K, 3, 6 and 9 with age appropriate goals, activities and measurable guidelines. The curriculum includes tick awareness, prevention tips, proper tick removal, and the signs and symptoms of Lyme disease. The curriculum is designed for use in elementary school (grades K and 3), middle school (grade 6) and high school (grade 9). The K and 3rd grade programs focus on what ticks look like, where they live, and what to do if you find a tick with activities designed to ensure understanding of the program. The 6th grade program introduces more sophisticated concepts of prevention that is also delivered in a 22 minute DVD.

The ninth grade program adds a discussion of the psychological, emotional and social ramifications of Lyme disease, best described in the words of the high school students through a 20-minute DVD, specifically designed to address this complex issue. Our hope is that education will prevent Lyme disease in those who are well, and promote empathy, understanding and compassion for those who are struggling to overcome their illness.

In addition to the curriculum (including the 6th and 9th grade DVD’s), the packet also includes:

**I. Tick Removal Kit** - A complete tick removal kit including fine point tweezers with attached magnifier in a travel case, designed in collaboration with the American Red Cross and the Greenwich Department of Health.

**II. Nurses Information Packet** - A general packet of information about Lyme disease symptoms as well as a protocol that can be used in schools to help identify students at risk for Lyme disease.

Figure 14. This was taken from the Connecticut Department of Health’s Website (CDH 2014)

The preventative strategies offered by Connecticut do not differ from those offered by the Vermont Department of Health. Additionally, their educational program seems to focus on
increasing education and awareness for school nurses, similar to that of Vermont. However, their educational program continues through high school, which Vermont’s does not. Perhaps Vermont should consider continuing education surrounding Lyme disease through high school like Connecticut as we have seen that at-risk ages range from 0-19 indicating a need for continued education from primary through high school.

Connecticut also sets up their department of health Lyme disease homepage similarly to Vermont with helpful links all gathered neatly on the first page so that navigating the website is easy for readers. This website also offers a plethora of images which catch readers’ attention and helps to break up the text.

**New York**

New York’s website struggles with their presentation of information surrounding Lyme disease, making their website less effective than that of Vermont or Connecticut. Their use of color, text size and spacing make it difficult to read all of their information presented on Lyme disease. However, unlike VT and CT, New York discusses the need for more research on Lyme disease trends as well as on the use of four poster bait boxes and a vaccine for animals. New York was also examined as a case study because of its historically high prevalence of Lyme disease. New York offers the following preventative strategies that were taken from the New York Department of Health’s website.
Additional recommendations from New York focus on the need for more research and data about past, current and future disease trends; increased public awareness, implementation of preventive measures such as “4 Poster” devices and bait vaccines for animals to reduce the infected tick population and measures to improve diagnosis and treatment for those who have the diseases. I was not able to find information on New York’s educational resources for Lyme disease on their Department of Health’s website.

New York also offers general information about Lyme disease and displays is using black and green font in tightly spaced paragraphs. Perhaps double spacing the paragraphs and choosing a more calming color would make it easier for readers to digest all of the information provided. Here is an example from their website:
Overall, the preventative strategies do not differ between states thus far. New York encourages lawn maintenance, as does Connecticut and Vermont, which will be discussed in the following chapter.

**New Jersey**

New Jersey has, perhaps, the least effective website. With no evidence of educational materials, and presentation of Lyme disease in conjunction with other tick-borne disease, it would be easy for a lay-educated reader to become confused by the presentation of materials as well as on the details of Lyme disease. New Jersey was chosen as a case study as they have struggled with high numbers of Lyme disease throughout the years. New Jersey’s Health Department offers the following preventative strategies, which were taken directly from their website:
These preventative strategies do not seem to differ from those provided by Vermont, Connecticut, or New York. Unfortunately, I was unable to obtain any information about New Jersey’s educational resources through their Department of Health’s website.

New Jersey does offer a brochure on their website which talks briefly about tick-borne diseases in general. The brochure packs a lot of information in a small amount of space using red and black lettering that is not very aesthetically pleasing. In addition, it may be helpful if they had a brochure on each tick-borne disease as well as this summary brochure so that people could gain more information about each disease individually. Here is an example from the brochure:

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How can tick-borne diseases be prevented?

- Perform tick checks:
  1. Remove ticks from your clothes before going indoors.
  2. Wash your clothes with hot water and dry them using high heat for at least one hour.
  3. Perform a daily tick check after being outdoors. Inspect all parts of your body, including your armpits, scalp, and groin.

- Safely remove any found ticks:
  1. Use fine-tipped tweezers.
  2. Grab the tick close to the skin. Do not twist or jerk the tick, as this may cause the mouthparts to break off and remain in the skin.
  3. With a steady motion, gently pull straight up until all parts of the tick are removed.
  4. After removing the tick, clean your skin with soap and warm water.
  5. Contact your healthcare provider if you develop any symptoms.

- Do not use petroleum jelly, hot matches, nail polish remover or other products to remove a tick.

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(New Jersey Department of Health 2015)
New Jersey does not offer any obvious links on their website to the CDC or other educational resources like Vermont or New Hampshire (as you will see in the following paragraph). However, upon further investigation, the department of health does reference the CDC and the NIH as two sources for more information, yet this is only noted in a separate Lyme disease “Frequently Asked Questions” section. Perhaps providing more information regarding additional resources for information on Lyme disease and making their font colors more aesthetically pleasing could improve their Lyme disease resources and prevention.

**New Hampshire**

New Hampshire’s Department of Health website offers a wealth of information regarding Lyme disease and how to avoid ticks and tick bites. They use color and text in an aesthetically pleasing way while providing the public with helpful information regarding Lyme disease. The following image was taken directly from their website regarding preventative strategies.
Avoiding Tick Bites

- Stay on trails outdoors; avoid areas of overgrown brush and tall grasses.
- Wear light-colored clothing so ticks can be easily seen.
- Wear long pants, a long-sleeved shirt, closed toe shoes with socks, and a hat. Tuck your pants into your socks and your shirt into your pants.
- Check yourself, your children, and your pets often for ticks, shower after returning indoors.
- Use insect repellent containing DEET or permethrin (always follow directions).
- After returning indoors, run clothes in the dryer on high heat to kill any ticks that may be on the clothing.

How to Do a Tick Check

Black-legged ticks are very small, and a tick might look like a freckle or speck of dirt on a person’s skin. Ticks often like to bite in warm, dark, secluded areas of the body. It is important to check your clothing for ticks while you are outside, and do a whole body tick check at least once a day. Pay close attention to: hairline and scalp, in and around ears, underarms, elbows, backs of the knees, between fingers and toes, belly button, groin area, and areas where clothing presses against your skin (for example waistbands, collars, cuffs, watchbands). Don’t forget to check your pets as well! Remove any attached ticks promptly.

(New Hampshire Department of Health 2010)

The use of shapes to encompass the text draws readers in to the important information quickly and easily. They also provide visuals and information on the proper way to remove a tick and what a tick bite looks like. Their website also offers quick links to the CDC where readers can gather more information about tick bites, prevention, Lyme disease as well as other tick-borne diseases. The information provided is also consistent with CDC guidelines as well as that of other states. They do not seem to offer any educational tools on their website, similar to New Jersey. Perhaps they have educational tools in another location or simply do not offer links to them on their website. It would be interesting to investigate further into any education surrounding Lyme disease in either of these states.
In conclusion, the states do not differ in their preventative strategies against Lyme disease. The main ways in which these websites differ is in their available resources and presentation of information. Based on resources, aesthetics, and usability, I would argue that VT, CT, and NH have the most effective websites. They use color to highlight important information, employ clear and concise language to communicate with a lay educated audience, use images and shapes to provide a visual context for readers, as well as provide a wealth of resources and links to external sites where readers can gather more information.

**Challenges to Education and Awareness**

Interviewees as well as scholarly literature agree that increasing education and awareness throughout Vermont is the most effective way to increase prevention and decrease incidence of Lyme disease. However, only the interview participants identified that budgetary restrictions and challenges surrounding how to measure the efficacy of educational tools remain the main obstacles in Vermont’s public health campaign against Lyme disease.

The Vermont Department of Health is limited by its resources in both monetary and personnel that it has available to them, constricting how much outreach and education they’re able to do. According to Dr. Bloom, “it’s a challenge because we don’t have a huge budget and education is always more expensive than people think”. Cluss supports this statement by adding that “we don’t have the same resources in the state and it always comes down to money. You either have to write the grants or appropriate it in the state budgets”. Clearly, budgetary constraints are at the forefront of any public health campaign and is often the greatest limiting factor. Although we have discussed the idea of sending out educational tools and PSAs to schools surrounding Lyme disease and prevention, perhaps this would be too costly a venture for the Vermont Department of Health. Consideration for electronically communicating such
materials should be considered as well as collaborating with other governmental organizations to pool funds. Identifying at-risk groups and focusing effort and resources on them may be one way to save money and decrease the incidence of Lyme disease.

The idea of evaluating educational tools is imperative and was discussed throughout this chapter. However, designing evaluative tools and employing them can be costly and challenging. According to Dr. Bloom,

“… measuring the effect of educational outreach is very challenging. We haven’t done a lot of post surveys, mostly it’s just anecdotal feedback of how people find our materials. In May we did some underwriting with VPR as well as placed some Google and FB ads and that really drove a lot of traffic to our website. We think the online ads were effective but we did it with VPR underwriting and we think with those two combined it drove people to our website, but there’s no way to measure if people are learning anything”.

Here Dr. Bloom touches on a critical problem – it is difficult to assess what is driving people to check out the VDH website without some kind of survey or feedback system that has yet to be put into place for the VDH. Perhaps considering a feedback survey and emailing subscribers or posting it on the VDH website could improve knowledge of where people are getting their information, alternative ways they would like to receive information and what they are taking from the website or other PSAs.

According to the interviewees, a lack of monetary resources is the main constricting factor for public health campaigns against Lyme disease in Vermont. To address budgetary concerns, consideration should be given to electronic administration of information, as well as increased collaboration between governmental organizations. Finally, there is a need to evaluate existing educational resources to identify what works, what doesn’t, and prioritize how we can more efficiently and effectively educate the public about Lyme disease and how to prevent it.
Conclusion

Interview participants as well as the scholarly and grey literature agreed that increasing education and awareness should be at the forefront of public health campaigns against Lyme disease. Specifically, they all agreed that awareness should focus on what Lyme disease is, where it is most prevalent in Vermont, the signs and symptoms, and the serious complications that can arise from this disease, and that education should focus on behavioral preventative strategies including tick checks, wearing protective clothing, and using repellant. The scholarly literature differed from interview participants in that it specified that we should educate the public on not only what constitutes a preventative behavior, but on the efficacy of preventative behaviors. Interviewees differed from the scholarly and grey literature in that they specify that education should also include information on tick habitat as well as when (in terms of season and time of day) ticks are most active. Furthermore, preventative behaviors, information on how to remove a tick, as well as signs and symptoms of Lyme disease listed on the VDH website do not differ from those provided on the CDC website. However the CDC offers information on post treatment Lyme disease syndrome as well as on chronic Lyme disease, while the VDH does not. In comparison with surrounding states, no state excelled in all three aspects of aesthetics, usability, and resources. However, the websites of VT, CT, and NH did the best job at creating websites that had a range of resources presented in an aesthetically pleasing way and that were easy to use. Finally, only the interview participants identified budgetary constraints and the need for an evaluation tool as two main challenges to Vermont’s campaign against Lyme disease. To address these challenges, Vermont should consider communicating with schools electronically as well as increasing collaboration between states and governmental organizations. An evaluative tool needs to be created in order to better study what educational resources are effective and
which are not, so that the department of health can prioritize and use their budget to its maximum potential.
5. Prevention By Targeting At-Risk Groups: Age, Occupation, and Behavior

In this chapter, I will discuss how identifying at-risk groups to target with educational resources could improve prevention throughout the state as well as examine the best ways to reach people and the most effective tools to use. This chapter thus hopes to address the following research questions: What is Vermont currently doing to address Lyme disease, and how can we improve prevention in the context of educating at-risk groups? Scholarly and grey literature as well as interviewees agreed that Vermont could improve prevention by increasing education and awareness among groups of people who, due to age, occupation, or preferred leisure activity (behavioral risk), are at an increased risk of exposure to Lyme disease. Interestingly, among interview participants, there was some disagreement surrounding which groups of individuals are at an increased risk of exposure. The majority of interviewees agreed that people that loved to hike, fish, spend time outdoors in wooded areas or areas with a great amount of shrubbery were at an increased risk. One interview participant did not believe hunters were at an increased risk, while two other interview participants did identify them as having an increased risk of exposure. Interview participants also identified summer campers and low socioeconomic status populations as at-risk groups. Finally, there was significant debate among interview participants about the best way to reach at-risk groups in Vermont with education and awareness. The majority of participants felt that utilizing the radio, TV, and local papers, were the best ways to disseminate information and reach the majority of at-risk groups. Other suggestions, which came from myself (as a born and raised Vermonter) and from other knowledgeable Professionals in Vermont (my thesis committee), included continuing to put Lyme disease awareness ads in hunting and fishing magazines, incorporating Lyme disease education into Vermont college freshman orientation, putting ads in local grocery stores, YMCAs, and senior centers, providing tourists with Lyme
disease information on VT websites and resorts, and incorporating Lyme disease education into summer camps and Girl or Boy Scout clubs.

**How Vermont Can Improve Prevention: Identifying At-Risk Groups in Vermont**

**Age**

Interviewees, scholarly and grey literature agree that in order to stop or slow the spread of Lyme disease in Vermont, targeting at-risk groups with education and resources, could help decrease their risk of exposure. One of the main ways to target individuals in Vermont for education and preventative measures is by breaking it up by age. In talking about increasing education in schools, Ms. Green noted that, “I think that’s a great route to go to get at a younger audience, kids who are out and active, letting them know about ticks and what Lyme disease is”. Kids are often incredibly active and love to play outdoors, explore in the woods and run through bushes, all areas that are endemic to ticks. Increasing education for younger generations could foster positive preventative behaviors that could last throughout their lifetimes. Allen noted that, “definitely camps, like outdoor camps”, would be a good place to reach kids who are at risk of coming into contact with Lyme disease. Kids at summer camps are outdoors all the time and often spend ample time in wooded or grassy areas. The combination of being outdoors in the summer time and playing in wooded or grassy areas, makes summer camps a prime location for coming into contact with ticks and increasing your risk of Lyme disease. Therefore, interview participants agree that increasing education and awareness for students and campers represent two ways to target an at-risk population.

Grey literature from the CDC supports the interviewees’ view that certain age groups are more at risk for Lyme disease than others. According to the CDC, the greatest number of cases is
often seen among the youngest population (between the ages of 0-19) and between the older generations (between the ages of 30-59).

![Confirmed Lyme disease cases by age and sex--United States, 2001-2010](image)

**Figure 15.** This image shows that the populations most likely to become infected are between the ages of 0-19 and 30-59 and was taken from the Vermont Department of Health’s website (VDH 2010)

The scholarly literature supports the findings of two age groups that are more at risk than others. One study found that “the prevalence [of Lyme disease] was highest among age groups 0-19 and 30-49 years” (Phillips et al 2001: 220). The study noted that younger individuals were much less likely to practice preventative behaviors, indicating a need for increased education and awareness in younger generations. Interestingly, another study found that increasing age was associated with decreasing use of preventative behaviors only if the subject had no history of Lyme disease (McKenna et al 2004: 25). This indicates that there is a need for continued education and awareness even in older populations (those between the ages of 30-59 years) to ensure that preventative behaviors are continued throughout life.
The question is then raised on how to best reach these two demographics with education and resources. Perhaps we should consider asking these two age groups how to best reach them with information. Perhaps we could send out a survey or have students sent out into the public to collect data on how best to reach these two demographic populations. Information about Lyme disease could also be given out at senior centers or at any senior events that are subsidized by the community. For the younger generation, as discussed earlier, camp counselors should be educated on Lyme disease as well as information about Lyme disease taught at summer camps. Girl and Boy scouts, 4-H clubs should also employ Lyme disease education as part of their programs. Information should also be given out to local youth programs such as the YMCA or recreational sports. These ideas came from myself, as a born and raised Vermonter as well as knowledgeable professionals in Vermont.

In addition, it is worth noting that the first age cluster includes first year college students. Each year, thousands of students from around the country come to the University of Vermont, and surrounding Vermont colleges, many of them with little to no knowledge of Lyme disease. Perhaps Lyme disease education should become part of student (freshman) orientation.

**Occupational and Behavioral Risk**

Interview participants and scholarly literature agree that there are certain populations in Vermont who, due to occupation or behavior, are at an increased risk of tick exposure and consequently of becoming infected with Lyme disease. Hikers were named by interviewees as one of the most at-risk groups, along with anyone that routinely works outside or in the woods. Opinions differed on whether or not hunters constitute an at-risk group because they are out in the woods in the fall, which is not the time of year in which nymphs are most active. Finally, one
participant identified people of low socioeconomic status as being at an increased risk of Lyme disease.

When talking with the two employees from the Vermont Department of Health about the ways in which they reach at-risk groups, Ms. Green and Dr. Bloom discussed the importance of having warning signs and messages out where these groups are primarily located. For instance, Ms. Green noted that, “we do have some materials, like trail head signs that warn about ticks, for hikers and that type of thing so there’s not much we do specifically for at-risk groups”. The fact that the Vermont Department of health uses trail head signs to warn hikers indicates that they do view hikers as an at-risk group and is taking steps to reach them with information and warnings so they may be able to better protect themselves. Having trailhead signs is a good way to reach an at-risk population. Hikers in the woods are in tick habitat and therefore, by warning them at the location, we are meeting them where they are and informing them of the risks prior to their participating in that activity. By warning them about ticks, perhaps they are less likely to deviate from the main trail and more likely to check their bodies after the hike or apply DEET to their skin prior to hiking. Currently there is no evaluation tool to see how effective such signs are, which is something that is needed. If we were able to assess how people received trailhead warnings and how it affected their likelihood to partake in preventative behavioral strategies, we could design better warnings and signs to make it more likely that hikers would take precautions.

Dr. Bloom noted that in addition to trailheads, the Vermont Department of Health puts, “… an ad in the hunters guide every year. So it’s always good to meet people were they are. We’ve done some groups with the green mountain club. Meeting people where they are in their groups is always good. It’s a challenge because we don’t have a huge budget and education is always more expensive than people think”.

Here, Dr. Bloom emphasizes the importance of meeting people where they are. Once at-risk groups - such as hikers or hunters – have been identified, the best way to reach them with information and warnings is to go to the places in which they will be. Having information booklets or warning signs on trailheads or placing ads in hunting magazines will allow these at-risk populations to see the messages and may encourage them to practice preventative behaviors.

Dr. Bloom also raises the point that education is expensive and limited resources means that decisions surrounding what materials are distributed and where are crucial. Therefore, identifying at-risk groups in Vermont could help budgetary concerns by administering materials to the groups who are most at risk of coming into contact with Lyme disease.

There is some debate, however, over which groups are deemed to be at an increased risk of exposure. For instance, Allen noted that,

“I don’t think that deer hunters are at a huge risk because they hunt in November…its late summer when the nymphs are out that you have to be careful…definitely camps, like outdoor camps and hikers and stuff like that. Going to day camps and talking to the staff or having park rangers along the Appalachian trails. I do think that would be a great avenue…thinking about who those at-risk populations are and coming up with ways that the state could address them”.

Allen believes that due to the seasonal activity of nymphs, hunters are not at an increased risk because of when they hunt. Looking back at Figure 7, it is clear that nymphs are most active during the peak summer months. However, adult ticks, which still pose a threat to humans as they can bite and infect people with Lyme disease, are most active between October and December, which does in fact coincide with hunting season. Therefore, it is believed that hunters are in fact at an increased risk as they frequent tick habitats at a time when adult ticks are most active. Just as Dr. Bloom noted that hunters are often targeted with information by placing Lyme
disease warnings in hunter magazine, Cluss also noted that he believes hunters are at an increased risk. He noted that,

“Hunters and people who fish have to renew their license every year…I would hope that there is safety and training…I bet there is literature that is handed out with the licenses and it would be interesting to look at that. There is a transaction that takes place and there is an opportunity to educate. Not so much for hikers or people that just want to get out and do stuff. So you could have information at trailheads and there might be posters, information about using DEET, checking yourself after your hike”.

Here, Cluss identifies hunters and fishers, two groups who frequent tick habitats as being at an increased risk of coming into contact with ticks and becoming infected with Lyme disease, as well as sharing the view that hikers are at an increased risk as well. Although Allen feels that hunters may not be at an increased risk because of when they are active outdoors, Dr. Bloom and Cluss share the belief that hunters are at an increased risk of exposure because they are active outdoors in tick habitat at a time of the year when adult ticks are active. Therefore, the Vermont Department of Health should continue to place ads in hunter magazines as well as consider other ways to reach and educate this population. Perhaps they should consider placing education about Lyme disease and how to protect yourself in hunter training programs through the Vermont Department of Fish and Wildlife so that individuals will have to gain knowledge and understanding of ticks and Lyme disease prior to getting their hunting and fishing license.

Finally, Brown agrees with the other interviewees in that he believes anyone who frequently works outside is at an increased risk of tick exposure. However, he also identified people of low socioeconomic status as being at an increased risk. He noted that those at risk include, “anyone that works outside all the time. People that like to do recreation outside. It’s also an issue for people who are of lower socioeconomic standing because they are least likely to have the awareness and least likely to be educated on the challenges”. This is both an interesting
and important point and one that no other participant raised. Low socioeconomic status populations are often at an increased risk of disease and may receive less or less adequate healthcare. Therefore, targeting these populations with education and resources could be incredibly beneficial and may help to decrease the incidence of Lyme disease. Identifying areas of Vermont with increased poverty and then going into such areas with educational resources, signs, and public service announcements may increase knowledge and awareness of Lyme disease in these areas and could increase the likelihood that people will take precautionary measures to protect themselves and their families against Lyme disease. Other suggestions from myself (as a born and raised Vermonter) and knowledgeable local professionals from Vermont (my thesis committee) also suggested increasing signs and information available at local grocery stores, Re-stores, clinics, and temporary shelters could help reach low socioeconomic status populations.

It is also worth noting that Vermont has a large tourism industry and many flock to the green mountains in the summer and fall months to hike and sight see. Perhaps increasing information available on tourism websites in Vermont, popular tourist resorts throughout Vermont as well as continuing to have signs/pamphlets/tick identification cards at all popular hiking trails could help increase education and awareness of Lyme disease amongst tourists.

The scholarly literature on at-risk groups seems to be in agreement with the views of the interview participants. Studies in California have shown that infected individuals were much more likely to spend time outdoors than non-infected people and forestry workers in particular were more likely to test positive for Borrelia burgdorferi antibodies than controls (Gregory A Poland 2001: 67). This study strengthens the assertions made by interviewees that suggested that
anyone who works outside or spends ample amount of time outside is at an increased risk of exposure.

Occupational risk of exposure to Lyme disease is a serious threat and has been documented in many countries (Goldstein et al 1990: 1225). In another study, 70% of forestry workers reported having been bitten by a tick at least once in their lives (Zhioua et al 1997: 959). Similarly, another study revealed that 53% of forestry workers reported a history of a tick bite and they were significantly more likely to test positive for Borrelia burgdorferi antibodies than 200 controls (Rath et al 1996: 374). Finally, another study found that not only were forestry workers at an increased risk, but so were those that lived in or near heavily wooded areas. According to the study, those “working or playing in the woods are at an increased risk and should be targeted by public health efforts” (Maupin et al 1991: 1107).

Scholarly and grey literature, as well as interview participants, agree that identifying at-risk groups and targeting them with additional educational resources and messages may be the best way to increase the practice of preventative behaviors and decrease incidence of Lyme disease throughout the state. First, it is necessary to start education in Vermont at a young age. My interviewees and the literature agree that infection rates are highest between the ages of 0-19 and 30-59, which means that Vermont should increase education surrounding Lyme disease and how to protect yourself for these age groups. Perhaps the best way to do this would be to increase education in schools and education for summer camp counselors and campers so that they can protect themselves when outside. Furthermore, perhaps the state should consider approaching these two age demographics and asking them about the best ways to reach their age groups. In addition, anyone who routinely works outside, loves to hike, hunt, or fish, or lives in or near heavily wooded areas is considered to be at an increased risk of exposure and should be
targeted by additional public health education surrounding Lyme disease. Similarly, those who fall into the low socioeconomic status populations are at an increased risk and should also be targeted with increased education and awareness about Lyme disease and how to prevent it. One of the main challenges to education is money and resources. Therefore, by identifying these at-risk groups, the Vermont Department of Health can focus their energy on smaller populations, minimizing resource waste and decreasing the spread of Lyme disease in Vermont.

Finally, it would be interesting to examine if the Vermont Department of Health collects information such as occupation or behavioral habits on cases of Lyme disease that are reported in the state. Perhaps if they had patients report their occupation or leisure activities, we could gain a better understanding of which occupations or behavioral habits place people at the greatest risk of coming into contact with Lyme disease in Vermont to get even more specific and focus resources on those at-risk groups.

**Discussion**

**How the Vermont Department of Health Reaches the Public, and How to Improve their Strategy**

Interview participants in the study agreed that the main ways in which Vermont is educating the public about Lyme disease is through educational materials on their website, radio spots, and adds on Google and Facebook. However, interviewees disagreed on which avenues would be the most effective way to reach the public, and especially at-risk groups. Professor Cluss and Ms. Green agreed that perhaps the most effective way to spread information is by targeting at-risk groups and directing information to them (i.e., trail head signs, or ads in hunting magazines) while George Cook thought that TV and social media were two of the more
promising ways to disseminate information. Professor Brown worried about how many people still watch TV and thought local papers could be a good route to educate the public but noted that special consideration should be given to reaching individuals of low socioeconomic status as they may not listen to NPR or read the Burlington Free Press.

Experts from the Vermont Department of Health agreed that the main way in which Vermont is reaching the public with messages about Lyme disease and prevention is through the VDH website. According to Dr. Bloom, the main way that information about Lyme disease and prevention strategies is disseminated to the public is through the Vermont Department of Health website. She noted the following:

“The main way is through our website. We do have educational booklets that we give out at health fairs. We advertise on our website so people can contact us and order the materials. We give presentations every year. We have health people go to health fairs and there is some media coverage. We share several new stories to get the word out”.

Dr. Bloom also stated:

“We have flyers and send information out through the town health officers. Each town has a town health officer and some of them are very professional and some are part-time volunteers and many of them are on an email list serve we have so we can send them information. Sometimes the town clerks will get them to put up flyers. Media is probably the main way we get information out”.

Ms. Green supported what Dr. Bloom was saying and added that,

“We have materials here that can go to practices or that can go to the public. We don’t do a lot of education specific to providers, if they request materials we would send them but we don’t advise them on how to treat It’s all based on CDC guidelines. But there are materials they can review or provide to patients.”

Ms. Green also noted that, “we’ve done ads on Facebook and Google with the ‘be tick smart’ logo. We do a video contest for high school students. Whoever the winners are, they’re supposed to go on WCAX and talk about their video.”
Both Dr. Bloom and Ms. Green emphasized the Vermont Department of Health website as the main avenue for information concerning Lyme disease and how to prevent it. However, the main problem with this is that there is no way to tell how many people are looking at the website, who is looking, and what they are gaining from looking. Perhaps some people are gaining valuable information about Lyme disease while others simply scroll through and miss some of the more important messages on the website. Evaluation of the website is needed in order to structure it in a format that is the most effective at conveying accurate and helpful information surrounding Lyme disease and how to prevent it.

One of the main challenges facing the Vermont Department of Health is their ability to effectively and efficiently distribute information about Lyme disease and prevention. Dr. Bloom noted that they have given information to town health officials in the past to distribute in their towns. However, she also noted that it isn’t clear if, how and when the town health officials administer such information, so it is difficult to tell if this is an effective strategy for reaching the public. It seems that increased communication is needed between town health officials and the department of health as well as a way to evaluate how information is being given out and how it is being received by the public.

Town health officials seem to play an important role within the Department of health by distributing information surrounding Lyme disease throughout Vermont. Dr. Bloom noted that the Vermont Department of Health also gives presentations and health officials often go to health fairs. In talking with the specialist from Vermont Agrability, he noted that Lyme disease has been discussed at Vermont Farm shows in the past, but rarely has it been a regular topic of discussion. According to Cook,

“"We have brought the subject up and have put up press releases, blog posts…that’s a topic that has been exhibited at our Vermont farm show and
such…so anywhere we’ve had the opportunity to spread the word, that’s been one of those topic from time to time, has it been one of the key topics… maybe not necessarily”.

This shows that information surrounding Lyme disease may not be reaching rural Vermonters and especially farmers. More consideration should be given on how to reach these populations. Perhaps there should be a sign, pamphlets, or even an employee form the Vermont Department of Health present at summer farmers markets. This way, we could reach at-risk groups in the peak seasons that ticks are most active. Additionally, consideration should be given to increasing messages about Lyme disease through the media. Cook identified a TV show that has been running in Vermont since the 50’s and is targeted at farmers. According to Cook,

“Television here in Vermont, we’ve had the good fortune to have *Across the Fence*, which is the daily program. *Across the Fence* is a daily farm and home program that is produced by UVM extension and is the oldest longest running day time home program in the United States. Started back around 1950 and it is Monday through Friday, 12:10-12:30, it’s a show and a lot of extension folks use it. A good program are shows by extension folks across the state of Vermont and there are times when seasonal programs are used to fill in the open spots. It’s a 15-minute show, sometimes in the beginning of the show they may have time to include some of these seasonal or timely warnings.”

This show, targeted at farmers seems like it would be a good way to reach an at-risk population and educate them about Lyme disease, when ticks are most active and how to prevent being bitten. Interestingly, Cluss raises the question, “a lot fewer people are watching commercial TV now and a lot fewer people are reading newspapers now so the schools are a good place, but how do you get to the adults?” Therefore, while *Across the Fence* may be a good place to administer information to farmers, commercials may not be the most effective way to reach adults in the general public throughout Vermont. Certainly increasing education in schools, especially for the younger generations could increase the practice of preventative behaviors and decrease the
incidence of Lyme disease. The use of social media and Google ads, like Dr. Bloom noted, are also good ways to reach older populations.

Another possible venue for getting information out to the public would be the radio. NPR and VPR are common radio programs played in Vermont and may be a good place to administer public service announcements concerning Lyme disease. However, Brown challenges this suggestion, noting that NPR and VPR may only be reaching certain demographics in Vermont. He said that,

“You have to find out what it is that reaches them. Some of the less traditional routes of information… things like radio spots, but then you have to think about the spots on what radio stations. Lower socioeconomic status populations may not be listening to VPR, who knows. The other thing that comes to mind is that many parts of the state have local papers and I think often people will look at their local weekly paper and many parts of the state have those so I think that would be a good place to run educational messages.”

Interestingly, Cluss believed that, “people don’t read the Burlington Free Press much anymore”. Here we have a fundamental disagreement on which avenues people are receiving their news from in Vermont. More research is therefore needed to examine where people are getting the majority of their news from and which demographics in Vermont are using which news sources.

Identifying the best avenues to reach the public with information about Lyme disease and prevention is a continuing challenge for the Vermont Department of Health. Barlow and Brown agree that before we can create an effective educational campaign, we must first identify the most effective media outlets to disseminate such information. Barlow notes that, “public health has an education effort based on educating people on Lyme disease and on mosquito control that goes to the general public. I don’t know how well they are distributed or what their impact are”. Here, Barlow emphasizes the idea that although the department of health is currently running a “Be Tick Smart” campaign, there is no way to know how well this information is being received
by the public and what messages they are taking from it. Brown noted that, “you have to find out what it is that reaches them.” Identifying the best ways to reach people is going to be key moving forward. Creating evaluation tools to examine how well information is being absorbed by the public and how it is getting them to perform preventative behaviors will also be imperative in order to improve how and where we reach people with information about Lyme disease and preventative strategies.

**Conclusion**

In order to stop or slow the spread of Lyme disease, interview participants and the scholarly and grey literature agree that certain groups in Vermont are at an increased risk of exposure to Lyme disease, and education and awareness strategies should be targeted at such groups. At-risk groups include those between the ages of 0-19 and 39-50 in Vermont. At-risk groups also include hikers, hunters, fishermen, anyone who works outdoors in the spring, summer and fall months, kids working at or attending summer camps, and low socioeconomic states populations in Vermont. The Vermont Department of health should target these at-risk groups with education and resources with the hopes of increasing their awareness of Lyme disease as well as their practice of preventative behaviors. Interviewees disagreed on the best avenues to reach the public with information. The majority of interview participants felt that the most effective avenues in which to disseminate information included NPR, TV, and local radio stations. Other suggestions included continuing to put Lyme disease awareness ads in hunting and fishing magazines, incorporating Lyme disease education into Vermont college freshman orientation, putting ads in local grocery stores, YMCAs, and senior centers, providing tourists with Lyme disease information on VT websites and resorts, and incorporating Lyme disease
education into summer camps and Girl or Boy Scout clubs. Moving forward, we must find a way to evaluate how effective our modes of disseminating resources are. The Vermont Department of Health needs to examine the watching, reading and listening habits of specific demographics to see what they take away from health messages, in order to find the best news outlet as well as the most effective public service announcements.

In order to examine how Vermont can better address Lyme disease, it is necessary to examine all possibilities of primary prevention, one of which being a Lyme disease vaccine for humans. In the following chapter, I will discuss the history of the Lyme disease vaccine according to scholarly literature, as well as examine why it is unlikely that a human vaccine will be manufactured and used as a prevention method in the future. This chapter thus hopes to address the following research questions: In what ways can Vermont better prevent cases of Lyme disease in the context of vaccination? Interview participants as well as scholarly literature agree that for political and economic reasons, a vaccine is not a feasible prevention method for Lyme disease in humans.

Significance

History of the Lyme disease vaccine

According to scholarly literature, in the early 1990’s, two vaccines were developed to prevent Lyme disease. One vaccine was eventually withdrawn three years after it went on the market, and the other was withdrawn prior to the regulatory review. Both vaccines had shown safety and efficacy in clinical trials and in post-marketing surveillance. Author Robert Aronowitz (2012) noted the main challenges surrounding the production of these vaccines stemmed from the fact that this was a, “geographically limited disease that was treatable and preventable by other means” (250). In the beginning of production, many Lyme disease advocacy groups were supportive of the vaccine, but would eventually become some of its biggest opponents. Demand for the vaccine began to wane not long after its introduction on the market when rumors of Lyme disease-like side effects occurred in vaccinated individuals.
Two pharmaceutical companies, SmithKline Beecham (SKB) and Connaught Laboratories worked independently of one another to produce a Lyme disease vaccine. Both vaccines depended on the OspA protein on the outer surface of the Borrelia Burgdorferi bacteria. In addition, both vaccines underwent animal trials as well as phase III clinical trials on humans. SKB’s LYMErix vaccine contained an aluminum adjuvant, which can be used to boost immune defenses, while Connaught’s ImuLyme did not contain aluminum, which may have led to less side effects (Robert Aronowitz 2012: 255). Findings from both sets of clinical trials revealed that both vaccines were safe and effective. The number of nontrivial adverse reactions were similar in controls and subjects. Patients administered LYMErix also showed no cases of asymptomatic infection and the FDA licensed LYMErix in 1998 (Robert Aronowitz 2012: 255).

According to author Robert Aronowitz (2012), the two separate Lyme disease vaccines worked by utilizing the outer surface protein OspA that was present on the Borrelia bacteria (252). The vaccines essentially blocked the transmission of Borrelia Burgdorferi from passing from tick to human. OspA antibodies in the human would enter into the tick that was feeding on a vaccinated individual and neutralize the Borrelia within the tick before it could be transmitted to humans. The antibodies from the human would enter into the tick as it fed on human blood. The antibodies would enter into the tick’s gut and neutralize the Borrelia there before they were able to be transferred into the human host (Robert Aronowitz 2012: 252). The vaccine was administered in a three dose series and was 78% effective at preventing Lyme disease (Janice Carr 2014: 2).

**Concerns Surrounding the Vaccine**
According to author Robert Aronowitz (2012), there were three main concerns surrounding the LYMErix vaccine (255). The concerns focused on the fact that the clinical trials had excluded children, which limited the age groups that the vaccine could be administered to until safety and efficacy in children could be established. It was also believed that boosters would be needed in order to keep levels of antibodies high enough to kill the spirochetes in ticks. Finally, there was concern that side effects could arise years down the road and there was need for a long-term follow up study (Robert Aronowitz 2012: 255).

According to Author Janice Carr (2014), during clinical testing, 6,748 people received 18,047 doses of the vaccine with the most common adverse reaction being pain or reaction at the injection site, joint pain, muscle pain, and headache within 30 days of receiving the first dose (2). Given these rather routine side effects and the tested efficacy of the vaccine, LYMErix was given permissive recommendation which means it wasn’t added to routine vaccination lists for children or adults but was recommended to people who were at risk based on where they lived or their occupation. Between its licensing in 1998 and its removal in 2002, around 1.5 million doses were given out (Janice Carr 2014: 2).

Author Janice Carr (2014) also notes that, according to reports, some individuals, who had genetic predispositions that made it more likely that they would get arthritis from Lyme disease, reported getting Lyme arthritis after receiving the vaccine (2). In addition, pre and post-safety licensure data showed no difference in the “incidence of chronic arthritis between those who received the vaccine and those who did not” (Janice Carr 2014: 2). There were a total of 66 cases of serious adverse effects (life threatening illness, hospitalization, lengthened hospitalization, or disability) reported during the time that LYMErix was being administered. The number of adverse effects was not higher than would be expected in the general population.
regardless of the vaccine. Despite the fact that the number of adverse effects was not unusual, the media began to cover the story of side effects with the Lyme disease vaccine heavily. In addition, because LYMErix was only permissively recommended, it wasn’t covered by the National Vaccine Compensation Program (NVCP), which handles lawsuits and payoffs to anyone injured by vaccines. Therefore, people were filing lawsuits directly to the pharmaceutical company (SKB) making it more risky and costly to produce this vaccine (Janice Carr 2014: 2).

The media began to cover the story in length, emphasizing concerns over adverse effects, class action lawsuits as well as individual lawsuits that had been filed against SKB. Surrounded by lawsuits and negative media attention, SKB withdrew the Lyme disease vaccine in 2002 (Janice Carr 2014: 2).

**Results of my Research**

**Participant Views of the Human Vaccine for Lyme Disease**

Professors Allen and Cluss agreed that while having a human vaccine for Lyme disease would be an effective way to prevent Lyme disease, it is unlikely that one will be developed in the near future due to controversy surrounding side effects of the previous Lyme disease vaccine that was discontinued in 2002. Professor Allen noted that, “I think a vaccine would be great, it’s the ultimate preventative method and then people in high-risk areas could take the vaccine”. He makes a good point, emphasizing the idea that vaccines are the best primary prevention strategy against diseases in many cases. Vaccines allow our bodies to mount defenses against a disease prior to actually coming into contact with that pathogen so that when our body does in fact run into that disease in nature, it will already have the antibodies to attack and kill the pathogen before it has the chance to cause us to fall ill. He also noted that a vaccine would be beneficial
for those in high-risk areas. This is an important piece about the vaccine. Not everyone in the US would need to be given the Lyme vaccine simply because they don’t live in high-risk areas or their behaviors (such as gardening or hiking) don’t place them at an increased risk of exposure that would warrant them getting the vaccine. Therefore, although the vaccine would not be needed for everyone (it wouldn’t become part of routine vaccination schedules at your primary care office), it would be incredibly beneficial for those at an increased risk of coming into contact with the disease. Professor Cluss also noted that, “it would be good to give that vaccine to people that are at risk. So those are people that work in like fish and game, people that work in parks and are out where the ticks are. The other thing with Lyme disease is that there isn’t a huge market for it.” Here, Cluss is supporting the idea of vaccinating at-risk groups as a preventative strategy. He noted that although there is not a huge market for the vaccine (i.e., not everyone would need to receive it as part of their regular vaccine schedule), it could reduce the prevalence of disease among populations that are at an increased risk of exposure.

One of the main problems with vaccine development is the relationship between the cost of production and the monetary return. Both Allen and Cluss note the monetary challenges with vaccines as a primary reason as to why it is unlikely that another Lyme disease vaccine will be developed. When talking about why the previous Lyme disease vaccine was taken off the market, Allen talked about the challenges associated with getting pharmaceutical companies to produce a product that will have little revenue producing potential. He noted that,

“I think because the vaccine was on the market and then taken off and because it’s expensive to develop them and they need a lot of support, I think it’s going to be really hard to develop another one. I think the pharmaceutical companies don’t think it’s worth the risk and there’s not a huge market for it because it’s a regional disease.”
Allen emphasizes the problems associated with incentive that often drive pharmaceutical companies to develop products. The incentive to develop a vaccine that won’t be part of routine vaccinations is low simply because this is not a vaccine that will be purchased and used in large quantities regularly. This is a vaccine that would only apply to certain geographically located populations, making it less likely that the pharmaceutical companies producing this product would profit. Therefore, pharmaceutical companies are more likely to invest time and money into producing products that can be used by large populations of people at regular intervals in order to increase profits.

Similarly, Cluss talks about the risk of adverse reactions as a major deterrent to pharmaceutical companies when considering production of a new vaccine. Due to controversy over side effects with the previous Lyme disease vaccine and subsequent law suits and payoffs, it is likely that many pharmaceutical companies are hesitant to create another Lyme disease vaccine. Cluss noted that,

“The thing about vaccine in this country in general is that vaccines are not a good bet in terms of a revenue generating product. People can have adverse reactions and there can be big payoffs involved. So vaccines are only made by a few different pharmaceutical companies these days. So why don’t we nationalize vaccine production in this country because the private industry isn’t getting it done. I’m not blaming them, there’s no incentive to do it.”

Cluss raises an interesting point; with only a few major pharmaceutical companies producing vaccines, the risk for manufacturing and distributing a brand new vaccine is incredibly high for one company. Especially if that vaccine in question would not be protected under the National Vaccine Compensation Program, the risk of payoffs due to unexpected side effects falls on the pharmaceutical company. Therefore, it is unlikely that any one company would want to
assume that risk, in fear of lawsuits and hefty payoffs, in order to produce a vaccine that has little profitability from the start.

Both interview participants agree that while a vaccine for Lyme disease would be beneficial and an effective form of primary prevention for at-risk groups, the lack of profitability coupled with concerns surrounding previous side effects, make it unlikely that a new Lyme disease vaccine will be produced in the near future.

**Discussion and Conclusion**

Although the vaccine was deemed safe and effective in clinical trials, according to scholarly literature and interview participants, negative media attention surrounding reported side effects as well as lawsuits that went directly to SKB rather than to the NVCP made it incredibly costly and difficult to produce this vaccine. The vaccine was tested and proven to be safe and effective. The pattern of adverse reactions reported was not unusual and was not more than would be expected in the general population if the vaccine had not been given out. Additionally, the majority of patients who suffered Lyme arthritis after receiving the vaccine had a genetic predisposition to this condition. The torrent of negative media attention was supported by anti-vaccination advocacy groups as well as Lyme disease advocacy groups. In addition, the scholarly literature and interview participants agree that because Lyme disease is only a threat in certain geographical locations, preventable by other means (such as using DEET, wearing protective clothing, avoiding tick habitat, and doing tick checks) as well as not deadly and is treatable (the majority of symptoms and complications go away on their own or can often be successfully treated with antibiotics), a vaccine is not needed. Finally, the scholarly literature emphasizes that there is little to no evidence that Lyme disease can be transmitted person to
person and therefore a vaccine would not confer immunity to those that are unvaccinated, further decreasing the need for a vaccine. Therefore, like Allen and Cluss suggested, although a vaccine would be an effective way to prevent Lyme disease, especially among at-risk groups, it is highly unlikely that a human vaccine for Lyme disease will be developed because of the history of the vaccine. There is too little of a population that would benefit from this vaccine to be profitable for pharmaceutical companies, and the fact that lawsuits would go directly to the companies (not protected under the NVCP) creates a disincentive for companies to produce this product.
7. Prevention by Targeting Host Populations: An Innovative New Idea

In order to stop or slow the spread of Lyme disease, interview participants and scholarly literature suggest targeting host populations as a preventative strategy. In the following chapter, I will explore prevention strategies that focus on host populations such as four-poster bait boxes, targeting small mammals that carry the Lyme disease bacteria, and removing host populations. This chapter thus hopes to address the following research questions: In what ways can Vermont better prevent cases of Lyme disease in the context of targeting host populations? Interviewees and scholarly literature agreed that four-poster bait boxes for large mammals may be a positive preventative method. Two interview participants felt that targeting small mammals with bait boxes would be an effective Lyme disease prevention method, while the majority of scholarly literature suggested that bait boxes for small mammals were ineffective at controlling tick populations. Finally, both the scholarly literature and one participant found host removal to be an impractical and unfeasible option.

Targeting Large Mammals: Four-Poster Bait Boxes

Both Professor Allen and the scholarly literature agreed that four-poster bait boxes targeted at large mammals that are competent hosts for Borrelia bacteria may provide a good way to address Lyme disease by decreasing tick populations. Four-poster bait boxes, which target hosts with acaricide to kill ticks, represent a possible method of tick control that could be beneficial in the state of Vermont. Four-poster bait boxes are placed in densely wooded areas highly trafficked by deer, a host for Lyme disease. Ears of corn are placed in the boxes as bait for the deer, and when the deer reach their necks in to eat the corn, they have to push through two paint rollers which are coated with an acaricide which is then transferred to the deer. Ticks on the
deer’s neck are brushed off and killed by the paint rollers and acaricide, essentially decreasing tick populations in these areas.

Professor Allen felt that four-poster bait boxes could present a promising preventative strategy against Lyme disease by decreasing tick populations. According to Allen, “deer…can support large tick populations…. The research on how effective those [four-poster systems] are is pretty varied. I’ve never heard of them being used in Vermont”. Allen noted that deer, represent an animal population capable of supporting large tick populations, meaning that in order to decrease the prevalence of ticks in Vermont, we must seek ways that incorporate the host populations. Interestingly, Allen noted that he hasn’t seen any evidence of these boxes being used in Vermont. I also was not able to find any information in the scholarly or grey literature on past or current use of bait boxes in Vermont as a prevention strategy. Perhaps this is something that Vermont should consider using, especially as a state with large areas of densely wooded forests, which are a prime habitat for both deer and ticks.

Figure 16. This image shows a conventional four-poster bait box system. The image was taken from the American Lyme Disease Foundation (2012)
The scholarly literature seems to suggest that four-poster bait boxes are, in fact, an effective way to decrease tick populations. One study compared the prevalence of nymph and adult ticks in an area with the four-poster device and from similar control areas over a six-year period in five different locations throughout Northeastern US. The study found that in areas with four poster bait boxes, the prevalence of nymphal and adult ticks decreased by 68% compared to control areas, indicating that the device successfully limited tick population and decreased the probability of Lyme disease in those areas (Hoen et al 2009: 473). In a similar study conducted in Connecticut between 1999 and 2003, they found, “46.1%, 49.6%, 63.4%, 64.6%, and 70.2% reductions, respectively, in the nymphal tick population in comparison with the untreated community and initial tick abundance” (Stafford et al 2009: 375). Such significant reductions in tick populations suggest that bait boxes may be an effective way to decrease tick populations as well as decreasing the risk of Lyme disease.

Although bait boxes are effective, their efficacy is short lived. One scholarly study examined the longevity of effects from bait boxes to see how sustainable they are. The bait boxes were used for two years and decreased nymphal and adult tick populations by 50%. According to the study, “that level of tick control was maintained for 1 year after removal of the 4-Poster devices but began to wane 2 years after treatment ended” (Miller et al 2009: 405). This is an interesting study as it shows that the decreased levels of tick populations continue to be low within a window of two years once the bait boxes are removed. However, perhaps this is not a very long time when considering how much money and maintenance are required for an individual bait box. Bait boxes must be checked up upon to see if they need any repairs, acaricide must be reapplied to the paint rollers and corn must be continuously placed in the boxes as bait. Considering such costs against the benefits of decreased tick prevalence and risk of Lyme
disease, perhaps bait boxes are not the most economical choice for prevention in Vermont. Perhaps a small number of bait boxes could be placed in strategic locations throughout Vermont in areas with the highest density of cases of Lyme disease as a prevention method rather than placed in abundance throughout Vermont.

Overall, Professor Allen mirrored findings in the scholarly literature, agreeing that four-poster bait boxes provide an effective method at reducing tick populations and could decrease the risk of Lyme disease throughout Vermont. However, although bait boxes appear to be effective and have been shown to reduce both nymphal and adult tick populations, decreasing the risk of Lyme disease, as stated earlier, the relatively short lived results of two year sustainability indicate that these may not be the most economically smart preventative method. It would be worth investigating the cost benefit relationship for bait boxes as there is currently little to no literature on the topic. It may also be worth placing a small number of bait boxes in areas around Vermont that see high numbers of Lyme disease, to evaluate if bait boxes could help to reduce the number of cases in these areas. More research into the economic demands of bait boxes is needed prior to administering four-poster bait boxes throughout Vermont.

**Targeting Small Mammals: Bait Boxes**

Although two interview participants feel that targeting small mammals would be an effective preventative method, the majority of scholarly literature suggests that bait boxes for small mammals are ineffective at controlling tick populations and any reduction in tick population size was short lived. Only one scholarly study suggested that bait boxes for small mammals had the potential to significantly reduce tick populations. Small mammals, including chipmunks and white-footed mice represent two competent hosts for the *Borrelia burgdorferi*
bacteria. Administering cotton balls soaked in acaricide, bait boxes, and reduction of host habitat represent three possible ways to reduce the prevalence of infected ticks. Two interviewees agreed that in order to better address Lyme disease, we must somehow target the host populations, especially the white-footed mouse, a very competent host for Borrelia bacteria. In contrast, the scholarly literature is inconclusive on the benefits of targeting small mammals with bait boxes.

Both Professors Allen and Cluss agreed that there is a connection between population sizes of small mammals and prevalence of Lyme disease. Especially with the white-footed mice, which are hardy mammals that can live in forest edges and in human interrupted environments very easily; they contribute to the maintenance of tick populations. According to Allen, “that’s one reason that people think of that Lyme disease is on the rise. Usually a lot of things can’t live in that small forest fragment but mice are totally fine there -- some time in the barn, some time in the field.” Allen emphasized the hardiness of mice as competent hosts. They are able to inhabit a variety of habitats fairly easily, making it difficult to decrease their population size and consequently decrease tick population sizes. Cluss also emphasized the importance of the relationship between mice and ticks, noting that, “anything that will increase the population of mice will contribute to a potential increase in Lyme disease.” The relationship between mice and ticks seems clear and they are indisputably linked. Therefore, the challenge falls on finding the best way to address Lyme disease by targeting the host populations.

Professor Allen emphasized the idea that bait boxes for small mammals have the potential to effectively reduce tick populations because they capitalize on natural small mammal nesting behaviors. Allen noted that, “more feasible would be to put out cotton balls soaked with pesticide that kills ticks. Mice use cotton balls to build homes. Biocide targets ticks. Instead of killing the mice, you kill the ticks.” Allen emphasized that we should take advantage of the mice
and chipmunk’s scavenging habits and get them to help us decrease tick populations by using acaricide soaked cotton balls. By utilizing nesting habits, we can target the most competent hosts and decrease prevalence of bacteria infected ticks.

Figure 17 shows a white-footed mouse, the most competent host for Ixodes scapularis ticks. The image was taken from Northern Woodlands online Magazine website (2012)

The scholarly literature on the use and efficacy of bait boxes is varied and inconclusive, with the majority of studies suggesting that bait boxes for small mammals are not effective at reducing tick populations. According to one scholarly study that administered bait boxes containing wicks dipped in acaricide (in this case it was fipronil), the wicks provided protection against ticks for up to 7 weeks. However, the study concluded that the overall usefulness of bait boxes is unclear due to the short-lived results and several studies are currently in progress examining this topic in Northeastern US (Dennis and Piesman 2005: 9). Another study examined the efficacy of administering cotton balls soaked in permethrin in a cardboard tube in mice territory. The success was dependent upon the white-footed mice using the cotton balls in their nests. Unfortunately, this study did not reveal any significant reduction in tick populations in Connecticut and New York and only limited reduction was seen in Massachusetts. However, another study examining the protective abilities of fipronil found that when administered to
white-footed mice in the wild, “the prevalence of infection with B burgdorferi in the mice dropped dramatically after one year and nymphal tick populations were substantially reduced after only two years of use” (Kirby Stafford 2004: 35). In addition, this study noted an alternative to the cotton balls. It suggested the use of a, “sealed, ready to use, child resistant box containing nontoxic food blocks and an applicator wick impregnated with 0.70% fipronil”. This device treats both mice and chipmunks as they walk through the box to retrieve the bait.

Although two interview participants feel that targeting small mammals with bait boxes would be an effective preventative method, the scholarly research concerning the efficacy of bait boxes suggests that bait boxes are not effective at reducing tick populations and any reduction is often short lived. It is also unclear as to the cost of bait boxes and any maintenance they require or how often acaricide needs to be reapplied, and consequently more research is needed. Due to the findings in the scholarly literature, it seems that bait boxes targeted at small mammals do not represent a positive preventative method that should be used or encouraged by the Vermont Department of Health.

**Host removal**

Several scholarly studies have been conducted examining the efficacy and feasibility of removing host populations that carry the Borrelia burgdorferi bacteria. However, both the scholarly literature and an interview participant agree that host removal is not a feasible option and should not be something that Vermont considers as a means to controlling Lyme disease.

According to interviewee Professor Allen, the prospect of eliminating an entire population of animal from Vermont is incredibly unlikely to be successful and should not be considered as a preventive technique for Lyme disease. Allen argued that “it’s not feasible to just
eradicate mice”. He goes on to emphasize that it would be “really really hard to eradicate white footed mice – they are total troupers and they are very good at living in human disturbed areas”. Allen staunchly opposes trying to eradicate the white-footed mouse from Vermont, simply because of the feasibility. Although the white-footed mouse is the most competent host for I scapularis ticks in Vermont, eliminating them would not eliminate ticks as they can still feed on a variety of other animals such as deer, chipmunks and birds. Attempting to eliminate any of the host populations for ticks would be costly, difficult, and highly unlikely to achieve complete elimination and there is no telling the environmental impacts eradication could have on the environment and surrounding animal populations.

According to the scholarly literature, there have been few attempts in the US to eliminate or reduce host populations as a way to reduce populations of ticks. One study examined the effects of removing white-tailed deer completely from an isolated island off the coast of Maine. The study revealed that, “close monitoring of populations of I. scapularis during the period following deer removal demonstrated that adult ticks initially increased, as they could not find a host, but eventually crashed to 1/28 of their original levels”. This study concluded by suggesting that in isolated circumstances, deer eradication can significantly reduce the presence of Lyme disease (Rand et al 2004: 780). The important thing to note about this study was that it was conducted on an isolated island and therefore results cannot be extrapolated to states in Northeastern US because deer can migrate between states and there is no way to completely eliminate them from the entire country. Both this study and Professor Allen stress the impracticality of eradication on mainland states and suggests fencing as a possible alternative to decrease the prevalence of deer entering into highly trafficked human territory. Fencing and other landscape management practices will be discussed in the following chapter.
Discussion and Conclusion

First, both Professor Allen and the scholarly literature agree that the use of four-poster bait boxes targeting large mammals is an effective method of tick control and could be a beneficial Lyme disease prevention method to be used in Vermont. More research is needed into the costs of maintenance for four-poster systems before widespread application throughout the state. Perhaps limited use in Lyme endemic areas of Vermont could show whether or not bait boxes targeting large mammals should be used on a wider scale throughout the state. Next, while two interview participants felt that targeting small mammals with bait boxes could decrease tick populations and stop or slow the spread of Lyme disease, the scholarly literature yielded a contrasting view on the topic. The majority of scholarly literature suggests that bait boxes for small mammals are not effective at reducing tick populations, and any reduction in tick population is short lived. Therefore, based on findings in the scholarly literature, bait boxes for small mammals should not be considered for use in Vermont as a preventative method against Lyme disease. Finally, both the scholarly literature and Professor Allen agreed that host removal in a state that is landlocked - like Vermont – is simply unfeasible and could have serious environmental and ecological effects.

In this chapter I will examine the safety of and alternatives to traditional synthetic acaricides that are currently used in Vermont and surrounding states. I will also explore landscape management best practices as well as landscape management practices that Vermont encourages through its Department of Health website. Finally, I will consider the practicality of disease and animal surveillance for Lyme disease in Vermont. This chapter thus hopes to address the following research questions: What is Vermont currently doing to address Lyme disease, and how can we improve prevention in the context of acaricide use, landscape management best practices, as well as animal and disease surveillance. Mirroring the grey literature, one interview participant shared the concern that synthetic acaricides could be damaging to the health of humans, animals and the environment. The majority of information I found on synthetic acaricides was from grey literature, however I did find scholarly literature on the safety of DEET. A review of scholarly literature revealed that at low doses, DEET is a safe repellant. However, the scholarly literature also identified a number of natural alternatives to synthetic acaricides that were as effective as DEET at repelling ticks and were also safer for the health of humans, animals and the environment. Furthermore, grey literature from the VDH, CDC, and Connecticut Department of Health shared similar landscape management practices. Scholarly literature on the topic of landscape management practices differed from grey literature only in that it encouraged landscape management practices to be extended to schools, parks, and playgrounds. One participant deviated from the literature, suggesting that in addition to current landscape management practices, Vermont should consider getting rid of certain invasive species as a tick control method. Finally, among the interviewees, views differed on the efficacy of
surveillance in Vermont, however, the majority of interviewees agreed that disease surveillance is necessary while tick surveillance is costly and unnecessary.

**Safety of and Alternatives to Synthetic Acaricides**

The scholarly and grey literature, as well as one interviewee shared the idea that natural alternatives to synthetic acaricides provide a safer and equally as effective option for repelling ticks. In my interviews, Professor Cluss raised concerns over the use of acaricides to prevent tick bites, noting that there could be possible health complications that arise from their continued use. Cluss noted that many people often, “treat with larvicides, stuff that goes after eggs and adults. It’s somewhat controversial because when that spraying truck comes around its pretty nasty.” In my own research, I have not found evidence that Vermont currently performs any routine spraying of land by acaricide, however they do encourage the use of acaricides on clothes and in the yard. Therefore, it is necessary to examine the effects acaricides and investigate alternative repellants that may pose less of a health threat to humans, animals, and the environment.

The Vermont Department of Health has a handbook out encouraging the use of acaricides as a means to decrease populations of I. scapularis ticks. They name 7 different acaricides in the booklet for personal and/or commercial use (Pesticides for Tick control handbook: 2015).
Table 4. Acaricides with products labeled for the control of ticks in the residential landscape.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Some brand or common names*</th>
<th>Chemical type and usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bifenthrin</td>
<td>Talstar® Ortho® product</td>
<td>Pyrethroid insecticide. Available as liquid and granular formulations. Products available for homeowner use and commercial applicators.</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>Sevin®</td>
<td>Carbamate insecticide. A common garden insecticide for homeowner use, some products are for commercial use only.</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>Tempo® Powerforce™</td>
<td>Pyrethroid insecticide. Available for commercial and homeowner use with concentrates and ready to spray (RTS) products.</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>Suspend® DeltaGard® G</td>
<td>A pyrethroid insecticide for commercial applicators.</td>
</tr>
<tr>
<td>lambda-cyhalothrin</td>
<td>Scimitar® Demand®</td>
<td>A pyrethroid insecticide for commercial applicators.</td>
</tr>
<tr>
<td>Permethrin</td>
<td>Astro® Ortho® products</td>
<td>Pyrethroid insecticide. There are concentrates and ready to spray (RTS) products. Most are for homeowner use, a few are for commercial use only.</td>
</tr>
<tr>
<td>Pyrethrin</td>
<td>Pyrenone® Kicker® Organic Solutions All Crop Commercial &amp; Agricultural Multipurpose Insecticide®</td>
<td>Natural pyrethrins with the synergist piperonyl butoxide (PBO) or insecticidal soap provide limited tick control. A combination of pyrethrin and PBO with either insecticidal soap or silicon dioxide (from diatomaceous earth) was found effective against ticks in one trial.</td>
</tr>
</tbody>
</table>

*Active ingredients and brand names frequently change as new products are registered and others discontinued. New formulations for homeowner use may become available. Mention of a product is for information purposes only and does not constitute an endorsement by the Connecticut Agricultural Experiment Station.

Figure 18. This image lists the different types of repellants suggested for use by the Vermont Department of Health. This image was taken directly from their Tick Management Handbook, available at http://healthvermont.gov/prevent/lyme/documents/handbook6.pdf (VDH 2015)

In order to gain a better understanding of the risks that certain acaricides can pose, I first consulted grey literature as such resources are targeted at consumers and offer a large amount of information on the topic. I began my research on the Pet Poison Helpline which is authored and edited by board-certified veterinary internal medicine (DACVIM), emergency critical care (DACVECC) specialists, and veterinary toxicologists (DABVT, DABT). According to the Pet Poison Helpline website, acaricides including Bifenthrin, Cyfluthrin, Deltamethrin, lambda
cyhalothrin, permethrin, and pyrethrin are all *pyrethroid insecticides*, which are deemed poisonous to cats and dogs. Furthermore, the toxicity of pyrethroid insecticides ranges from mild to severe and can be life threatening. According to this website, “pyrethrins are a class of drugs derived from the *Chrysanthemum* flower/plant, while pyrethroids are synthetic derivatives” (Pet Poison Helpline 2015). Pyrethrins and pyrethroids come in a variety of concentrations (from < 1% to up to 55% or more). Although higher concentrations can be safely used on dogs, cats are very sensitive to these chemicals and can’t metabolize these drugs as well as dogs (Pet Poison Helpline 2015). The most common accidental poisoning of cats with pyrethrins or pyrethroids is by the application of dog flea and tick medication onto cats, which should never be done without the consultation of a veterinarian (Pet Poison Helpline 2015). Cats may also be poisoned if they lick tick or flea medication off of a dog that has been recently treated with it (Pet Poison Helpline 2015). The website also notes that, “profuse drooling, vomiting, tremoring, hyperexcitability, agitation, seizures, weakness, and difficulty breathing”, could all be signs of poisoning in cats (Pet Poison Helpline 2015).

Pyrethroids can have a range of possible side effects on humans and animals, ranging from being an irritant at low levels to being toxic at higher doses. The following excerpt was taken from the Institute of Food and Agricultural Science Extension through the University of Florida, which partnered with the U.S. Department of Agriculture..

“Pyrethroids are one of the least acutely toxic insecticides to mammals because they are quickly deactivated by metabolic processes. However, rats fed high doses (1,000 mg/kg of body weight) showed liver damage (Hayes 1982). Toxicity by inhalation and dermal absorption is low. Sensitization sometimes occurs in some individuals after a single exposure, which causes either an asthmatic condition or a skin rash or inflammation”. (Frederick Fishel 2015)
This indicates that pyrethroids can be toxic at high levels and can be irritants at lower levels.
Additionally, “pyrethrins are highly toxic to fish and tadpoles. They affect their skin touch receptors and balance organs” (Frederick Fishel 2015). This is an important point because many pyrethroids are sprayed outdoors and could contaminate local ponds, or even small pools of water where tadpoles live. Perhaps an environmental impact study is needed before continued use of pyrethroids in Vermont.

Pyrethroid acaricides can produce a number of side effects that can be very uncomfortable for humans and/or animals. According to the Institute of Food and Agricultural Science Extension through the University of Florida, some of the common side effects that occur due to exposure to pyrethroids include, “stinging, burning, itching, and tingling, progressing to numbness, with the face most commonly affected. Persons treated with permethrin for lice or flea infestations sometimes experience itching and burning at the site of application” (Institute of Food and Agricultural Science Extension: 2015). The grey literature suggests that there are number of side effects for both humans and animals that can occur and cause harm at both low and high levels of exposure to pyrethroids, strengthening the argument that natural alternatives to synthetic acaricides should be considered. In addition, “scientists have no data from work-related, accidental poisonings, or epidemiological studies that indicate whether or not pyrethrins are likely to cause cancer in humans” (Frederick Fishel 2015). Additionally, this website states that, “poisoning due to pyrethroids in humans: Despite their extensive world-wide use, there are relatively few reports of human pyrethroid poisoning. Less than ten deaths have been reported from ingestion or following occupational exposure” (Frederick Fishel 2015). A scholarly article examining the safety of exposure to pyrethroids in humans revealed similar results, finding that, “concentrations recommended for treatment… [posed] little or no hazard to people” (Zairn et al
Although there has been little research conducted on the effects pyrethroids have on the environment, animals, and humans, the grey literature emphasizes that negative effects, ranging from irritation to death, have been recorded in animals. Therefore, more research (especially longitudinal studies looking at effects over time) is needed to look at the safety and health effects of pyrethroids. Natural alternatives should also be considered.

Another type of insecticide that the Vermont Department of Health recommends is Carbaryl, which is a carbamate insecticide. According to PETMD, which notes that information provided on their website is gained from scholarly articles written and reviewed by certified veterinarians, exposure to toxic levels of carbamate insecticides have been shown to cause seizures and respiratory arrest in dogs. Other reported side effects include anorexia, muscle weakness and muscle twitching which can last for days or even weeks. Carbamate insecticides, “inhibit cholinesterases and acetylcholinesterase, essential enzymes in the body” (PETMD 2015). Cholinesterases are enzymes, which break down acetylcholine, an essential neurotransmitter involved with many pathways in the body, especially muscle movement. When cholinesterase is inhibited by the insecticide, it can’t break down acetylcholine which means acetylcholine remains attached to postsynaptic receptors of neurons causing muscle twitching and seizures (PETMD 2015). Symptoms of poisoning by carbamate occurs at high levels of exposure and include, “muscle weakness, dizziness, sweating, and slight body discomfort are commonly reported early symptoms. Headache, salivation, nausea, vomiting, abdominal pain, and diarrhea” (Frederick Fishel 2015). Overall, Professor Cluss as well as grey literature share the view that the synthetic acaricides encouraged for use by the Vermont Department of Health pose a threat to the health of animals, humans, and the environment. Next, it is necessary to
examine the safety of DEET, a synthetic acaricide that is encouraged for use to repel ticks by the VDH.

**Efficacy and Risks Associated with DEET as well as Alternatives**

Scholarly literature suggests that DEET is safe to use in low doses and alternatives to DEET and synthetic acaricides exist, are safer for humans, animals and the environment, and are as effective at prevention as synthetic acaricides. There have been a number of scholarly studies examining the efficacy of DEET as a repellant as well as its possible side effects on humans, animals and the environment. The majority of studies agree that in low doses DEET is safe to use as a repellant. One study concluded that, “the risk of adversity from label-directed use of N-diethyl-m-toluamide appears low. Future efforts should focus on the prospective collection of adversity data with special attention paid to the documentation of clinical effects” (Osimitz and Murphy, 1997: 437). Therefore, the recommendation to use DEET as a repellant on your skin to avoid contact with ticks by the Vermont Department of Health seems appropriate, based on findings in the scholarly literature. Perhaps continued research and monitoring into possible health effects in the long term should be conducted to ensure continued safety and best practices. Additionally, perhaps more time and effort should be put towards identifying and promoting natural alternatives to traditional synthetic acaricides and DEET so that consumers can have a healthier option to use on themselves, their families, and their yards as well as minimize their environmental impact.

According to the scholarly literature, natural alternatives to DEET and synthetic acaricides include nootkatone, carvacrol, PMD, valencene-13-ol, citronella oil, cloves, lily of the valley, and lavender. The safety and efficacy of these alternatives indicate that at certain
concentrations they can be as effective as DEET at repelling ticks, especially *I. scapularis* ticks. In addition, repeated application of these repellants indicates that results can be maintained over long periods of time, similar to synthetic acaricides and DEET. Also, the use of these natural alternatives creates less health concerns for humans, animals, and the environment, making such alternatives a better choice to DEET and synthetic acaricides.

There is a wealth of scholarly literature examining alternatives to synthetic acaricides for use as tick repellant. A number of promising alternatives to synthetic acaricides that can be as effective at preventing tick bites have been identified. For example, one study examined the efficacy of nootkatone and carvacrol, two natural, plant-derived acaricides to suppress *I. scapularis*. Results from this study revealed that 5% aqueous solution of either nootkatone or carvacrol applied to apparel or leaf litter resulted in 100% control of *I. scapularis*. When applied to the leaf litter, this protection lasted for 6 days with reduction decreasing to 71.5% at 28 days (Dolan et al 2009: 2317). A second study echoed these results, showing that both carvacrol and nootkatone effectively repelled ticks when applied to backpacks and showed that protection could be maintained for longer if a second application was administered 7 days after the initial spraying (Jordan et al 2012: 104). These studies therefore showed that natural alternatives, especially nootkatone and carvacrol, are as effective as acaricides and have lasting effects and should be considered for use over synthetic acaricides.

In addition to nootkatone and carvacrol, there are a number of possible natural alternatives that are currently being evaluated for safety and repellant efficacy. One study examined the efficacy of PMD as a repellant alternative to DEET. The CDC endorsed this study and the results showed that PMD is a promising alternative to DEET (Carroll and Loye 2006: 507). Additionally, another study identified nootkatone (again), carvacrol (again), and valencene-
13-ol as three possible natural alternatives to DEET. Although these pesticides did not seem to be more effective than DEET, they were as effective at repelling ticks and offer a safer, more natural alternative that could have less of an impact on humans, animals, and the environment (Dietrich et al 2006: 957). Similarly, another study examining alternatives to DEET found that, “the most pronounced effects were observed for the oils of citronella, cloves and lily of the valley. They possessed repelling activities of the same magnitude as the reference repellent DEET (Thorsell et al 1998: 320). Certain concentrations of lavender and eucalyptus have also been identified as having repellant properties comparable to DEET. This study noted that, “although from an economical point of view synthetic chemicals are still more frequently used as repellents than essential oils, these natural products have the potential to provide efficient, and safer repellents for humans and the environment (Nerio, Olivero, and Stashenko 2010: 375).

In conclusion, the scholarly literature has identified a number of natural alternatives to synthetic acaricides that present effective tick repellant options that are safer for human and animal health as well as are more environmentally friendly. Based on these findings in the scholarly literature, the Vermont Department of Health should encourage the use of natural alternative repellants throughout the state. Finally, more research is needed into the economical demands of using natural pesticides over those currently marketed and endorsed. It may be more expensive to use natural alternatives, however, scholarly literature suggests that the health benefits gained from using natural alternatives outweigh the possible additional costs.

**Landscape Management**

Interview participants as well as scholarly and grey literature agreed that landscape management practices that aim to reduce tick and host habitat are effective ways to decrease the
incidence of Lyme disease. One participant identified reduction of invasive species in Vermont as a way to improve landscape management practices to reduce tick populations in Vermont and the scholarly literature suggested that landscape management practices extend beyond rural areas into playgrounds, parks, and schools.

The primary way to avoid coming into contact with Lyme disease is simply to avoid tick habitat. Dr. Bloom noted that the primary way to avoid contact with ticks and infection with Lyme disease is, “staying out of tick habitat when you can”. Avoiding heavily wooded areas thick grass especially in the peak summer months will decrease your contact with ticks and chances of getting Lyme disease. Avoiding tick habitat is the primary way to avoid getting sick.

In addition to avoiding tick habitat, reducing possible tick habitat around your house can greatly decrease the prevalence of ticks around your house and decrease your chances of coming into contact with Lyme disease. Dr. Bloom encouraged, “reducing tick habitat around your house, which is essentially removing habitat that deer and mice like.” This is something that the Vermont Department of Health advocates for, as it can be an essential tool in limiting numbers of hosts and ticks in residential areas. Getting rid of or preventing tick habitat from forming around your house is essential to decreasing tick prevalence. Allen supports this idea, noting that, “if you rake up or burn the leaf litter it won’t have as many ticks in there”. Leaf litter, which generally consists of leaves, twigs, and soil, keeps the soil underneath cool and moist, which is essential for tick survival as they are susceptible to drying out if exposed to direct sunlight. Therefore, getting rid of tick habitat, especially as Allen noted, getting rid of leaf litter, you get rid of ticks because they can’t survive in direct sunlight. Getting rid of leaf litter may also decrease the prevalence of small mammals like white-footed mice and chipmunks that like to forage through leaf litter, again reducing prevalence of ticks.
In addition to getting rid of leaf litter, reducing certain types of invasive species around your house that are favorable habitats to ticks may decrease tick population sizes. Cluss noted that,

“There are some ways to try and control…one of the things…there are a number of invasive species plants, one of them is Japanese barberry, another is Honeysuckle, these invasive plants are incredibly favorable for ticks. You burn them or you cut them out and that helps cut down on the incidence of ticks in that area”.

Invasive species can quickly spread throughout backyards and residential areas. Eliminating them, especially the Japanese Burberry and Honeysuckle may decrease incidence of ticks by taking away their habitat.

Although the primary way to avoid contact with ticks is to avoid tick habitat, interview participants and grey literature from the Vermont Department of Health website agree that decreasing tick habitat through reduction of leaf litter and invasive plant species may also decrease the incidence of hosts and ticks. Elimination of habitat is essential, especially around your house, schools, parks and playgrounds. By eliminating tick habitat, you decrease the population of ticks and consequently decrease the risk of Lyme disease in those areas.

Landscape Management Practices of Vermont

Grey literature from The Vermont Department of Health, the CDC, as well as Connecticut’s Department of Health all share similar landscape management best practices. The scholarly literature on the topic of landscape management supports many of the landscape management practices found in the grey literature but also encourages such practices to be extended beyond residential areas into schools, parks, and playgrounds. First, the Vermont
Department of Health offers landscaping suggestions on how to decrease the prevalence of ticks and decrease risk of Lyme disease. The following excerpt is from their website.

(Ticks that transmit Lyme disease thrive in humid wooded areas. They die quickly in sunny and dry environments. Here are some simple landscaping techniques to help reduce tick populations.

- Remove leaf litter and clear tall grasses and brush around homes and at the edges of lawns.
- Place wood chips or gravel between lawns and wooded areas to restrict tick migration to recreational areas.
- Mow the lawn and clear brush and leaf litter frequently.
- Keep the ground under bird feeders clean.
- Stack wood neatly and in dry areas.
- Keep playground equipment, decks and patios away from yard edges and trees.

(VDH 2015)

The Vermont Department of Health relies heavily on Connecticut’s *Tick Management Handbook* for landscaping management best practices. The VDH includes the landscaping picture, shown in Figure 20, from Connecticut’s *Tick Management Handbook*, which is a detailed and useful diagram highlighting areas in one’s yard that are “tick zones”, or likely to have a high prevalence of ticks so that homeowners can target these areas and make them less habitable for ticks. The VDH also note a number of ways to discourage deer and small mammals from entering your yard and bringing ticks into your area, similar to what Allen noted when he suggested that getting rid of leaf litter may decrease host populations in your area. Suggestions include:
Interestingly, the VDH website does not talk about the four-poster system targeting large mammals. Due to the efficacy of four-poster systems as demonstrated in the scholarly literature, perhaps Vermont should consider adding information about the system to their list of possible landscape management techniques aimed at decreasing tick populations.

The CDC also offers a variety of landscape management techniques aimed at reducing tick habitat that seem to mirror those of Vermont and Connecticut.
Figure 19 This image was taken from the Vermont Department of Health Website and is also featured in Connecticut’s *Tick Management Handbook*, by Kirby C. Stafford (2004)

In addition to the CDC, Connecticut’s *Tick Management Handbook*, by Kirby C. Stafford (2004), that the Vermont Department of Health relies on for landscape management practices, makes the following suggestions for decreasing tick and host prevalence and decreasing risk of Lyme disease:

- Keep grass mowed.
- Remove leaf litter, brush and weeds at the edge of the lawn.
- Restrict the use of groundcover, such as pachysandra in areas frequented by family and roaming pets.
- Remove brush and leaves around stonewalls and wood piles.
- Discourage rodent activity. Clean up and seal stonewalls and small openings around the home.
- Move firewood piles and bird feeders away from the house (see section on small mammals and birds).
- Manage pet activity, keep dogs and cats out of the woods to reduce ticks brought back into the home.
- Use plantings that do not attract deer or exclude deer through various types of fencing.
- Move children’s swing sets and sand boxes away from the woodland edge and place them on a wood chip or mulch type foundation.
- Trim tree branches and shrubs around the lawn edge to let in more sunlight.
- Adopt hardcape and xeriscape (drier or less water demanding) landscaping techniques with gravel pathways and mulches. Create a 3-foot or wider wood chip, mulch, or gravel border between lawn and woods or stonewalls.

(Stafford 2004)
The landscape management best practices suggested by the VDH, CDC, and Connecticut seem to be in agreement. Perhaps the best way to avoid ticks is to reduce their habitat by reducing leaf litter, reducing shrubs around your house, mulching around the forest edges, moving play sets away from forest edges, keeping grass short, removing invasive species that are favorable tick habitats, putting up fences to reduce host traffic, and encourage sunlight (by reducing trees) around your house as ticks can’t survive in direct sunlight.

Scholarly literature on the topic of landscape management for Lyme disease prevention revealed a number of ways to make environments less habitable for tick populations. One way to reduce host and tick habitat is to reduce shrub edge. One study found that, “higher density of shrub edge was positively associated with the density of nymphs, supporting this habitat as a source for human infection”. In addition, this study found that forest fragmentation was associated with higher tick density (Finch et al, 2014: 850). Therefore, reducing shrub edge around your house, school, playground, or park as well as decreasing forest fragmentation can
reduce tick populations and decrease the risk of Lyme disease for residents. This is similar to the landscape management practices offered by the VDH website where they encourage keeping grass short around lawn edges.

The scholarly literature also examined where ticks are most prevalent within states in order to identify areas that need the most landscape management practices. One scholarly study found that two parks with the highest annual attendance also had the highest population of ticks (Falco and Fish 1989: 7). This indicates that Vermont should extend landscape management practices form residential areas to parks, playgrounds and schools - areas that are both highly trafficked and that are tick friendly habitats.

**Surveillance**

In order to stop or slow the spread of Lyme disease, surveillance of both Lyme disease as well as ticks was considered as a preventative method. Vermont does not currently fund any surveillance projects on tick populations through the State of Vermont. However, St. Johnsbury College does some surveillance in one of their labs, but it is unclear if and how the results of their research are or will be shared with the public. In the past, Vermont has completed some surveys on tick populations; however the cost/benefit relationship from such an endeavor is unclear and has led to differing opinions among interviewees on the use of surveillance in Vermont. Overall, interview participants felt that disease surveillance was necessary and should continue, while tick surveillance is costly and should not be incorporated as a preventative method.

The Vermont Department of Health complies with mandatory reporting laws as both physicians and laboratories throughout Vermont report cases of Lyme disease to the state. According to Dr. Bloom, the Vermont Department of health conducts, “human surveillance. It is
a reportable disease, so physicians and laboratories have to report it to us when they have suspected cases so that’s where we get our numbers from and we have them on our website.” The VDH offers yearly reports of Lyme disease case numbers and trends on their website.

Scholarly literature on the topic of Lyme disease case reporting suggests that in order to identify the most cases of Lyme disease in a certain areas, both physician and laboratory confirmed cases should be reported. According to Ertell et al (2012), cases reported by physicians were more likely to occur in the summer months and cases often expressed common symptoms of Lyme disease such as the erythema migrans rash (242). In addition, cases reported by laboratories were more likely to have late manifestations (Ertell et al 2012: 242). Therefore, the literature emphasizes the need for both physician and laboratory case reporting in order to have the most effective disease reporting system.

The Vermont Department of Health does an effective job with Lyme disease case reporting, however, the state does not currently fund any tick surveillance. When asked about surveying for ticks, Dr. Bloom responded,

“From a public health standpoint, we aren’t learning a ton about Lyme disease from the tick surveillance. Perhaps if we could do surveillance on other tick-borne diseases, that would be helpful. I don’t know [where the funding for increased surveillance would come from]. Lyndon state gets a small grant from the VDH that comes from climate control budget to survey the northeast Kingdom for ticks.”

Dr. Bloom makes a good point, noting that Lyme disease has been in circulation in Vermont for many years, and sampling to estimate population numbers of ticks would not really bring any new information to the Department of Health, as we already know where the greatest incidence of cases are occurring due to case reporting. Therefore, the cost of sampling for ticks appears to outweigh the benefits of sampling. However, she also notes that sampling for the distribution and
prevalence of tick borne disease could yield helpful information. Therefore, if sampling was to be considered by the Vermont Department of Health, it would have to include not only number of ticks, but diseases ticks in Vermont tested positive for carrying.

Multiple interviewees agreed that due to budgetary constraints, allocating funds to test ticks would be a superfluous and unnecessary endeavor by the Vermont Department of Health. Allen supported the point that was raised by Dr. Bloom, noting that, “I have a really hard time saying, just because I don’t know how expensive that would be and what the payoff of that would be relative to the other things that they could be doing with the money. I think it would be a great thing to do if the resources were there”. Allen continued to say that sampling, “would probably be really expensive and then you’re just sampling for the ticks and not the bacteria.” This supports the idea suggested by Dr. Bloom in that if sampling is to start in Vermont, it would have to focus not only on number of ticks, but also on what diseases the ticks carry. Brown further supports the idea that surveillance may be too costly an endeavor for the Vermont Department of Health to take on when it would yield little new information. He noted that, “the surveillance costs are kind of high and how much information do you gain from that. But who pays for that? If you have a disease that has a relatively low incidence and a major surveillance program that costs a lot per case prevented and unfortunately you think about it in those terms”. This is an important point as he notes that although Lyme disease is a serious health problem in Vermont, it remains at relatively low endemic levels, which means that the number of cases prevented by surveillance efforts would be relatively low as well, making the cost of this prevention method incredibly high.

On the other hand, Cluss advocated for increased surveillance, suggesting that Vermont has fallen behind in terms of monitoring. He noted that, “Vermont has used NY, CT and New
Hampshire as sort of sentinel states with some of this stuff. I think that we’ve been behind the curve and surveying for Lyme”. In contrast to the other interviewees, Cluss feels that surveillance has benefits that would outweigh the costs. Barlow shares this opinion, stating that, “Sure, yeah, I think it would be a great thing if there were funds that could be identified to advance our surveillance of animal species for zoonotic diseases.” He also noted that, “I would be in favor of seeing an increase in the monitoring that we do and the communication and analysis of the monitoring that happens.” It seems that Cluss and Barlow are in favor of increasing surveillance throughout Vermont.

Scholarly literature on the topic seems to suggest that tick surveillance can be an effective tool to estimate the spread of Lyme disease in a certain geographic area. According to Ogden et al (2013), surveillance looking at tick prevalence as well as prevalence of ticks carrying the Borrelia bacteria in Southern Canada revealed that surveillance data could be used to estimate the spread of Lyme disease in those areas of Canada (510). This study suggested that Lyme disease risk could be extrapolated based on tick surveillance findings. However, it is worth noting that this study was conducted in Canada, an area that has not had a history of high tick or Lyme disease prevalence, making tick surveillance a more useful and relevant tool in this country compared within the State of Vermont, which has battled high prevalence of ticks and Lyme disease for many years.

Overall, the scholarly literature mirrors the opinions of the interview participants, suggesting that disease surveillance is necessary, beneficial and should be continued through case reporting in Vermont. According to results in the scholarly literature, it is important that Vermont continue Lyme disease case reporting from not only physicians but from labs throughout the states. Furthermore, Dr. Bloom, Allen, and Brown believe that the costs of tick
surveillance outweigh the possible benefits. They also both agree that the information that would be gained through tick surveillance would be of little to no benefit as case reporting is already in effect in Vermont. They suggest that if the funds were available for surveillance, checking for prevalence of not only ticks, but the diseases that they carry would be beneficial so that Vermonters could have a better idea of the diseases that are in circulation throughout the state. In contrast, Barlow and Cluss are in agreement with the scholarly literature, advocating for increased surveillance, suggesting that if the funds are available, any surveillance could benefit Vermont and increase prevention. Although opinions differ between the literature and interview participants, as well as between the interviewees themselves, it seems that currently, surveillance focusing solely on tick prevalence would be too expensive looking at it from a cost per case prevented standpoint. The scholarly literature on the topic focused on an area that had not seen a high prevalence of ticks or Lyme disease in the past, making tick surveillance a useful tool. However, Vermont has had a historically high prevalence of ticks and Lyme disease, indicating that tick surveillance would not yield significantly helpful or new information.

**Discussion and Conclusion**

In order to better prevent cases of Lyme disease, it is important that Vermont consider the use of alternatives to synthetic acaricides, continue landscape management practices as well as incorporate new techniques, and continue disease surveillance while not incorporating tick surveillance as a Lyme disease preventative method. One participant as well as grey literature shared the concern that synthetic acaricides could be damaging to the health of humans, animals and the environment. A review of scholarly literature revealed that at low doses, DEET is a safe repellant. However, the scholarly literature also identified a number of natural alternatives to
synthetic acaricides that were as effective as DEET at repelling ticks and were also safer for the health of humans, animals and the environment. Furthermore, grey literature from the VDH, CDC, and Connecticut Department of Health shared similar landscape management practices. Scholarly literature on the topic of landscape management practices differed from grey literature only in that it encouraged landscape management practices to be extended to schools, parks, and playgrounds. One participant deviated from the literature, suggesting that in addition to current landscape management practices, Vermont should consider getting rid of certain invasive species as a tick control method. Finally, among the interview participants and scholarly literature, views differed on the efficacy of surveillance in Vermont. The scholarly literature and my interview participants agreed that that disease surveillance is necessary and should continue in Vermont. Scholarly literature on tick surveillance in Canada and a number of interviewees felt that tick surveillance was important and could have useful applications. However, a number of other interview participants, specifically those who are from Vermont believe that tick surveillance is costly and unnecessary as Vermont has had a historically high prevalence of ticks and Lyme disease, and tick surveillance would not yield significantly new information. Therefore, tick surveillance should not be considered in Vermont as a Lyme disease preventative strategy because the costs would outweigh the benefits of tick surveillance information.
9. How Vermont Can Better Help Those Infected with Lyme Disease

In order to better help those infected with Lyme disease, Vermont must increase education and awareness surrounding Lyme disease and the myriad of complications that can arise from this disease. In this chapter, I therefore examine the controversial topic of post-treatment Lyme disease syndrome (PTLDS) as well as the legislatures’ and physicians’ role in diagnoses and treatment of Lyme disease and PTLDS. PTLDS is a controversial diagnosis and one that is currently being debated in both the political and medical fields. This chapter thus hopes to address the following research questions: How can Vermont improve diagnoses and treatment to better help those infected with Lyme disease? Like in the scholarly and grey literature, interview participants agree that PTLDS is a controversial and complicated diagnosis and one that could be better handled if diagnostic tests were standardized. In addition, many interviewees felt strongly that legislators in Vermont should not be enacting laws that concern the medical field, as they do not have any medical training. There is concerning political movement around Lyme disease treatments allowed in Vermont that could hurt infected individuals more than they would help. Finally, interview participants and scholarly literature agreed that reaching the medical world and increasing physician training in Lyme disease and PTLDS could help to better diagnose and treat those infected with this disease.

Significance

Post-treatment Lyme Disease Syndrome

Post-treatment Lyme disease syndrome is a complication of Lyme disease that is the result of residual symptoms persisting after the standard course of antibiotics has been administered to a patient diagnosed with Lyme disease. According to the CDC, about 10-20% of
people treated with antibiotics for Lyme disease will develop, “persistent or reoccurring symptoms and are considered to have post-treatment Lyme disease syndrome (PTLDS)”.

Patients diagnosed with PTLDS were typically diagnosed with Lyme disease later, meaning they were infected for a while before being diagnosed and treated. People said to have post-treatment Lyme disease often report symptoms of fatigue, pain, or joint and muscle aches. In some cases, these can last for more than 6 months. This is different from chronic Lyme disease which is a label used for people who have been suffering from Lyme disease for a number of years but who have never been properly diagnosed (CDC 2015).

Although the exact cause of PTLDS is unknown, there are a number of theories that currently exist within the medical community. The majority of medical professionals believe that the symptoms of PTLDS are due to, “residual damage to tissues and the immune system that occurred during the infection” (CDC 2015). Interestingly, “similar complications and "auto–immune" responses are known to occur following other infections, including Campylobacter (Guillain-Barre syndrome), Chlamydia (Reiter's syndrome), and Strep throat (rheumatic heart disease)”. The problem arises when some healthcare experts tell their patients suffering from PTLDS that their symptoms are due to continued infection with Borrelia bacteria (CDC 2015). However, the initial treatment with antibiotics kills off active forms of Borrelia bacteria and little to no data has shown persistent active infection with Borrelia in patients suffering from PTLDS.

The National Institute of Health has conducted four placebo-controlled clinical studies looking at the costs and benefits of prolonged antibiotic treatment in patients with persistent symptoms following standard recommended treatment regimes. The studies underwent both statistical and peer review before publishing. The studies found that there is no benefit to prolonged use of antibiotics and this course of treatment is, in fact, contraindicated (CDC 2015).
In two of the studies, 129 patients who had been treated for Lyme disease and were still suffering from persistent pain, fatigue, impaired cognitive function, and unexplainable numbness were treated with either a placebo or prolonged antibiotic treatment. Some patients were treated with 30 days of intravenous antibiotics followed by 60 days of oral antibiotics while others were administered a placebo. According to Klempner et al (2001), patients who received antibiotics did not improve more than patients who received a placebo (85). The authors of this study therefore concluded that long-term antibiotic treatment should not be used to treat patients suffering from PTLDS (Klempner et al 2001: 85).

The NIH also looked at patients who reported persistent and severe fatigue for at least 6 months following antibiotic treatment for Lyme disease. Some of the participants were given 28 days of intravenous antibiotics while others were given a placebo. Patients were evaluated based on improvements in fatigue and cognitive functioning. Patients given the 28 days antibiotic saw improvements in fatigue, but not in cognitive functioning. Four patients given intravenous antibiotics had adverse reactions including one who had a severe allergic reaction and three others that got infections from the IV. The researchers concluded that, although there were some improvements in fatigue, the lack of improvement in cognitive functioning and risk of complication, prolonged antibiotic therapy should not be recommended (CDC 2015).

Finally, a fourth study compared clinical improvements in patients treated with 10 weeks of IV ceftriaxone or 10 weeks of IV placebo. All the patients participating had been treated previously for Lyme disease and reported memory impairment. According to Fallon et al (2007), “the ceftriaxone group showed a slightly greater improvement at 12 weeks, but at 24 weeks, both groups had made similar gains” (992). Interestingly, any differences in improvement disappeared once the therapy was discontinued. Fallon et al (2007) noted “problems such as blood clots,
allergic reactions, and gall bladder removal were attributed to IV ceftriaxone use in 26 percent of patients” (992). The authors concluded that because the improvements were brief and seemingly unsustainable along with the high risk of complications with prolonged ceftriaxone use, continued antibiotic use is not recommended in patients still suffering from symptoms after standard antibiotic treatment (Fallon et al 2007: 992).

Prolonged treatment with antibiotics is contraindicated in the medical community as treatment for those suffering from PTLDS, and scholarly studies have shown that the majority of individuals do eventually recover. What is challenging about PTLDS is that it can take weeks to months, to even years for individuals to fully recover. There are many factors that affect the recovery time, including how long it took someone to be diagnosed and originally treated, to individual’s immune systems strengths and responses. Patients with PTLDS may also be suffering from a different, underlying disease. It is therefore important to confer with your primary care physician about your history and symptoms. It may also be helpful to see an infectious disease specialist who may be able to identify an underlying auto-immune disorder or assist in the treatment of your symptoms in ways that do not include prolonged antibiotic treatment (CDC 2015). The CDC makes a number of suggestions to help those suffering from PTLDS to find relief. CDC suggestions include the following:

- Check with your doctor to make sure that Lyme disease is not the only thing affecting your health.
- Become well-informed. There is a lot of inaccurate information available, especially on the internet. Learn how to sort through this maze.
- Track your symptoms. It can be helpful to keep a diary of your symptoms, sleep patterns, diet, and exercise to see how these influence your well-being.
- Maintain a healthy diet and get plenty of rest.
- Share your feelings. If your family and friends can't provide the support you need, talk with a counselor who can help you find
ways of managing your life during this difficult time. As with any illness, Lyme disease can affect you and your loved ones. It doesn't mean that your symptoms are not real. It means that you are a human being who needs extra support in a time of need.

(CDC 2015)

Communicating effectively with your physician and finding scientifically peer reviewed, accurate information are two of the best ways to understand PTLDS. According to a recent study, patients believed to be suffering from PTLDS reported that, “negative experiences were associated with reports of dismissive, patronizing, and condescending attitudes [from healthcare providers]. Positive experiences were associated with providers who were reported to be attentive, optimistic, and supportive” (Ali et al 2014: 7). Positively communicating with your practitioner is crucial in healthcare settings and can greatly affect patient experiences, their attitudes, and their healing process. Communication also facilitates learning and allows patients to ask questions instead of depending on online findings that could be inaccurate, incomplete or misleading.

Results of my Research

Legislative Applications

My interview participants as well as grey literature agree that in order to better help those infected with Lyme disease, we must ensure that our legislative and medical communities are properly educated on the topic of Lyme disease, as well as have access to peer-reviewed, scientific data on the topic. Increasing education among Vermont state legislatures is imperative as they have the power to enact policy changes that can affect treatment and diagnoses for Lyme disease in Vermont. In order to ensure proper diagnoses and the best courses of treatment for Lyme disease in Vermont, it is necessary to ensure that our political community is receiving
information from scientifically credible and peer reviewed sources, rather than being swayed by patient advocacy groups. My interviewees agreed that the issue of Lyme disease in Vermont is complicated and often finds its way into politics. Cluss noted that, Lyme disease, “is a politically charged issue, there are a lot of patient advocacy groups that have forced physicians to treat a certain way”. The problem with advocacy groups is that they may or may not be basing their findings on peer reviewed, scientific studies. For instance, advocacy groups in Vermont push for continued treatment with antibiotics beyond the recommended course of therapy and have recently gotten Governor Shumlin to pass a bill allowing physicians to administer continued courses of antibiotics for patients suffering from post-treatment Lyme disease.

Politicians represent a unique population of individuals that need education surrounding Lyme disease. They are large figures in society that are both influenced by the public and influential to the public. Bakken summarizes this point quite nicely when he states,

“There is a much greater need for education among our legislatures because they are driving political agendas based on their subjective understanding of Lyme disease and to the extreme degree, legislative decisions become a situation where politicians practice medicine without a license. They have a say in what physicians should and should not do when it comes to Lyme disease.”

The idea that politicians can have a say in medical practices throughout Vermont and throughout the country is a bit unnerving. They are influenced by advocacy groups that may not rely on peer reviewed scientific information, or perhaps they themselves rely on poor information. Without adequate education targeted at political groups and especially the legislature, there is no way to know and ensure that the information they are receiving is scientific, peer reviewed, and recent. Otherwise, they are basing their laws and actions on inaccurate or incomplete information and can greatly affect how people are diagnosed and treated. This is a crucial piece and is something
that the Vermont Department of Health should increase in terms of education. Legislators should be given adequate educational resources.

Additionally, politicians should be targeted with education, as they are a public group that the general public trusts and relies on for accurate information. As Bakken noted, “it becomes very difficult for how the public sees them because we tend to believe politicians”. Our gut reaction as community members is to trust and abide by what our politicians tell us, what they suggest and what they rule as law. We are conditioned to trust them without thinking, making them an incredibly important group to focus efforts on in increasing education and awareness surrounding Lyme disease. Perhaps if we can increase knowledge and understanding of this disease as well as recommended courses of treatment, we can better educate the public and reach advocacy groups.

According to the Burlington Free Press, Governor Shumlin recently signed a new law into effect for Vermont that, “is supposed to encourage more Vermont physicians and other health care providers to learn about treatment options for chronic Lyme disease and to treat patients without feeling threatened with disciplinary proceedings” Remsen 2014: 1). The law states that physicians cannot be disciplined

"solely for the use of medical care recognized by the guidelines of the Centers for Disease Control and Prevention, Infections Diseases Society of America, or International Lyme and Associated Diseases Society for the treatment of a patient's symptoms when the patient is clinically diagnosed with Lyme disease or other tick-borne illness" (Remsen, 2014: 1).

Interestingly, the third group in the list, the International Lyme Associated Disease Society is the only organization that encourages long-term treatment with antibiotics. This is perhaps the most important part of the bill as it allows physicians to treat patients suffering from Lyme disease with long-term antibiotics without repercussion. According to the article, the Lyme Support
Network in Vermont pushed to have this organization included in the bill, probably so that long-term treatment with antibiotics could become a more standard course of treatment.

However, the medical community of Vermont seems to oppose the Bill signed into effect by Governor Shumlin. According to the Burlington Free Press, “the Vermont Medical Society opposed the bill, seeing the measure as lawmakers setting standards for medical practice” (Remsen, 2014: 1). The law went into effect on July 1, 2014, and while the Vermont Lyme network views this as a step in the right direction for those suffering from post-treatment Lyme disease, many believe this was not the right move for Shumlin and oppose the bill. Continued treatment with antibiotics is contraindicated by the CDC and NIH and many believe that allowing this bill to be passed equated legislatures with practicing medicine, which in itself is inherently and morally wrong. Overall, interview participants as well as grey public health literature share the view that there is a need to increase education and awareness among political groups in Vermont, in order to better help those infected with Lyme disease as politicians have the power to directly affect treatment options available to those suffering from Lyme disease.

**Physician Awareness and Post-treatment Lyme Disease Syndrome**

Many interview participants as well as the scholarly literature agreed that physicians’ awareness surrounding Lyme disease and PTLDS is also a serious concern throughout Vermont as they are the primary population identifying, reporting and treating this disease. It is imperative to increase education and awareness among physicians and public health officials in order to adequately and correctly identify cases of Lyme disease within Vermont. Challenges surrounding diagnostic tools and controversial courses of treatment continue to make it difficult for Vermonters with possible cases of Lyme disease to get diagnosed and treated. Cluss notes that, “the problem is there is no standardized way to diagnose…I’m sorry to say that there’s a lot
more ambiguity out there than there should be. I don’t know why we don’t standardize this better, this is a politically charged issue”. Although labs should technically follow the two step diagnostic process outlined by the CDC on their website, there is no way to enforce that those tests are the ones being used in every lab or doctor’s office around the country. Therefore, some labs use a variation of tests yielding inconclusive results. Standardizing a way to diagnose Lyme disease is challenging, however the use of the two step system outlined by the CDC is the most accurate and effective diagnostic tool if read by someone who is familiar with such diagnostic technology. Perhaps creating a battery of standard tests (according to the CDC) to which all labs and offices must comply to when diagnosing Lyme disease would help take some of the ambiguity out of the diagnosis process.

However, standardizing how one tests for Lyme disease is only half of the problem. Standardizing how Lyme disease is diagnosed according to those results is equally challenging. According to Dr. Bakken,

“Once the antibodies have been generated, it’s hard to tell if the person’s antibodies are in response to an active ongoing infection or to a past event and the active infection has been destroyed. And that’s the downside with the testing for Lyme disease that we have today, it’s an indirect confirmatory test because it doesn’t describe presence of the microorganism.”

In other words, you may be treated for Lyme disease and still test positive for antibodies post treatment. It is difficult to tell if those antibodies are the result of your past exposure or if they are the result of a continued active infection, and many physicians disagree on the meaning of antibodies for Lyme disease. Bakken notes that,

“Once the antibodies have been generated, it’s hard to tell if the person’s antibodies are in response to an active ongoing infection or to a past event and the active infection has been destroyed. And that’s the downside with the testing for Lyme disease that we have today, it’s an indirect confirmatory test because it doesn’t describe presence of the microorganism.”
Therefore, you must rely on other indicators such as, “elevated levels of interleukin 56” (Bakken) that would point to an active infection rather than presence of antibodies. Antibodies for whichever strain of Lyme disease that you were infected with will often stay in your body for years as a form of defense in case your body comes into contact with that strain again. Bakken emphasizes this point by stating that “there is misunderstanding among primary care/family practices about what the meaning of antibody testing is and what the limitations of such testing are”. Bakken suggests that, “trying to bring the message to our new generation of physicians, to disseminate science based information in their formative years of education and residency and fellowship” would be incredibly helpful. Increasing awareness among physicians, especially while they are still in school or training will be key in moving forward in order to better diagnose and treat those suffering from Lyme disease.

The scholarly literature on the topic of awareness in medical communities surrounding PTLDS agrees with the interview participants in that it suggests that there is a need for increased education. According to Crowder et al (2014), researchers conducted a study by surveying faculties of public health about their knowledge of both Lyme disease and PTLDS (784). The results showed that while many knew someone suffering from Lyme disease and believed it to be a serious illness, few had as much experience or knowledge about PTLDS and many expressed a lack of knowledge surrounding the etiology of PTLDS (Crowder et al 2014: 782). The authors conclude that there is a serious need for increased education surrounding Lyme disease and PTLDS among medical and public health communities (Crowder et al 2014: 782).

Diagnostics also plays a role in the treatment of Lyme disease beyond the suggested course of treatment outlined by the CDC. Because labs are able to use differing diagnostic tests to identify cases of Lyme disease as well as confusion over analyzing the results of said tests,
there are differing views on how to best treat Lyme disease, especially in cases where individuals continue to have symptoms well after their course of antibiotics is over. Some physicians and many Lyme advocacy groups argue that continued treatment with antibiotics for weeks or months after the initial treatment is effective and should be encouraged by providers. However, as stated in the introduction, clinical studies conducted by the National Institute of Health have shown that continued treatment with antibiotics yields little to no improvement compared with placebo groups and is contraindicated due to subsequent infections and complications. Nevertheless, the debate over continued use of antibiotics continues throughout the country and my interviewees agree that it is a controversial topic.

Cluss talks about the controversy of treating Lyme disease with antibiotics past the recommended course of treatment when tests are inconclusive on whether or not a patient has an active infection with Borrelia bacteria when they have already completed their standard course of antibiotics. He states,

“The whole issue with chronic Lyme disease is incredibly charged. These are inflammatory processes that they are dealing with that are real. Whether it was triggered by the primary case of Lyme disease... we have other disease... diabetes is one of them that is triggered by certain viral infections... type 1 diabetes, there are certain diseases where there’s a strong cause and effect where there is a preceding infection with something where these people often times there’s a correlation with that and the presentation of certain diseases. I think anything that triggers a broad inflammatory response can trigger a whole bunch of things. The problem is how do you relieve the inflammatory response? Can you still treat Lyme disease when the other evidence of clinical infection is not there but a patient clearly has neurological problems, they have fatigue... many of the patients present like they have MS.”

Cluss covers a variety of topics here and brings up some key points. Many of these patients suffering from post-treatment Lyme disease have serious and sometimes debilitating symptoms, there is no denying that.
The debate is over whether or not those symptoms are due to an active infection or whether they are lingering effects from the infection, or whether they are side effects from an underlying cause that has yet to be diagnosed that could have risen due to exhaustion of the immune system by infection with Lyme disease. Allen emphasizes this point when he states,

“I think there are definitely people who have symptoms that even if they’ve had the standard course of antibiotics they still have these long term symptoms like fatigue, pain, aches in the joints, trouble concentrating -- stuff like that. I think that’s a legitimate syndrome that people get. The literature suggests that if you get treated later, it’s more likely you get that. I think that most of the controversy comes from the fact that patients who exhibit those symptoms, do they have an active infection of the Borrelia still, or no?”

One of the main problems is that we don’t yet know how to answer these questions. Some people believe that presence of antibodies means that there still is in fact an active infection. However, no labs have been able to culture live spirochetes from a patient suffering from post-treatment Lyme disease, suggesting that the standard course of antibiotics does, in fact, kill the bacteria and any lingering symptoms will eventually subside or are due to another underlying condition.

Bakken noted that:

“When the time comes that all the Borrelia have been destroyed, that time doesn’t necessarily correlate with the immune response that has been elicited. So many of the symptoms are driven by an over-response on the part of the immune system well after the therapy is over. The longer you go prior to treatment, the longer symptoms are likely to last”

Interview participants agree that the longer one waits to be treated, the longer symptoms will persist after treatment has been completed. There has been little research on the topic of why this is so and therefore represents a new frontier for future research. Understanding how Lyme disease spirochetes interact with the body and our immune system as well as their long-term effects on our body have been studied very little. More research is needed in order to better
understand the mechanisms by which spirochetes affect our bodies and how best to treat people, especially those suffering post treatment.

Although PTLDS is a challenging disease as there are no real therapies or treatments available to patients, seeking medical attention and testing for underlying etiologies can be helpful and may help to alleviate some of the symptoms. According to one participant, often the best things to do for people suffering from post-treatment Lyme disease is to treat their symptoms and check them for underlying conditions such as chronic fatigue, MS, or diabetes. Bakken suggests that one should “treat the symptoms symptomatically. Take measures that reduce chronic aches and pains, such as non-steroidal anti-inflammatory agents, muscle relaxants, perhaps some people need an anti-depressant for some period of time”. Antidepressants can be useful as they modulate neurotransmitters that play a role in our central nervous system – an area that can be greatly affected by Lyme disease.

Discussion and Conclusion

The topic of chronic Lyme disease is incredibly charged and controversial. Many physicians disagree on the best course of action and therefore treat this disease differently. Many patients believe that they need to continue antibiotics after their regularly therapy simply because their symptoms persist. However, it can take months to years for symptoms to completely go away and it depends on a variety of factors including a person’s individual immune response, as well as when they were diagnosed relative to when they became infected. There is no denying that symptoms that persist after standard treatment are a common problem and are widespread throughout the US. However, grey literature from the CDC as well as scholarly studies on randomized control trials indicate that there is no benefit to be gained from long-term treatment
with antibiotics outside of the standard course of therapy and could result in bacterial infection and complications. My interviewees, like the scholarly and grey literature, suggest that the best way to treat symptoms that persist past the standard course of therapy would be to seek an infectious disease specialist, rule out any underlying condition, and treat the symptoms symptomatically. Finally, my interviewees and the scholarly and grey literature agree that more education and awareness over the scientific evidence behind post-treatment Lyme disease is needed among the public (especially among Lyme advocacy groups that often push for continued treatment with antibiotics), the legislature, specifically Governor Shumlin (who can influence physician treatment), and physicians and public health officials who are at the front line of treating this disease.
10. Conclusion

Based on the evidence analyzed in this thesis, Vermont is currently doing a reasonably effective job marshaling sound Lyme disease public health prevention measures. Vermont has a well-organized website with plenty of information that is in line with recommendations provided by the CDC. They offer preventative behaviors, educational resources, as well as implement landscape management techniques to reduce tick habitat and are meeting basic Lyme disease reporting standards. After conducting a literature review of both scholarly and grey sources as well as talking with a variety of professionals specializing in public health, animal science, and one medical professional specializing in Lyme disease clinical matters, I have identified a number of ways in which Vermont could improve their public health campaign against Lyme disease. By increasing education and awareness, targeting at-risk groups, using bait boxes to target large mammals, reducing invasive species, extending landscape management practices to parks, playgrounds, and schools, and improving diagnostic and treatment options for those infected with Lyme disease, as well as raising awareness and education among legislative, physician and public health communities about Lyme disease and PTLDS, Vermont can better prevent cases of Lyme disease from increasing throughout the state.

Participants in my interviews agreed with the scholarly and grey literature that the most emphasis should be placed on increasing education and awareness surrounding preventative behavioral strategies. Vermont needs to increase education and awareness among at-risk groups (those between 0-19 and 30-49), as well as those who work outside or often take part in activities that put them at an increased risk of coming into contact with Lyme disease, and lower socioeconomic status populations. The scholarly literature on this topic differed from participant
views and grey literature in that it suggested education should focus not only on preventative behaviors, but on educating the public on the efficacy of preventative behaviors.

Furthermore, in order to reach at-risk groups, Vermont should consider sending these demographics a survey asking about the best way to reach them with educational resources, or send students out to collect data on these demographics. Vermont should also consider targeting incoming students to the University of Vermont and other Vermont colleges with education on Lyme disease. Vermont should also work to increase information and education available to tourists that frequent Vermont in the spring, summer and fall months.

Additionally, interview participants agreed that it is essential that a way to evaluate how educational tools and awareness outreach is being absorbed and judged by the public be developed. Currently, there are no tools used by Vermont to see how particular demographics are getting their news, how public health campaigns are being received, and what information is being absorbed by the public. If we are ever to truly improve education and awareness surrounding Lyme disease as well as be more effective at reaching the public and increase behavioral prevention strategies used by the public, we must first create a system that allows evaluation of tools being used.

My interviewees also argued that budgetary concerns remain a central challenge in addressing Lyme disease in Vermont. Perhaps increasing collaboration between governmental organizations and sharing data and resources between states could help alleviate some of the state budget constraints.

Furthermore, interview participants as well as scholarly literature agreed that although a vaccine for Lyme disease could be an effective form of primary prevention in Vermont, for social, economic, and political reasons, it is unlikely that one will be produced in the near future.
There is too small of a population that would benefit from the vaccine; the vaccine would not fall under the list of routine vaccinations given at doctor’s appointments, and therefore would also not be covered by the National Vaccine Compensation Program - making drug companies liable for lawsuits and payoffs if someone decides to sue. Therefore, it would cost too much money and would be too “risky” a vaccine for drug companies to produce.

Interview participants and scholarly literature agreed that four-poster bait boxes for large mammals could be an effective way to prevent cases of Lyme disease by targeting a host population. In consideration of using bait boxes for small mammals, my interviewees felt it could be a positive preventative method, while the scholarly literature seemed to suggest that bait boxes for small mammals are relatively ineffective at reducing tick populations. Based on the scholarly literature, bait boxes for small mammals should not be considered for use as a preventative method against Lyme disease in Vermont. Additionally, interview participants and scholarly literature agreed that host removal is not a feasible option for reducing prevalence of Lyme disease and therefore, efforts should focus on using acaricides or natural alternatives to target host populations.

My interviewees and grey literature share the view that synthetic acaricides are harmful to the health of humans, animals, and the environment. The scholarly literature found that DEET was a safe synthetic acaricide to use in low doses and that pyrethroids, when used at recommended concentrations, pose little threat to human health. The scholarly literature also found a number of natural alternatives are more environmentally friendly, safer for humans and animals, and as effective at repelling ticks as traditional acaricides and DEET. Therefore, the Vermont Department of Health should look into using alternatives to synthetic acaricides.
In terms of landscape management, my interview participants believe that the landscape management practices offered on the VDH website are positive prevention methods and should be continued. One participant identified decreasing invasive species as way to improve Lyme disease prevention in Vermont. Grey literature from The Vermont Department of Health, the CDC, as well as Connecticut’s Department of Health all share similar landscape management best practices. The scholarly literature on the topic of landscape management supports many of the landscape management practices found in the grey literature but also encourages such practices to be extended beyond residential areas into schools, parks, and playgrounds.

Evidence from the scholarly literature is indisputable and asserts that long-term treatment of Lyme disease with antibiotics is not effective at reducing symptoms and is contraindicated due to the myriad of health complications (such as infection or death) that can occur. My interviewees as well as grey literature agreed that in order to better help those infected with Lyme disease, we must work to ensure that the information given to our legislatures is from scientifically credited sources. Like the scholarly and grey literature, my interview participants also argued that we must ensure that our physicians and public health officials in Vermont are following the standardized tests for Lyme disease diagnoses as outlined by the CDC. They also noted that we must also increase education surrounding post-treatment Lyme disease syndrome among physicians and Vermonters alike. In order to better help those infected with Lyme disease, we must increase education among our legislators and provider communities, as well as standardize diagnostics and treatment.

**Scholarly Implications**
Future research should focus more on the biology of preventative strategies. This may include examining the possibility and feasibility of creating an animal vaccine against Lyme disease that could be administered in a stable solid form to host populations. Similar to that of rabies vaccines which can be administered to wild animals via a salt lick, similar efforts should be made to vaccinating host populations to stop the cycle of Lyme disease. Additionally, future research should examine the cost of switching to alternative, natural, acaricides for both the use by homeowners to use in their own backyards and for the Vermont Department of Health to use in a larger scale on playgrounds, parks, and around schools.

Perhaps a sociological perspective could also be taken to examine what encourages people to comply with certain behaviors. Examining things such as social learning theory and motivation may help to create messages and educational tools that increase compliance with preventative behavioral strategies against Lyme disease.

An economical perspective is also needed. More research into budgetary concerns and the possibility of collaboration between state and local sectors to improve and increase the campaign against Lyme disease is needed. Perhaps an analysis of the cost/benefit relationship of starting a surveillance program in Vermont that would count ticks as well as survey which diseases they carried could benefit public health efforts against tick borne diseases.

An ecological approach should also be taken, looking at the effects of climate change on tick prevalence and rates of Lyme disease. One interview participant explored the relationship between climate change and tick prevalence, concluding that it could either increase or decrease tick populations in the north, but it is too soon to tell. Further topics covered could look at the relationship between forest growth, host populations, tick populations, and rates of Lyme disease over a span of years. This research paper did not address climate change simply because of the
amount of research available on the topic. Addressing Lyme disease from an ecological point of view with a focus on the effects of climate change would be a large topic and one that deserves its own research paper.

Finally, a biochemical approach is needed to examine how to better standardize diagnostic procedures for Lyme disease. There remains some ambiguity in the testing and diagnostic procedures for people suffering from Lyme disease and post-treatment Lyme disease. More research is needed into the diagnostic process as well as the treatment process.

**Practical and Social Implications**

The main implications of this study surround the need to increase education and awareness with the hope of increasing behavioral preventative strategies amongst Vermonters. Sharing educational resources between states seems like a positive and feasible possibility that Vermont and surrounding Northeastern states (especially Connecticut) should consider. Additionally, increased collaboration between states and local sectors is needed to improve education, awareness, and outreach to the public.

Schools throughout Vermont should consider increasing education for their students as well as faculty, not only in elementary school but throughout high school as studies have shown that people between the ages of 0-19 are at an increased risk of exposure to Lyme disease. Perhaps schools in the surrounding New England states could share educational tools and resources as well. Colleges in Vermont should incorporate Lyme disease education into their freshman orientation. Vermont should also target tourists by providing information on VT tourist websites and at popular tourist destinations around the states. Vermont should also consider
putting up Lyme disease information in local grocery stores, senior centers, temporary shelters, free clinics, as well as incorporating it into Girl and Boy Scout groups and summer camps.

**Limitations of this Study**

This study was conducted via convenience sampling and involved interviews with only eight participants. This is a serious limitation to the study as only a small variety of academic professionals were interviewed which could skew the results. It would have been beneficial to talk to someone from the Vermont department of Agriculture, the Vermont Department of Fish and Wildlife, a sociologist, someone from the general public, and more specialists on Lyme disease. This study is also not an exhaustive search of existing literature and therefore findings are limited to the literature that was available to the primary investigator and answers provided by the interview participants to the study. Additionally, this study was qualitative, not quantitative, which could limit the results. Attitudes and knowledge surrounding Lyme disease and prevention strategies were not investigated in this project and therefore could also affect the results and implications for future public health intervention strategies against Lyme disease in Vermont. Finally, the focus of this research was mainly on the state of Vermont and therefore results may not be able to be extrapolated to surrounding states.

**Areas for Further Research**

There is a critical need to find a way to evaluate current educational and prevention strategies in Vermont. More research is needed for the development of an evaluation program. In order to improve education and awareness, we must first understand what reaches the public (what people are listening to, watching or reading), and then we have to determine what the public is taking away from such educational messages so that we can improve them and increase
education and awareness about Lyme disease. We must identify the most effective way to reach people (which news outlets – Google, NPR, the Burlington Free Press – reach the most people) and what messages are the most effective at raising awareness and education.

More research is also needed on how to increase level of engagement – how to get people to check for ticks the same way, to apply repellant the same way and to respect endemic areas in the same manner to lower their risk. Research into social learning theories cold potentially improve public health outreach and increase compliance and efficacy of behavioral prevention strategies.

There is also a great need for research into the costs of using natural alternatives such as nootkatone and carvacrol as opposed to DEET and synthetic acaricides. Studies have shown the efficacy of such alternatives is comparable to traditional acaricides, however there is little to no research on the economic costs of using natural alternatives over commercially available acaricides. There should also be longitudinal studies looking at the long term effects of using synthetic acaricides.

More research is needed on the effects of climate change on tick prevalence as well as incidence of Lyme disease in Vermont and surrounding states. Global temperatures are rising and there should be research conducted on the effects of changing temperatures and environments on tick and host populations.

Finally, more research is needed into post-treatment Lyme disease syndrome. There have been a small number of studies that indicate recurrence with Lyme disease diagnosis is likely due to infection with a new strain rather than reinfection of the same strain. This could have implications for treatment. More research should also focus on patients with Chronic Lyme
disease – those that are diagnosed months to years after initial infection – and the best way to treat these cases, as they are often the most challenging to treat effectively.

**Recommendations**

Although this is just a preliminary analysis of Lyme disease in Vermont, there are a number of ways that the state could improve its public health campaign against Lyme disease. For example, the main focus of Vermont public health efforts to stop and slow the spread of this disease should be on increasing education and awareness, especially among at-risk groups. Efforts should focus on increasing education and awareness among Vermonters between the ages of 0-19 and 30-49, hikers, outdoor workers, camp counselors and campers, school nurses, outdoor leaders at schools as well as increasing education from primary through high school aged students in Vermont. Vermont should also consider providing information about Lyme disease and preventative strategies in local grocery stores, temporary shelters, and YMCA’s to reach lower socioeconomic status populations. In addition, Vermont should target first year college students with education during freshman orientation as well as provide tourists with information on Lyme disease and preventative strategies.

Aside from increasing education and awareness, there must also be a way to evaluate existing and new educational/awareness resources. There needs to be a way to measure and evaluate the efficacy of how Vermont is reaching the public with information in order to better educate the public. We must find a way to identify the reading, watching and listening habits of people within particular demographics in Vermont, at what times of the day/year these habits occur and what information they are taking from existing educational/awareness messages. Once there is a way to evaluate news sources and educational/awareness messages, we can improve
upon them and increase their efficacy (reach more people and have more information be absorbed by the public).

Putting time and resources into creating a human vaccine for Lyme disease does not seem to be an effective use of time and resources, according to the interview participants as well as scholarly and grey literature. Because of social, political, and economic reasons, a human vaccine for Lyme disease is unlikely in the near future. Perhaps efforts should be put into researching a possible vaccine for host populations that could be administered in a stable solid form (such as on a salt lick, like the rabies vaccine). If we inoculate host populations, we could stop or slow the cycle of Borrelia burgdorferi bacteria between hosts and ticks – decreasing the number of infected ticks and consequently decreasing the incidence of Lyme disease.

In consideration of host populations, four-poster bait boxes for large mammals should be considered for use in Vermont. Based on findings in the scholarly literature, targeting small mammals with bait boxes is not an effective way to reduce tick populations and therefore should not be considered as possible Lyme disease preventative method in Vermont. Similarly, based on findings among the interview participants, scholarly and grey literature, landscape management practices should be continued throughout Vermont, with the addition of removal of invasive species and extending landscape management practices to schools, playground, and parks. According to my interview participants as well as scholarly literature, host removal should not be considered as an option is it is simply not feasible and could have serious environmental and ecological effects. Finally, although the scholarly literature suggests that tick surveillance could be beneficial, experts from Vermont believe that it should not be considered as a strategy due to its high cost and the limited information that it yields. Scholarly literature as well as my interviewees agree that disease surveillance should be continued, by both physician and
laboratory reporting, as this is a good way to track incidence of Lyme disease in Vermont and surrounding states.

Furthermore, the Vermont Department of Health should encourage the use of alternatives to synthetic acaricides in order to increase human and environmental health, according to findings by my interview participants and the scholarly and grey literature. The scholarly literature identified natural alternatives to include nootkatone, carvacrol, PMD, valencene 13-ol, citronella oil, cloves, lily of the valley, lavender, and citronella. More research is needed into the costs of using such alternatives on a personal scale (backyards) and on a larger scale (for schools and parks).

Finally, more educational resources should be administered to legislators (specifically Governor Shumlin and staff) and physicians in Vermont regularly. In order to better help those infected with Lyme disease, we must build a group of well-educated legislators, clinicians, and public health officials. According to my interviewees as well as scholarly and grey literature, Vermont should increase awareness surrounding post-treatment Lyme disease, as well as the fact that long term antibiotic use is contraindicated due to lack of evidence surrounding efficacy and concerns about drug resistance developing.

In conclusion, Vermont is currently doing a reasonably effective job at marshaling sound Lyme disease public health prevention measures. Vermont offers educational resources on their department of health website, as well as preventative behavioral strategies. Vermont is also implementing sound landscape management best practices to reduce tick habitat, and is meeting basic Lyme disease case reporting standards. However, there are a number of ways that we can improve upon the prevention of this zoonotic disease. With education and awareness as the forefront of the public health campaign against Lyme disease and secondary techniques
including identifying at-risk groups, targeting host populations, expanding on landscape management practices, and raising awareness and education among legislative and medical communities, Vermont can better address Lyme disease and stop or slow the spread of this disease.

Concluding Note

The Vermont Department of Health is currently doing a reasonably effective job of addressing Lyme disease. However there are some key areas in which improvement could lead to stopping or slowing the spread of Lyme disease in this state. Moving forward, increasing education should be at the forefront of efforts to stop the spread of Lyme disease. Secondary preventative techniques include: identifying at-risk groups and targeting them with education and resources, using four-poster bait boxes for large mammals to reduce tick prevalence throughout Vermont, expanding landscape management practices to parks, schools and playgrounds as well as reducing invasive species, and raising awareness and education among legislative and medical communities. By putting education and awareness at the forefront of Vermont’s public health campaign against Lyme disease as well as employing promising secondary techniques, Vermont can better stop and slow the spread of Lyme disease.

Additional, or tertiary strategies include increasing collaboration between intrastate and interstate departments of health to address budgetary concerns, and finding a way to evaluate existing educational/awareness tools, resources, and messages given to the public in order to improve upon them. Identifying the most effective way to reach Vermonters will allow the department of health to prioritize time, money and resources.
Appendix

Research Information Sheet and Consent Form

Title of Study: Time for Lyme: Public Health Approaches to Lyme Disease in Vermont
Principal Investigator (PI) and Faculty Sponsor: Jessie Gay (PI), Jeanne Shea, Ph.D., Associate Professor, Department of Anthropology, University of Vermont.

Introduction:
You are being asked to participate in a research project that is examining how Vermont can improve public health efforts to stop the spread of Lyme Disease.

Purpose:
To discover ways that Vermont can improve its preventive strategies, educational tools and treatment options to slow and/or stop the spread of Lyme Disease.

Study Procedures:
If you take part in the study, you will be asked to spend about thirty minutes verbally answering a series of questions about your knowledge of past and present preventive strategies, educational tools and treatment options for Lyme Disease in Vermont, and how these could be potentially improved upon. The interviews will take place at a time and place that is convenient for you.

The interviews will be conducted by Jessie Gay, a senior honors college student at the University of Vermont. Jessie has received training in research ethics, interview technique, and medical anthropology in Professor Shea’s course, Anth 174: Culture, Health, and Healing, in the Department of Anthropology at the University of Vermont.

Your answers will be audio-recorded, transcribed, and coded. The information collected will be de-identified, unless you specifically request to be identified after the interview. At the close of the study, you will be informed of the results. The results will be included in Jessie’s senior honors thesis, which will be presented in April, 2015.

Benefits
As a participant in this research study, there will be no direct benefit for you; however, information from this study may benefit other people now or in the future.

Risks or Discomforts
There are no known risks other than a potential risk of an accidental breach of confidentiality. We will do our utmost to protect the information that we collect from you. During the interview, we will not ask for any information that will identify you unless you specifically request to be identified after the interview.

Costs
There will be no costs to you for participation in this research study other than your time.

Compensation
You will not be paid for taking part in this study.
Confidentiality:
All information collected about you during the course of this study will be kept without any identifiers. Your recorded responses will be coded to protect your confidentiality. Contact information will be kept separate from your recorded responses and any notes that may be taken during the interview. You will be referred to in the research records by a pseudonym (code name) or case number (serial number) only, unless you request to be referenced by name. There will be no list that links your identity with this code. Research information will be stored in a locked file cabinet in the Department of Anthropology and on a secure password-protected UVM server. These materials will be accessible only to the research personnel. Once full and accurate transcription of the contents is confirmed by the PI, the audio recordings will be destroyed. The results of this study may eventually be published, but your confidentiality will be maintained unless you specifically request to be identified after the interview.

Voluntary Participation/Withdrawal:
Taking part in this study is voluntary. You are free to not answer any or all questions or to withdraw at any time. You may choose not to take part in this study, or if you decide to take part, you can change your mind later and withdraw from the study. If you decide to withdraw from the study, if you wish, we will destroy any interview data that we have already collected from you and not include it in any reports or publications.

Questions:
If you have any questions about this study now or in the future, you may contact Jessie Gay PI at 802-249-3840 or at jgay@uvm.edu, or Jeanne Shea at the following phone number: 802-656-3181. If you have questions or concerns about your rights as a research participant, then you can contact Nancy Stalnaker, Director of the Research Protections Office at (802) 656-5040.

Participation:
You have been given a summary of this research study. Your participation is voluntary, and you may refuse to participate without penalty or discrimination. By completing the interview you are agreeing to participate in this study.
IRB Subject Recruitment Email
SAMPLE EMAIL

Title: Time for Lyme: Public Health Approaches to Lyme Disease in Vermont

Student Researcher Name/Principal Investigator: Jessie Gay

Student Researcher Phone and Email: 802-249-3840; jgay@uvm.edu

Faculty Advisor: Jeanne L. Shea, Department of Anthropology, University of Vermont

Faculty Advisor Phone and Email: 802-656-3181; Jeanne.Shea@uvm.edu.

Dear Professor or Dr. __________

You are being invited to take part in a research study because you are an employee of the Vermont Department of Health or a professor at the University of Vermont.

I am reaching out to you as a student at the University of Vermont who is working on her Senior Honors Thesis. You are being asked to participate in a research project that is examining how Vermont can improve public health efforts to stop the spread of Lyme Disease.

If you would be willing, I would like to set up an interview, which should take about thirty minutes to complete. You will be among three to ten participants with whom I will interview sometime between October and December 2014, at a time and place that you agree upon with me. Questions will ask about your knowledge of and/or experience with Lyme Disease in Vermont. The interview will focus on the transmission, prevention, education, treatment, and regulations for Lyme Disease in Vermont. The goal is to discover ways that Vermont can improve its preventive strategies, educational tools and treatment options to slow and/or stop the spread of Lyme Disease. You may choose to credited for all or part of your interview by specifying so once the interview is complete. Otherwise, all names and personal information will be withheld.

May I contact you to arrange an interview at a date, time and place of your choice?

Thank you,

Jessie Gay
Works Cited

Airley Fish, Yuri Pride, Duane Pinto

American Lyme Disease Foundation


Beaujean Desiree, Marloes Bults, Jim VanSeenbergen, Helene Voeten

Carroll SP, and Loye J

Cartter ML, Farley TA, Ardito HA, Hadler JL

Center for Disease Control and Prevention

Connally Neeta, Durante Amanda, Yousey-Hindes Kimberly, Meek James, Nelson Randall, Heimer Robert

Dennis D.T., and Piesman J,

Dietrich G, Dolan M.C., Peralta-Cruz J, Schmidt J, Eisen R.J., Karchesey J.J.
Dolan Marc, Jordan Robert, Schulze Terry, Schulze Christopher, Manning Mark, Ruffolo Daniel, Schmidt Jason, Piesman Joseph, Karchesy Joseph

Falco RC and Fish D

Finch Casey, Salim-Al-Damluji Mohammed, Krause Peter, Steeves Tanner, O’Keefe Corrine, Diuk-Wasser Maria

Frederick M. Fishel

Ginsberg, Howard

Goldstein MD, Schwartz BS, Friedman C, Maccarillo B, Borbi M, Tuccillo R,

Gould LH, Nelson RS, Griffith KS, Hayes EB, Piesman J, Mead PS, Cartter ML

Gregory A Poland

Herrington JE, Campbell GL, Bailey RE, Cartter ML, Adams M, Frazier EL, Damrow TA, Gensheimer KF

Herrington JE
Hoen Gatewood

John Brownstein, Theodore Holford, Durland Fish

Jordan, Schulze, and Dolan.

Khatchikian CE, Nadelman RB, Nowakowski J, Schwartz I, Wormser GP, Brisson D

Kirby Stafford
2004 Tick Management Handbook
http://www.ct.gov/caes/lib/caes/documents/special_features/tickhandbook.pdf Published by the Connecticut Agricultural Experiment Station.


M. Zairn, A. Aitio, N. Nakashima


Maupin GO, Fish D, Zultowsky J, Campos EG, Piesman J

McKenna D, Faustini Y, Wormser GP
Miller NJ, Thomas WA, Mather TN

National Institute of Allergy and Infectious Diseases


Nerio, Olivero, Stashenko

Nicholas Ogeden, Lindsay Robbin, Patrick Leighton, Andy Sheppard

Northern Woodlands Online Magazine

Osimitz and Murphy

Pet Poison Helpline

Rand et al


Remsen, Nancy
2014 Burlington Free Press

Robert Aronowitz

Shadick NA, Daltroy LH, Philips CB, Liang US, Liang MH

Stafford KC, Denicola AJ, Pound JM, Miller JA, George JE

Starr-Hope Ertel, Randall Nelson, Matthew Cartter

State of Connecticut Department of Health

State of New Hampshire Department of Health

State of New Jersey Department of Health
State of New York Department of Health

State of Vermont Department of Health

T. D. Brock, Michael Madigan, John Martinko

Janice Carr


Wong, Derek


Zhioua E, Rodhain F, Binet P, Perez-Eid C