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Improving Communication with the Public about Tick-borne Diseases

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Improving Communication with the Public about Tick-borne Diseases

An Interactive Qualifying Project

submitted to the faculty of

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

By

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Date: December 16, 2010

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Abstract

This report for the Nantucket Tick-borne Disease Committee was created to help improve public communication concerning ticks and tick-borne diseases on the island of Nantucket. Based on findings from background research, interviews and a survey administered to the students of Nantucket High School, the project team crafted recommendations for a multi-pronged communication strategy based on the knowledge, attitudes and behaviors of the townspeople. The team developed a health-risk communication strategy which targets specific audiences through diverse communication channels.



Acknowledgements

We would like to thank our advisor, Professor Dominic Golding, for without your comments, recommendations and comprehensive feedback, our work would have been unequivocally lost in translation. Your dedication to guiding us in our efforts to produce a fine-tuned research project allowed us to learn from one another and our team dynamic to thrive as we assembled a fine paper which we are all proud to have been a part of.

We would also like to thank our project sponsors, Dr. Tristram Dammin and Dr. Malcolm MacNab, who with their great enthusiasm and vast knowledge of the topic and the Nantucket community, guided us in mind and spirit throughout the duration of our time on Nantucket. Your knowledge and wisdom were quintessential in helping us achieve our goal in making recommendations to aid the Tick-borne Disease Committee and Town of Nantucket in finding the right path toward a Lymeless Nantucket.

We would like to thank those who took the time out of their busy lives to be interviewed by us as we gathered differing opinions from key stakeholders, opinion leaders, and experts. We would like to thank Principal John Buckey and Nurse Margaret Roberts of Nantucket High School for adding valuable perspective from an educational standpoint. We also want to thank Mrs. Elizabeth Trillos and Mrs. Beverly McLaughlin for taking such care sharing their knowledge and for offering such generous hospitality during our interviews.

We would like to express our gratitude to the passionate Director of the Nantucket Health Department, Richard Ray and to Dr. Tim Lepore, Nantucket's only general surgeon who is also a tick expert and fanatic. We would like to thank Sam Telford III, a professor in the Biomedical Sciences Department at Tufts University and a specialist in infectious diseases, and commend him for his decades of working with ticks on Nantucket. We want to thank Dr. Sarah Oktay, Managing Director of the UMASS Boston Nantucket Field Station, who offered valuable eclectic information about the broader Nantucket environment relating to ticks. We would also like to acknowledge the representatives from Mass Fish and Wildlife, for speaking with us about the current practices and efforts in place at the Nantucket Deer Check Station.

We would like to thank Harvey Young's Bicycle Shop for lending us the bicycles, which served as our primary mode of transportation on the island. We would also like to thank the Nantucket Maria Mitchell Association for providing us with a clean and warm place to stay and work from.

Lastly, we would like to thank the Barnstable County Entomologist, and renowned tick expert, Dave Simser, who passed away on November 26, 2010, at age 57. We were fortunate enough to have worked with Dave during our time on Nantucket, and have nothing but the highest level of respect for his professionalism and dedication to his research and community.



Executive Summary

Nantucket Island has ranked among the top three Lyme disease counties in the US since 1992 (Bacon RM, 2008). The number of Lyme and other Tick-borne diseases reported annually on Nantucket is a concern for the island and its residents, of whom nearly 60% report having had tick-related sickness affect their households (N'Sider, 2010). Addressing this problem is not easy, especially given Nantucket's tourist-driven economy.

In response to the issue, the Nantucket Tick-borne Disease Committee was formed to analyze the complex scientific, political, ethical, and socioeconomic factors. The goal of the committee was to evaluate the problem on the island and make recommendations to the town about actions regarding tick-borne disease, prevention, and education. In the summer of 2010, after having met its mandate, the committee disbanded as a formalized entity, but still remains very much active in the ongoing tick issue on the island, as was anticipated by the chairmen (Nantucket Tick-borne Disease Committee, 2009, p. 6). Two prominent members of the committee, Dr. John Tristram Coffin Dammin and Dr. Malcolm MacNab, served as advisors on this project.

The goal of this IQP was to help the Nantucket Tick-borne Disease Committee strengthen the effectiveness of public outreach methods designed to educate the residents and visitors of Nantucket about ticks and tick-borne diseases. Lyme disease on Nantucket has become a large concern for most of the visitors to and residents of the island in recent years. To address this problem tick education to the island community is a key facet in keeping the number of tick bite incidences at a minimum and hopefully, in remission. The project team worked towards achieving this goal by completing four key objectives. The project team: (1) Evaluated the successful and unsuccessful aspects of health and risk communication efforts made throughout the nation that had commonalities with tick and tick-borne disease awareness efforts made on Nantucket; (2) Assessed previous and current efforts made to educate the public on Nantucket about ticks, tick-borne diseases, and disease prevention; (3) Gauged the level of existing knowledge and awareness of ticks and tick-borne diseases in target segments of the population on Nantucket; and (4) Developed a health risk communication strategy regarding tick education on Nantucket, which the team recommended to the Nantucket Tick-borne Disease Committee.

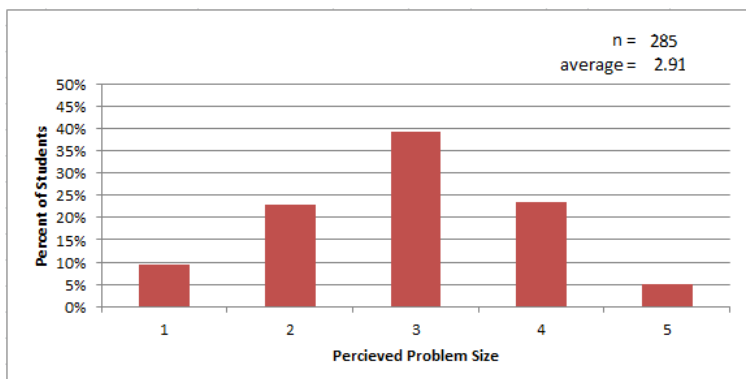


The team completed these objectives primarily through a series of interviews with local officials, small business owners, community opinion leaders, and leading tick experts as well as a survey of students at the local high school. The interviews served to give the team a stronger understanding of the scientific aspects of tick control, the subtle ways the issue plays out in the Nantucket community, the town’s plans and aspirations for tick control, and the past communication and tick control efforts conducted on the island.

The survey of students at Nantucket High School served to help gauge the level of knowledge, attitudes, behaviors, and opinions about the tick issue in the community. The students returned 291 usable surveys representing households from all geographic regions of the island. The findings provide a solid foundation on which to build recommendations to the Nantucket Tick-borne Disease Committee for improved communications in the based on the existing knowledge, attitudes, and behaviors of the community. The survey also served to highlight some of the most effective channels of communication.

From the survey and interviews, the team extracted a number of compelling findings that aided in the crafting of the recommendations. We discovered that 70% of the responding students reported taking no measures to protect themselves from tick bites and over 70% of students considered Lyme disease to be a ‘moderate’ or ‘minor’ problem (see Figure 1). We also found that the proclivity to take measures against tick bites as well as the perceived size of the Lyme disease problem tend to increase in students with a recent history of family Lyme disease and in students that own pets. From this the team concluded that protective behaviors can be encouraged with greater understanding of the threat of Lyme disease, which can most easily be conveyed through trusted sources such as friends, loved ones, and personal experience.

Figure 1: Perceived Problem Size



Findings from the interviews served primarily to identify different issues in a potential public communication campaign on the island. There are a number of methods to control ticks and tick diseases and many of these must be implemented in a multi-pronged approach to help solve the island's problem. Accomplishing any of these methods requires the support of the public, local businesses, and town officials. While some of the proposed methods, such as a public education campaign about ticks and tick diseases, are generally supported fully by the community, other methods generate considerable controversy and any attempt to implement these would require an extensive communication campaign.

Most controversy revolves around any efforts to reduce the island's White-Tailed Deer population as a way to control the number of ticks, and the topic has both political and ethical dimensions. Although an annual hunting season has been long in place on Nantucket, the idea of substantially increasing deer reduction efforts is a sensitive topic for many of the townspeople. The project team gathered valuable qualitative data and opinions from a number of credible sources about the broader issues that surround this dilemma. It is going to be very difficult to achieve any sort of consensus on deer herd management, however in the meantime there is much that can be done to improve the public's understanding of the problem and promote appropriate protective behaviors.

Based on our research, we recommend:

- 1. That the town target students as a primary audience for tick education by implementing a tick information program into the school curriculum**

Upon concluding our interview with Principal John Buckey we established that the school has tremendous potential to convey information and raise awareness to the local youth. We suggest this information be included in the curriculum so students can have more opportunities to retain the information as well as to be graded on the material. We recommend focusing on students because the results of our surveys at Nantucket High School indicate that the majority of students; a) do not take preventative measures to protect themselves from ticks; b) do not perform daily tick checks; c) do not know the most common signs or symptoms of Lyme disease; and, d) do not believe Lyme disease to be a big problem on the island (even if they themselves a family member have had Lyme disease in the past three years). The students need greater attention because there is the possibility that they could still be living on the island in the years to come so it is



therefore crucial to try and target this group. It is also important because they can be used as a tool to spread the word and raise awareness amongst the general population about ticks and tick-borne diseases. Students can speak with families and friends about such things that they learn and will therefore increase overall awareness on the island.

2. That the town target visitors and tourists as an audience for tick education by increasing tick communications around ferries, the airport, and the shuttle as well as other public places tourists will likely congregate

The findings from our surveys and interviews lead us to believe that if information were readily available in these strategic locations, then more people will be able to become aware of ticks and tick-borne diseases. These locations are important due to the fact that the ferries and airport are the only ways by which to leave or enter the island. Therefore, especially during the spring and summer seasons, all the visitors to the island will have an equal opportunity to become aware of the local tick problem.

3. That the town work with local businesses to increase tick information dissemination through methods such as providing tick cards and placing information on bike and trail maps

We believe that in addition to information at transportation hubs, visitors would also benefit from seeing tick information around town as well. We believe information presented at inns and rental properties would effectively reach visitors. We also believe information presented on bike and trail maps will target those visitors more likely to be in tick risk areas.

4. That tick communications be printed in multiple languages to better reach the non-English-speaking audience and increase the use of visuals to reach the non-reading public

Through some of our interviews we concluded that the non-English speaking population is of special concern because many non-English speakers work outside in the landscaping and construction industries where they may be at increased risk of tick bites. Consequently, any future educational efforts should be conducted in multiple languages.



Since little is known about the level of knowledge and awareness of ticks and tick diseases among non-English speakers on the Island, we recommend further research be conducted on this topic.

5. That efforts be made to educate residents on various home tick control methods available and provide an easy way to find professionals offering such services

We believe that an increase in public awareness of home tick control methods such as Damminix Tubes and landscape management will not only lead to an increase in the use of these techniques, but an increase in public discussion and awareness as well. We believe a listing of professionals offering these services will make it easier for homeowners to utilize them and thus increase the likelihood of them doing so.

6. That before attempting to institute any public methods of tick control, efforts be made to educate the public on the township, social, and environmental benefits associated with it

We believe it is important that the public be educated on nature, effectiveness, and costs of various forms of deer and tick management methods. If there is more understanding and knowledge on the issue there is less potential for misunderstandings and controversy in the future. One of our findings is that people who are more aware and knowledgeable of the issue and the proposed methods are more supportive of the various tick and deer control methods. In order to create local awareness and support for the various proposed methods of tick control, a different kind of communication / education campaign should be established. We believe that in order for the public majority to support any large-scale tick control method, there needs to be a greater understanding of the effectiveness, expense, and feasibility of each potential method that could be implemented. Public communications surrounding these issues should work to ensure greater explanation of these themes to the public.

7. That local, trusted sources such as doctors, veterinarians, and schools be used to disseminate tick information



In order to improve the public education campaign it is crucial to convince the audience that the disease is an important matter of personal health and safety. This would most effectively be done for residents through trusted, local sources. Through our survey results we found that the most noted sources of information were family, friends, doctors, and schools, all of which are trusted sources. We believe that these are some of the best approaches to raise awareness about ticks.

8. That community events be implemented to increase public discussion and awareness of the issue such as a ‘pot luck’ dinner.

We believe that a gathering will be helpful for several reasons, the first of which being is our belief that by gathering people of different backgrounds and positions on the issue, communication can be enhanced as people will have the opportunity to understand each other more, and therefore could potentially clear up some of the misunderstandings that may have arisen between people who have never met in person. One example of a gathering which we conceived would be a “pot-luck” dinner. We believe that encouraging an informal meal like this, which would be open to the community, can serve as an opportunity which could lead to public education, particularly with the inclusion of public speeches.

9. That the town pursue the institution of a free tick clinic similar to the Provincetown AIDS clinic

After looking into alternatives for tick testing we established that it would be more convenient, for locals and tourists, to visit a clinic prior to going to the Hospital. This clinic would be free and would encourage more people to be checked, and if need be, may be encouraged to visit the hospital after testing. Similar programs have been implemented effectively in Provincetown for AIDS and we believe that it can be instituted on the island.

10. That future efforts to survey visitors to the island be conducted as well as future surveys to gauge the effectiveness of any campaign instituted

In order to effectively communicate with visitors, the town needs to understand their knowledge, attitudes, and behaviors in relations to ticks. To accomplish this we recommend a survey be done in the summer gauging these aspects of visitors to the island. We also recommend that further surveys be completed in the future to gauge the effectiveness of any communication campaign put in place.

Authorship

This report was a collaborative effort amongst the group members: Corey Alfieri, Jared Broberg, and Maximilian Kaiser. Although each section was originally written by one person they were all later read and revised by all group members to ensure clarity and a consistent style of writing that assures that all views and opinions of the group are represented in the final paper.

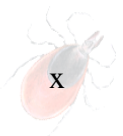


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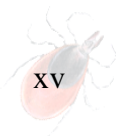
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Introduction

In rural and suburban areas across the nation, populations are contracting tick-borne diseases at disconcerting rates. Tick-borne diseases, also known as TBDs, are transmitted to humans when an infected tick bites an individual. Anaplasmosis (which is also referred to as Ehrlichiosis), Babesiosis, and Lyme disease are the three most common and serious diseases transmitted by infected ticks in the northeastern United States. These diseases can cause severe and crippling symptoms in afflicted individuals, and under certain circumstances each disease even has the potential to be fatal.

Communities with dense populations and a large number of infected ticks are predisposed to higher rates of TBDs because of the increased likelihood of tick-to-human contact. On the densely populated island of Nantucket in southeastern Massachusetts, the potential for repercussions caused by TBDs is a strong concern for many island residents not only because the disease may harm people but also because the diseases may negatively impact the island's close-knit community and tourist-driven economy.

Since 1992, the CDC has ranked Nantucket among the top three Lyme disease counties in the nation (Nantucket Tick-borne Disease Committee). In 2009, Nantucket had the highest incidence rate of reported Lyme disease cases in the state with 452 infections per 100,000 persons, followed by Dukes County (Martha's Vineyard) which had 187 infections per 100,000 persons (Massachusetts Department of Public Health, 2009). Also, according to Massachusetts Fish and Wildlife, the population of Nantucket has a seroprevalence of 12-18% (i.e., 12-18% of the population tests positive in blood tests for TBDs). According to a survey done by the Tom Nevers Civic Association in the Tom Nevers region of Nantucket it is estimated that nearly 60% of all the families in the Tom Nevers region include one or more members who have been infected by tick-borne diseases in the past, most commonly Lyme disease. In response to this issue, the Nantucket Tick-borne Disease Committee¹ was developed to evaluate the problem on the Island and create programs to address the problem. The ultimate goal of the committee is to

¹ The committee is no longer "operational". However the members of the committee and other officials and health professionals are keen to continue efforts to tackle the problem.



lessen the impact of TBDs on tourists and residents. The committee hopes to create a campaign that will educate the public about ticks, tick-borne diseases, and tick bite prevention.

Combating tick-borne diseases is a two-way street that involves participation from both the town and its residents. Managing the tick issue has to be an ongoing effort that requires persistence in both offensive and defensive tactics that must be carried out over an extended period of time. The goal of this project is to help the Tick-borne Disease Committee identify strategies to improve knowledge and awareness of tick-borne diseases and prevention strategies amongst island residents and visitors.

In order to do this we evaluated the success and failures of past efforts that have been conducted to mitigate TBD contraction on Nantucket and elsewhere. We did this through comprehensive research and interviews with experts involved in the field. We also interviewed key people on the island such as island inn-keepers and hotel operators since they are often the primary point of contact for visitors to the island of Nantucket. After having conducted interviews we then gauged the level of existing knowledge of ticks and TBDs in the Nantucket community by administering surveys to students at the Nantucket High School. We chose to survey high school students for several reasons. Firstly, we could acquire a lot of information in a short amount of time due to the captive nature of the high school audience. Secondly, the teenage population is a key target audience for tick outreach and educational efforts because they are often active outdoors and yet may underestimate the risks they face. Thirdly, evidence from the risk communication literature suggests that educational programs in schools (such as those on smoking cessation) can be effective in communicating to the broader public because students are likely to discuss the information in the home-setting or with family and friends.

We ultimately developed a health risk communication strategy which we recommended to the committee to help improve the effectiveness of their tick-education outreach. We used the knowledge gained from our research, interviews, and survey results to provide the committee with a better approach to improving the community's attitudes and behaviors toward ticks, tick prevention efforts, and knowledge of ticks and tick-borne diseases. With our suggestions and information, we hope the committee can formulate an educational campaign targeting residents and visitors to the island. In addition to providing suggestions for new initiatives, our work



provided the committee with further information on how it might improve current education and outreach efforts on the island.



Literature Review

Our project is concerned with the communication about the risks of ticks and tick-borne diseases and appropriate protective behaviors among the public. In order to effectively analyze risk communication efforts regarding ticks on Nantucket, we needed to develop a strong understanding of the underlying problems and possible solutions. Accordingly, this section reviews the background about ticks and tick-borne diseases in Nantucket, past attempts to solve the problem, and an overview of risk and health communication theory.

Ticks and tick-borne diseases in Nantucket

The scientific name for the black legged tick is *Ixodes scapularis*, (formerly *Ixodes dammini*) which is nowadays commonly known as the “deer tick”. This carnivorous arachnid feeds on the blood of mammals, often transmitting disease(s) to its host. For people living in New England, a bite from this vector may transmit any or all of three diseases: Anaplasmosis, Babesiosis, and most notably Lyme disease. Thus, these are known as vector-borne diseases.

Lyme disease is the most commonly known tick-borne disease. The disease gets its name from Lyme, Connecticut, where the illness was first described in 1975 (MMWR , 1988). It was discovered when children in Lyme Connecticut were observed with ring-like rashes and symptoms of juvenile arthritis, which are signs of Lyme disease. In the years between 1984 and 1986, the CDC, or Center for Disease Control, received an average of 1,500 reports of Lyme disease annually (MMWR , 1988).

According to the Center for Disease Control and Prevention, since 1992 Nantucket has maintained the third highest incidence rates for Lyme disease in among counties in the country (Bacon RM, 2008) and the highest in Massachusetts (Massachusetts Department of Public Health, 2009). As shown in Table 1, the incidence of Lyme disease in 2009 was 452/100,000 people in Nantucket, compared with 187/100,000 in Dukes County (Martha’s Vineyard) and only 9/100,000 in Suffolk County. The risk per person is thus highest in Nantucket, but the number of confirmed cases is low (43) in part because the population exposed is relatively small and also because many who contract the disease are likely visitors who are diagnosed ‘off island.’ By contrast, Middlesex County has a lower incidence of Lyme disease (43/100,000) but



a larger number of confirmed cases (633) because the population density and population exposed is high. Under-reporting of Lyme disease is a significant problem, for example, the Centers for Disease Control and Prevention estimates that only 10% of all Lyme infections are reported to it. This problem is exacerbated on Nantucket since such a large proportion of the population during the peak tick season comprises visitors to the Island.

Table 1: Lyme disease in Massachusetts 2009 - (Massachusetts Department of Public Health, 2009)

County*	2009 Confirmed Cases (#)	2009 Incidence Rate (per 100,000)
Barnstable	184	83
Berkshire	105	78
Bristol	232	43
Dukes	28	187
Essex	300	41
Franklin	53	74
Hampden	193	42
Hampshire	117	77
Middlesex	633	43
Nantucket	43	452
Norfolk	456	70
Plymouth	376	80
Suffolk	64	9
Worcester	420	56
State Total	4028	63
<i>* County was unknown for 824 cases</i>		

Tick-borne diseases in general and Lyme disease in particular are a growing problem. The CDC found that in the United States alone the number of Lyme disease cases more than doubled between the years of 1995 and 2005. “In the 10 states where Lyme disease is most common, the average in 2005 was 32 known cases for every 100,000 people. Lyme and other tick-borne diseases are crawling across the United States, exacerbated by warming temperatures and evolving land-development trends” (Tick-borne Infections Council of North Carolina, Inc., 2008). According to Massachusetts Fish and Wildlife there is a seroprevalence of 12-18% in Nantucket. Also, according to a survey done by the Tom Nevers Civic Association in Tom Nevers, a region of Nantucket, nearly 60% of the families have been infected or affected by tick-borne diseases. The term seroprevalence means the number of people in a population who test



positive for some sort of disease based on their blood work (Merriam Webster, 2010). In s 2007 and 2008 the Nantucket Cottage Hospital recorded reported cases of Anaplasmosis, Babesiosis, and Lyme disease on Nantucket (Table 2). They found that between 2007 and 2008 tick-borne disease cases increased from 258 to 411, and Lyme disease cases in particular increased from 190 to 325.

Table 2: Nantucket Cottage Hospital Contracted TBDs, (Nantucket Tick-borne Disease Committee, 2009)

	Lyme Disease	Anaplasmosis (Ehrlichiosis)	Babesiosis	Total
2007	190	15	53	258
2008	325	17	69	411

Figure 2 clearly shows that the northeastern region of the United States had the highest concentration of reported cases of Lyme disease in the United States in 2008. This pattern is typical of other years and may reflect the fact that more deer live in close proximity to densely populated neighborhoods, or it may be related to the gradual south and westward diffusion of the disease through the animal host population of deer and white-footed mice.

**Figure 2:
Reported Cases of Lyme disease – United States, 2008
Center for Disease Control and Prevention**

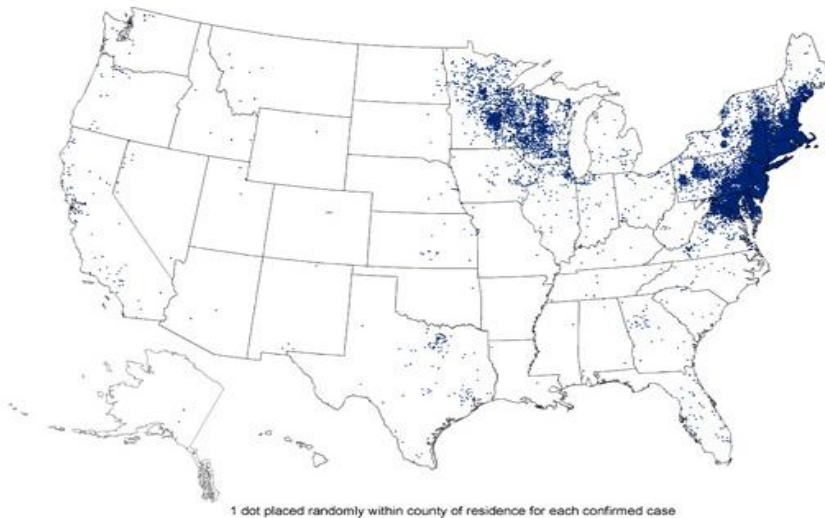
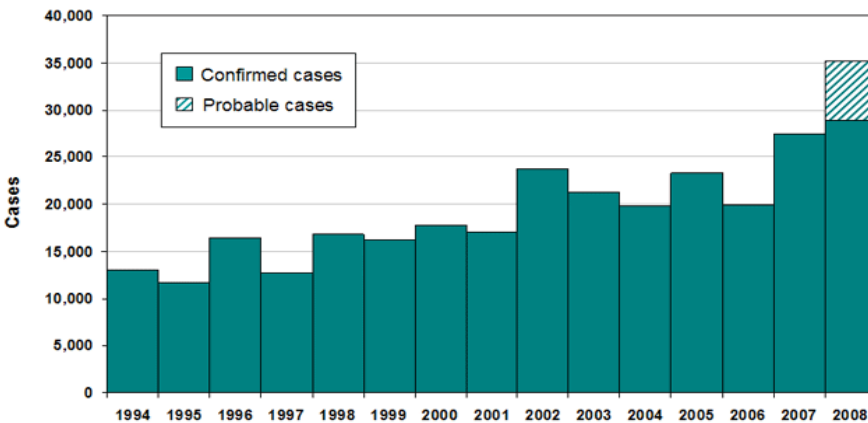


Figure 3 shows the steady increase in Lyme disease in the United States between 1994 and 2008. When this graph was constructed, a significant number of cases for 2008 had yet to be confirmed. The reason Nantucket has maintained this high incidence rate has to do with the fact that there is a lack of predators and a high density of deer and mice per square mile. According to several members of the Nantucket Tick-borne Disease Committee, 40% of the island of Nantucket is conservation land. This is a concern due to the fact that deer are able to roam almost half of the island without fear of being killed by natural predators. The more deer and mice there are in a given area, the more ticks there are in that area.

Figure 3: Cases of Lyme disease, United States, 1994-2008 (Center for Disease Control and Prevention)



According to Tristram Dammin (personal communication, November, 2010), one of the chairmen of the Nantucket Tick-borne Disease Committee, over 10% of Lyme disease patients on Nantucket also have one or more other tick-borne diseases such as Anaplasmosis or Babesiosis. This is also confirmed by Tim Lepore (personal communication, November 2010), the only surgeon on the island of Nantucket who has written many papers and pamphlets as well as conducted many studies on ticks and tick-borne diseases. This idea of “co-infection” is raising alarms in the scientific community and there is now more research being done on the topic. There have also been reports of Lyme disease starting to increase on Nantucket. This is a problem considering it’s a very severe disease that can be life altering for those affected with it. If it’s not treated right away it can be very crippling. Some of the reasons for these increases are that there could be more deer due to less hunting, the prices of the 4-poster systems could be too high, immunocontraception could be expensive, and pesticides are met with a lot of disapproval. The reason why there is less hunting is because in February of 2005 the Nantucket Selectmen



voted, after public hearings, to have an extended hunting season. This was met with much outcry due to many reasons, one of which being unfamiliar hunters hunting through people's yards. This could cause many problems; having many hunters in an unfamiliar hunting ground. To the residents of the island this can be a very disconcerting notion that can affect their daily life, causing them to be afraid to venture outside. Immunocontraception is very expensive, and according to some experts a better approach could be to neuter the male deer. Another reason for the increase in diseases is that it could be possible that more people are wandering out of their houses into the conservation lands, and other areas that ticks may be residing. This could be due to the fact that the economy is trying to grow and therefore there are some properties that are located on or near areas that ticks inhabit. In these situations someone could walk outside and already be at risk to get bitten. The problem with ticks on Nantucket now has to do mainly with people occupying areas filled with ticks. This would not be as big of a concern if everyone on the island did daily tick checks. The reason for this is that you have a greater chance of finding ticks on yourself if you periodically check yourself, especially after you've been in areas known for tick activity.

The white-tailed deer was introduced to the island in 1922 and is the key reason the island's deer tick population has increased (Brace, 2010). This original deer, cordially referred to as "Old Buck", was found swimming in the ocean where it was picked up by local fishermen. Old Buck was pitied upon and with the help of a summer resident two does were imported to the island thus allowing for the white-tailed deer population to survive and endure. Through the years the deer population was able to increase due to the lack of natural predators. There are now thousands of deer on the island. According to Massachusetts Fish and Wildlife there are approximately 2,500 deer on Nantucket with a density of 50 deer/sq. mile. The local hunting season currently harvests about 500 deer annually; roughly 20% of the deer population, every year. Hunting helps control the overall density but in order to use reduction as a tool to lessen tick-borne diseases, deer reduction efforts would need to increase to reach the desired density of 10 deer/sq. mile. Based on models from the Massachusetts Department of Fish and Wildlife years if the annual harvest rate were to be increased to 35% this desired density of 10 deer/sq. mile can be reached in approximately 10-12 years' time. The desired goal is 10 deer/sq. mile



because it will greatly decrease the number of ticks, and it will also appease those who are against the complete eradication of the deer from the island.

Although deer ticks have various hosts (see Figure 4), their primary host is the white-tailed deer. The deer are mobile and are responsible for distributing the ticks over wide areas. According to a paper produced in the summer of 2010, Hartney and Greymont reference the Patriot Ledger which says “It is estimated that there were fewer than 1,000 white-tailed deer in the early 1900s. Today the white-tailed deer is the state’s most prolific game animal, numbering 85,000”.

According to Michael Kopko, chairman of the Nantucket Board of Selectmen, a man whose wife and daughter have been infected with tick-borne diseases said, “Those of us who live here all know someone or are related to someone or have ourselves had a tick-borne disease” (Belluck, 2009). With rising number of cases of tick-borne diseases on the island there is an immediate need to try to control the problem. Deer hunting is by far the most controversial of the proposed control efforts. It is controversial for several reasons ranging from politics to practicality. Culling innocent deer from the herd is often frowned upon and achieving consensus about deer reduction goals and strategies is fraught with difficulties. Due to this dilemma we are left with other options which can sometimes be more expensive and less effective; nevertheless some of those efforts are proving to be very promising, most notably public education and the use of 4-poster deer treatment bait stations.

Attempts have been made in other parts of the country to either reduce deer populations or eradicate them altogether as a means to control tick-borne diseases. For example, in Monhegan Island, Maine the entire deer population was eradicated between 1996 and 1999 and recent tests reveal that deer ticks are almost non-existent (Telford, Tufts School of Veterinary Medicine.; Nantucket Tick-borne disease Committee, 2009). Monhegan Island demonstrates how the elimination of the deer can dramatically reduce the number of ticks and cases of tick-borne diseases, adopting such a radical approach may not be feasible on Nantucket. To start Nantucket has a larger population, which makes it harder for the island residents to come to a mutual agreement about deer hunting. Monhegan Island is a very small island, and with a population that was more closely connected than that of Nantucket. With a closer community it

would be much easier to agree on deer hunting. Nantucket also has a large tourist population in the spring and summers. That is another obstacle Nantucket has to consider because most of these tourists don't know much about ticks and the situation on Nantucket and the tourists could contract the disease and then leave only to be diagnosed on the mainland. Regardless, deer hunting on Nantucket has become a difficult approach due to the public outcry during their extended February hunting in 2005. However, another example of deer reduction was Mumford Cove, Connecticut where they first tried administering birth control, or immunocontraception. However that failed so they therefore tried the next most practical approach of hunting the deer. The deer population was reduced by 92%, and the deer density went from 100 deer/sq. mile to 10 deer/sq. mile. This resulted in their annual Lyme disease infection rate going from 30 per year to 2-3 per year. However successful these attempts have been the thought of controlling the white-tailed deer population, according to several people we interviewed, is unlikely to occur on Nantucket in the near future, if ever.

Lyme disease is a problem on Nantucket because it is a cyclic disease which has chronic, multi-systemic, neuropsychiatric manifestations (San Diego Natural History Museum, 2001). The cycles are long term. An example of this would be patients who start to show arthritis like symptoms; these symptoms can stay with the infected patient for the rest of their life. It can severely affect the joints, heart, and central nervous system of those infected. A cyclic disease is a disease with different stages. This cycle can be seen in Table 2, which shows three tick-borne diseases, and some of the signs and symptoms associated with each. Lyme disease causes functional, chemical, and structural changes to the brain and alters almost every organ system of the body. The most notable sign that anyone has Lyme disease is if they have the chills and a fever, and also if they have a ring-like rash on their body. This can be seen during the first stage of the disease. However, according to Tristram Dammin, not all people who are diagnosed with having Lyme disease report having a ring-like rash. This is also confirmed on webmd.com, which says that not all Lyme disease patients have a bull's eye rash, as is common in about one out of four that are infected. Positive identification of these signs can lead to an early diagnosis of Lyme disease, which if diagnosed early can be treated. Ticks are capable of transmitting several tick-borne diseases at once. "That could be because high numbers of ticks increase the odds of being bitten by co-infected ones or because the ticks' concentrated food supply increases their co-infection risk" (Belluck, 2009).



In order to effectively combat tick-borne diseases, specifically deer ticks, it is important to know that they have a life cycle of two years. The life cycle of the tick is shown in Figure 4. The ticks are born in the spring and turn into larvae. Once the tick turns into a larva it is searching for a host to feed on so it can acquire blood to grow. Larva deer ticks generally feed from white-footed mice. This period usually happens in the summer which is usually a very busy time on Nantucket due to the concentrated visiting tourist population. With more people around the island there are more hosts for ticks to feed on. This can be seen in Figure 5, which indicates that the spring and summer have the highest peaks for the nymphs and the adult deer ticks. The ticks feed from hosts in three of the four stages of their life cycle. They feed as larva, nymphs, and adults. In any of these stages a tick can become a transmitter of a disease and any host they feed from thereafter has the chance of becoming infected.

Ticks typically remain dormant in the winter in order to molt into their next stage. However during the winter the adult ticks are on the lookout for hosts in order to reproduce. After they have molted they start to become more active in the spring and summer, both seasons being when the island of Nantucket is very populated with people. This cycle continues until the nymphet eventually turns into adults. During this final stage they seek white-tailed deer as hosts so they can acquire blood and reproduce. Once the ticks reproduce the cycle starts over again.

Figure 4: Life Cycle of Deer Ticks
Center for Disease Control and Prevention

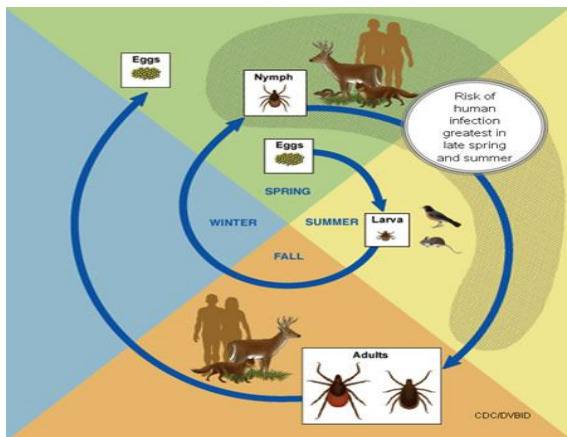
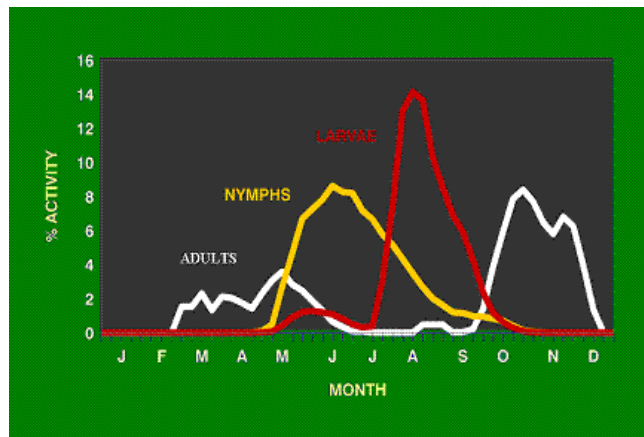


Figure 5: Deer Tick Stages vs. Month
American Lyme disease Foundation



Each new cycle of ticks being born increases as it is estimated that each adult female tick can lay up to 3,000 eggs (American Lyme Disease Foundation, 2010).

Table 3 is a table representing the types of the signs and symptoms of the three most common tick-borne diseases in New England, Lyme disease, Babesiosis, and Anaplasmosis and the most common signs and symptoms associated with them. They share some similar symptoms such as fevers, chills, muscles aches and fatigues. Lyme disease is the most common of the three but the other two have the potential to be fatal. These diseases can also be transmitted simultaneously into a person, meaning that a person can acquire more than one of these diseases at a time. In Lyme disease the first stage is the first three to 30 days and it mainly includes fevers, chills, and distinguishable ring-like rashes. The second stage is days to weeks after the onset of the illness. In this cycle those affected can show facial paralysis, irregular heartbeats, and even numbness or pain in the arms or legs. The third stage of Lyme disease occurs weeks to months after the onset of the illness. In this stage you can show signs of joint swelling from arthritis, problems with the nervous system, and persistent weakness and fatigue. With such evident signs and symptoms it has become much easier to identify these diseases, especially if the infected person knows that they have been bitten by a tick or knows that they spend a lot of time in areas where ticks live. Lyme disease is a very dangerous disease that if left untreated can lead to some very severe medical outcomes.



Table 3: Symptoms of Select Tick-borne Diseases (Minnesota Department of Health, 2010)

	Signs and Symptoms
Lyme Disease	<ul style="list-style-type: none"> • Three to 30 days after a blacklegged tick bite • A distinctive rash • Fever, chills, headache • Muscle and joint pain • Fatigue • Days to weeks after onset of illness, one or more of these signs and symptoms may occur: <ul style="list-style-type: none"> • Multiple rashes • Facial paralysis on one side of the face • Fever, headache • Stiff neck • Weakness, numbness or pain in arms or legs • Irregular heart beat • Dizziness, feeling lightheaded, or heart palpitations • Persistent weakness and fatigue • Weeks to months after onset of illness, some of these signs or symptoms may appear: <ul style="list-style-type: none"> • Joint swelling from arthritis in one or more joints, usually the knees • Problems with the nervous system • Persistent weakness and fatigue
Anaplasmosis	<ul style="list-style-type: none"> • Fever (over 102°) • Severe headache • Muscle aches • Chills and shaking • Nausea • Vomiting • Loss of appetite • Weight loss • Abdominal pain • Cough • Diarrhea • Aching joints • Change in mental status • Skin rash rare
Babesiosis	<ul style="list-style-type: none"> • High fever, chills, headache, fatigue • Loss of appetite, anemia

The Past, Present and Future Concourse of Tick-Borne Disease Prevention Efforts

Due to growing concern from the recent rise of reported tick-borne disease cases, the nation has seen an increase in the number of organizations, programs and efforts aimed at minimizing tick-bite incidents and spreading awareness of ticks, tick-borne diseases and the treatment of these diseases. Proactive and reactive risk communication measures are essentially being made by four core groups including various government entities, an array of public and private institutions, specialist groups and private parties.

Government entities generally address tick-bite prevention through funding and the appointment of officials and experts. On a national level, organizations such as the CDC are responsible for the dissemination of tick related information. On the state level, the issue is addressed by the Department of Public Health which also sponsors efforts at the county, municipal or town level to reach out to a localized community. On Cape Cod, the Massachusetts Department of Public Health funds the Cape Cod Cooperative Extension to provide the public with information about ticks and the risks associated with them. On Nantucket, the Nantucket Board of Selectman and the Nantucket Board of Health are examples of governmental entities involved in managing tick related issues. Government funding usually sponsors efforts involving the creation and distribution of a mix of handouts (namely brochures and signage) and public service announcements. Although government intervention concerning TBDs generally involves funding regional experts or organizations to address the issue in their respective area, sometimes government entities take a direct approach toward the issue. An example of this would be the Maine Center for Disease Control and Prevention's "*No Ticks for ME*" Kindergarten through 8th Grade Poster Contest which was conducted in May of 2010.

Institutional Organizations are organizations that provide a service to the public. This group includes schools, hospitals and also private businesses like lodging facilities and campgrounds. These are organizations that are usually affected directly when a customer or affiliate contracts a tick disease. These organizations can sometimes be involved in tick-borne disease reduction efforts. An example of this would be when schools set up an education program for the students about ticks, tick-borne diseases, and tick bite prevention.



Specialist Groups are typically third party, non-profit or not-for-profit groups comprised of dedicated experts that are specifically involved in making recommendations. The goal of these groups is to deduce and promote strategies that will ultimately lessen tick-bite incidence rates. Specialist groups such as the Tick-borne Infection Council of North Carolina or the Nantucket Tick-borne Disease Committee, make suggestions to local government and health organizations about ways to improve public efforts concerning TBDs. Other specialist organizations like the American Lyme Disease Foundation, deal almost exclusively with the public and are mainly concerned with making tick related identification and treatment information accessible to the general population.

Private Parties are cooperatives of proactive individuals that work to address local concerns at the community level. The Nantucket Rotary Club's *Reduction of Tick Borne Disease Program* (currently under development) is an example in this category (Rotary Club of Nantucket, 2010). A private party could also be a single individual who takes on the responsibility of disseminating information to educate on tick-prevention. Dave Simser, who was the Barnstable County entomologist and the leading tick expert on Cape Cod, gave free public speeches on tick and tick disease prevention and would be an example of this type of private party.

Although the risk communication efforts made by the groups described above may involve different approaches toward solving tick-related issues, the end goal of the organizations promoting the efforts is ultimately the same: to lessen the prevalence and incidence of tick-borne diseases. Each organization makes different attempts to reach out to their target audiences based on how different their target audience is from the others and what the organizations stakes are in that target audience. This diversity in target audiences points out that is important to have multiple communication channels in order to maximize the overall audience. By having diverse communication groups such as the four listed above, it is easier to accomplish this.

Nantucket's overall strategy for dealing with the issue of tick-borne diseases is mostly the same as the strategies implemented in other rural and suburban US towns whose populous is at high-risk for contracting a tick-borne disease. The following six key efforts have been made in

recent years on Nantucket and they give a general description of the Town's rounded strategy for managing the issues contributing to tick-related illnesses.

Public information is a stronghold in the fight against tick-borne disease on Nantucket because it is direct in approach (information goes from source to end-user) and usually involves recommending relatively simple procedures that anyone can do to reduce the chance of contracting a tick-borne disease. Tucking pant legs into socks or shoes, using a personal insect repellent (DEET or Pyrethrin), wearing brightly-colored clothing (to facilitate tick visibility on the body), performing daily tick-checks and showering with a long handled brush are widely advocated, relatively easy and inexpensive precautionary measures that are commonly advised on Nantucket (Ebbert, 2008). Tick information is generally disseminated by government entities and specialist groups, but is often made available by institutional organizations and private parties. In the town of Barnstable on mainland Cape Cod, a tick-knowledge effort took form in the distribution of wallet-sized cards showing scale images of ticks with relevant information on prevention, identification and removal of the tick. The effort was conducted by the Barnstable County Cooperative Extension with funding from the Massachusetts Department of Public Health and has proven a popular communication channel over the past several years (Simser, 2009). The Barnstable County Cooperative Extension also offers free tick awareness materials through the *Barnstable County Cooperative Deer Tick and Lyme Disease Prevention Program*. Complementary materials include tick posters, trail and golf course signs as well as activity books for children promoting communication and education on tick-related topics (Simser, 2009). It is difficult to report any conclusive evidence explaining the effectiveness of these materials, but Simser prints and distributes signs and wallet-cards in abundance on an annual basis for businesses, residents and visitors of the Cape and Islands. Although it is assumed that some of the materials may be acquired and never read or examined, it has been expressed by many tick experts that it is the initial awareness factor of receiving or recognizing the materials that matters the most. As Simser explained, when people pick up a flyer or spot a sign, they are at least reminded that ticks are around. Simser regularly changed and updated his signs on nature trails and golf courses to make sure that they were new in appearance to remind the public that ticks are not a back-burner issue that could be neglected.



Tick awareness in the school system is also a recognized method of information dissemination in the topic area of public information. Free programs, activities and materials are provided for teachers by a number of organizations such as the Maryland Infectious Disease and Environmental Health Administration, who offers Lyme Disease Jeopardy and crossword puzzles for students. While it is beneficial for younger generations to learn the hazards, habits and life-cycles of ticks, it can also be a learning experience for the families of those children who may be likely to converse with them on the topic (Nantucket Tick-borne Disease Committee, 2009). In their 2009 report to the Nantucket Board of Health and Selectmen, the Nantucket Tick-borne Disease Committee recognizes the Barnstable Public School System as the “...local leader in Tick education and related programs” (Nantucket Tick-borne Disease Committee, 2009).

Landscape modification is a tick-prevention tactic that authorities encourage to reduce tick populations around homes and businesses. By removing low-growing brush and vegetation, landowners (as well as public property caretakers) can make environments less hospitable to ticks and can subsequently limit tick numbers in certain areas—which is especially important in the immediate yard area around the home (Simser, 2009). Tick Experts working with the Cape Cod Cooperative Extension have recommended that homeowners replace vegetables and flora that attract deer with more foul-tasting plants like Marigolds, Hyacinth, Foxglove and Wisteria among others to deter the deer from feeding around the home, which can help to reduce the number of ticks brought onto a property that may be traveling on the hides of the animals (Simser, 2009). The Nantucket Tick-borne Disease Committee recommends keeping grass trimmed to three inches or less and installing “rumble strips” of stones or wood chips to create three-yard barriers around the home as these surfaces are unwelcoming to ticks. The use of fencing is also an option and one that is more guaranteed in terms of repelling deer, however installing barriers is a greater endeavor and involves more complications than vegetation management. Kirby C. Stafford’s *Tick Management Handbook* is a prominent cost-free tick publication in the US and Canada that discusses these architectural plans and suggestions as well as others that are geared toward designing a yard that will discourage ticks.

One issue involved with landscape related efforts is that many homeowners on Nantucket and elsewhere have their yards maintained by landscape professionals who may or may not be

aware of the variety of efforts that can be made to mitigate deer and tick populations around the home. The Cape Cod Cooperative Extension advises homeowners to consult their landscape agencies and talk to them about the use of pesticides on and around their properties (Barnstable County Cooperative Deer Tick and Lyme Disease Prevention Program, 2005). Information on landscape modification aimed at reducing tick exposure is freely available on numerous health awareness, disease prevention and government websites. In some cases, anti-tick landscaping information is provided from landscapers and arborists directly like Bartlett Tree Specialists, who offer customized tick-prevention landscape programs for homeowners on Nantucket (Booth).

Pesticides have proven to be an effective way of reducing the tick population in some select areas on Nantucket and in high tick population areas elsewhere. The problem with pesticides is however, that the widespread use of harsh chemicals generally has a negative impact on the environment and even when it does not, spraying or dispersing pesticides can often carry a negative connotation. It is because of these two factors that in most non-emergency scenarios, pesticides are only used in moderation or in finite amounts at specific locations, which makes it extremely difficult to conclude the efficiency and effectiveness of the chemicals. Nantucket has implemented the use of *4-Poster* deer feeders which coat the neck, head and ears of a feasting deer with Permethrin insecticide while the animal gorges at an alluring feeding station on the unit (Nantucket Tick-borne Disease Committee, 2009). In 2007 and 2008, four *4-Poster* units on the Linda Loring Nature Center Property on Nantucket were involved in a study with identical units installed in Barnstable, Chappaquiddick, and on Martha's Vineyard and it was determined that in both years, there was an overall improvement in the reduction of both adult tick and nymph populations (Nantucket Tick-borne Disease Committee, 2010, p. 41). An expanded, long-term *4-Poster* study is currently being conducted with units at several locations on Nantucket. In 2009, further reinforcing interest in the devices, a Cornell study revealed the effectiveness of *4-Poster* stations deployed on Shelter Island, New York which showed an improvement in tick-population reduction with low risk to the environment and deer health (although some specimens showed an increase in weight gain after feeding from the units) (Gilrein & Walker, 2009, p. 23). The success of the program and its relevance as a compact island community has made Shelter Island a model example for Nantucket, which is currently

considering further investment in an extensive 4-poster program. Unfortunately, the units are fairly expensive to maintain and they have some Nantucket hunters worried that the Permethrin on the deer hide could potentially contaminate the eatable venison during the butchering process.

The use of *Damminix*, another Permethrin insecticide has also been implemented on Nantucket to help control the propagation of nymphs that are transported on White Footed (field) Mice that are common hosts to ticks and an integral part of tick-borne disease transmission on Nantucket (Nantucket Tick-borne Disease Committee, 2009). Twenty-four Damminix tubes (enough to cover one-half acre of land) can be purchased for the cost of \$80.00 (Seccombe, 2007). Quantitative analysis concluding the effectiveness of the tubes is varied depending on geographic region, but the units are widely recognized as being a simple, safe and efficient manner of controlling ticks on a property. In the Tom Nevers region of Nantucket, Damminix tubes are in use on a number of private residence properties and they proved qualitatively, to be an effective alternative to the 4-Poster stations which residents were told they would need a Massachusetts Pesticide License from the State in order to operate. The use of anti-tick pesticides such as *Advantix* and *Frontline* on household pets is also encouraged on the Island and is a commonly used practice in keeping ticks out of the home.

In February of 2005, the Town of Nantucket opened an extended hunting season on the deer community and 246 animals were culled from the population of roughly 3,000 (Belluck, 2009, p. 2). Deer herd reduction greatly impedes the ticks' mobility and disease transmission capability due to the loss of an efficient host and mating site. Although the Department of Fish and Wildlife recognized the event as a success, Nantucket's quiet community was startled enough by the off-season hunting that the tactic has yet to be reinstated, and it is debatable as to whether or not it ever will be.

The question of whether or not to eradicate the non-indigenous and invasive deer population is an ongoing ethical dispute in the battle against ticks on Nantucket. In the mid to late 1990's, the rural community on Monhegan Island in Maine, voted to eliminate their non-indigenous deer population after various attempts to apply pesticides to the animals failed to manage the problematic tick population that thrived parasitically off of the deer (Adler, 1999, p. 43). Although the eradication yielded various reports concluding its overall efficiency, the



ultimate result was the near eradication of the deer tick population on the Monhegan Island, although some have challenged this conclusion. Nantucket's less radical 2005 rendition of the Monhegan scenario, unofficially titled the "February Hunt" still has split support amongst residents. Opinion over the questionably effective but inexpensive and time-efficient option to exterminate Nantucket's resident deer is disputed enough between Island neighbors to keep the topic in limbo for now (Belluck, 2009, pp. 2,4). Many island residents have expressed concern about the ethics of killing off the deer population. While an annual hunting season is in practice for now, exterminating the entire population and/or extending the hunting season, such as was done in 2005, are contested options with questionable upturns.

Reaching out to commuters on Nantucket-bound ferries has proven an effective way of establishing contact with a large number of people traveling to and from the downtown area. Island visitors and residents alike frequently travel to and from Nantucket on the local ferry. The amount of people that have to use the ferries is rather large and if they were to be surveyed about ticks, one would be able to receive a substantial amount of information from ferry goers. Over the course of two years, from May 1997 to September 1999, one study was able to survey 30,164 ferry commuters on tick avoidance and prevention measures along with specific knowledge assessment pertaining to certain Tick-borne Diseases (Daltroy, Liang, Phillips, Lew, Wright, & Shadick, 2007). Making contact with a diverse age group was facilitated by the bustling ferry environment and it would appear from the Society for Public Health Education study discussed above, that individuals are generally willing to discuss tick-related topics on the ferry boats (Daltroy, Liang, Phillips, Lew, Wright, & Shadick, 2007). Although most commuters arrive on Nantucket via boat, many choose to travel by air, arriving at Nantucket Memorial Airport, making the portal a potential location for future outreaches.

Nantucket's radical seasonal population trend is a major factor affecting tick-related education efforts on the Island and a factor that makes Nantucket unique from most other comparable communities at high-risk for tick-borne diseases. Seasonal population fluctuation not only makes analysis of the success of tick-prevention efforts difficult, but it makes the task of communicating tick risks to individuals more difficult. Nantucket's population fluctuates from roughly 10,000 people in the off-season to around 40,000 persons in the summer (Belluck, 2009, p. 2). Multiple literary sources express concerns about potential flaws in the number of recorded



TBD cases on the Island simply because a visiting tourist who contracts a tick-borne disease on Nantucket is likely to be off the Island by the time that the illness has caused symptomatic signs in the victim and has been identified as a TBD. Another issue involved with communicating tick-related information to a visiting population is that not every tourist arrives knowing about the severity of the tick issue. Although the prominence of tick-borne diseases on the island is clear and available in Nantucket Town resources, the issue is not made apparent in vacationing guidebooks in the same way that malaria might be when a publication recommends a tropical hotel with insect nets. Providing information about ticks in a manner that is easily-accessible to a tourist or visiting population audience is an important task and one that involves persistence as well as strategy. Drawing boundaries on the amount of information broadcasted as well as the tone used in addressing that information is an important decision factor that affects the way individuals perceive information and choose to act on it.

Communicating information to tourists is a delicate procedure, but necessary for the health of the individual and the tourist-driven component of the Nantucket economy. Risk communication is a fine balance that must inform but not startle the targeted individual. Expressing the severity of an issue to increase the individual's awareness can be difficult because the communicator does not want the listener to become overly fearful of the matter at hand. On Nantucket, frightening tourists with an onslaught of facts about Lyme disease could potentially drive them away. This prospect is similar to a local opinion held by some that talking publically about the tick issue will drive down property values on Nantucket (Belluck, 2009, p. 2). It has also proven difficult to convince island real-estate agents and inn keepers to explain the issue to customers, although the Nantucket Chamber of Commerce has printed information on the topic in past publications for visitors.

In order to avoid problems in risk communication involving ticks and the public on Nantucket, efforts made must be consistent and expected to be long-term. Increased knowledge and awareness of tick-borne diseases and tick bite prevention may increase vocalization and physical action regarding the issue, which could potentially help to increase response the issue in future voting opportunities. In April 2010, 128 people left no response for a question regarding the topic of deer reduction and tick population on the island. Experts and residents agree that it is necessary to make further attempts at communicating the risk of ticks through vectors

involving public education and public information outreach and these vectors could bolster future input from the community. It's likely that some personal topics such as hunting and choice of landscape won't change in their nature with improved tick awareness because of behavioral, habitual and moral differences between individuals. Although ethical differences between individuals may stall or hinder the development of some strategies to reduce TBDs on Nantucket, it is important that residents vocalize their opinions because talking about the issue rekindles awareness. It has been expressed by several sources on the island that visitors to Nantucket can only be expected to know and care for the issue to a certain extent. This means that it is up to the residents to make headway on the issue. This isn't to say that voting is the answer to making progress for every step of the tick issue on Nantucket. Elections are a single example of one way in which the town could get a better consensus on sensitive issues such as hunting and pesticide use. Keeping awareness levels up in the community through education and public outreach is probably the best short-term step toward gathering a consensus about future actions that may be made to help mitigate tick-borne diseases on Nantucket.

Risk and Health Communication

The field of risk and health communication is a complex, varied one. There is a wide expanse of different theories and practices, as well as different goals and focuses. Both risk and health communication focus on communicating risks to a public and sometimes creating a change in behavior, but the key difference is in the goal. Risk communication is often done in response to a problem that occurred or was caused by the agency doing the communication. It is often done to assuage public outrage. Cell phone companies, for example, would use risk communication methods to assure the public that cell phone radiation is not harmful to users. Health communication on the other hand, tends to deal with stirring the audience. Organizations creating health communication campaigns are often trying to move an audience into reacting to a risk. Health communication often takes the form of public service announcements and the like such as seatbelt use and anti-smoking campaigns. The difference in goals, however, does not change the effectiveness of the communication. Many theories and methods in both fields agree on a number of key aspects to any communication campaign such as understanding the audience,

finding the best methods and channels to communicate to the audience, and knowing what to communicate. Such a campaign on Nantucket to communicate with residents and visitors concerning ticks and tick-borne diseases will need to understand these concepts. This section will synthesize these major concepts found across the field of risk and health communication and highlighting several methods and examples of specific approaches.

Knowing the Audience

Agreed on by almost all risk and health communication theories, one of the most important aspects to any communication campaign is to know your audience. As Regina Lundgren points out, “You cannot communicate unless you know to whom you are communicating” (Lundgren & McMakin, 2004, p. 100). Learning about your audience is usually the first step in a successful communication program. One has to identify everything of importance about the audience being targeted. Knowledge, attitudes, and behaviors are all facets of an audience that can completely change the way communication is received.

Understanding these facets of your audience should be the first step in creating a communication campaign. The knowledge of your audience will show what it is they need to learn. It is difficult to understand and heed a risk that one knows very little about it. Likewise, a person will not mind suggestions to change their behavior if their attitude towards the risk is apathetic. Studying the behaviors of your audience will allow you to understand the specifics of what you need to change. For example, suppose a campaign is created that instructs people to apply bug spray to ward off ticks. This campaign would prove unsuccessful if people begin using ineffective bug sprays. Knowing this, a more successful campaign would specify the use of DEET based sprays.

When learning about your audience’s knowledge, attitudes, and behaviors, it is important to try your very best to limit the influence you may have on the results. It is important that you discover the audience’s knowledge, attitudes, and behaviors, not your own reflected back. One way to do this initially is through the use of open ended surveys in which you ask questions such as: what do you know about ticks? This allows the interviewees freedom in their answer so that you may collect what wrong information they have as well as the right (Morgan, Fischhoff,

Bostrom, & Atman, 2001, pp. 63-64). From there you can ask more specific questions until you have developed a rough idea of your audience. From here a more common structured survey can be used to discover if a wider audience shares such knowledge, attitudes, and behaviors.

Of all of the communication theories, the Mental Models approach perhaps places the most emphasis on the importance of understanding your audience. The authors believe that a failure to communicate “reflects the lack of systematic procedures for finding out what people know and need to know” (Morgan, Fischhoff, Bostrom, & Atman, 2001, p. 20). The Mental Models approach perceives each person’s ideas and attitudes towards a certain risk as their own “mental model” of it. A mental model is an ever changing mental construct of an idea that is constantly altered by any new information or thought about it. The idea of risk communication under this approach is that your goal is to add to, replace, or alter some aspect of your audience’s mental model (Lundgren & McMakin, 2004, pp. 16-17).

Using the Proper Channels

Determining the channels of your communication is a crucial step in any campaign. This part requires the understanding of your audience so that you will know how to reach them. Different groups of people are exposed to different parts of the media and receive information in different ways. For example, putting information on ferries to Nantucket would likely inform tourists and visitors, while local news and fliers put up around town will bring the message to residents. It is generally best to try to expose the most people to your messages and thus you should use as many channels of communication as possible while being careful not to overexpose yourself (Lundgren & McMakin, 2004, pp. 100-101).

If you have collected a strong enough understanding of your audience, you may be able to segment it. Being able to identify the specific channels each of these segments are open to will allow you to communicate different messages to specific groups. Doing this will allow you to specifically tailor your campaign to each of these smaller groups and will result in a more individualized and thus effective campaign. In the case of Nantucket, we may find that tourists know little about ticks and so we must inform them of everything, while residents already know much about ticks so we can focus on reinforcing safe behavior. Thus, combined with the

example above, it would make sense to put information packets on the ferries and putting reminders about protective behavior on the local news.

When choosing a channel for a communication campaign, one also has to be careful to consider how that channel will affect the message. The media, for example, has been known to overhype certain fears and concerns and the validity of its claims may be doubted by some. There is also sometimes doubt in towns about the interests of national sources of information. In such cases disseminating information through respected, credible sources such as local officials, doctors, or newspapers may be the best approach. In general, sources like doctors and local officials already regarded in the local community will be more likely to be believed, but larger media channels will be seen by more people. The internet brings this trend even further. Items on the internet can be seen by most anyone, but there is no guarantee that anything posted is valid. Ultimately, there is always a tradeoff in choosing your channel of distribution between the size of the audience reached and the perceived credibility of the information.

By using channels of communication that target individuals, like TV and fliers, a campaign can be seen as a one-on-one communication between two parties. Such a view is the center point for the Communication Process Approach. According to the Communication Process Approach, risk communication can be seen as a normal conversation in which a communicator sends a message via these channels to a receiver (Lundgren & McMakin, 2004, p. 14). This method assumes that an attempt at risk communication will succeed so long as each part of the communication is appropriate. Thus the source must be credible, the message must be understandable, and the channels must reach the intended party, the audience.

Other channels, however, can focus on a network of people rather than the individuals. The recent rise in constant communication through texting, Twitter, and Facebook has made such attempts easier and more frequent. The Social Network Contagion Approach takes notice of this fact that people often form up into groups sharing certain beliefs and ideas (Scherer & Cho, 2003, pp. 261-262). The idea is to focus on communicating specifically to these groups and allowing for them to spread the communication amongst themselves. The theory is that a person's ideas are most directly influenced by those around him and so by communicating to a few, we can reach many (Lundgren & McMakin, 2004, p. 23).

Earning and Maintaining Trust

Achieving and maintaining the trust of the intended audience is essential in a risk communication effort. Communication is built on a foundation of trust between the two parties. If the trust between them is broken, effective communication becomes extremely difficult. You cannot hope to appropriately sway the behaviors of an audience if they do not trust you. According to the New Jersey Department of Environmental Protection, “risk information that comes from trustworthy sources is more readily believed than information from untrustworthy sources” (Hance, Chess, & Sandman, 1988). Failing to maintain the trust of your audience will likely derail any communication effort and severely limit the effectiveness.

Audiences are inherently fickle. Maintaining trust with an audience is a difficult task that requires constant attention. “[Trust] is typically created rather slowly, but it can be destroyed in an instant—by a single mishap or mistake” (Slovic, 1999). There are many things, many of which can be surprising, which can cost you the trust of the audience. According to Paul Slovic, bad news and negative events garner more attention and are more likely to lead to mistrust than good news or actions do. This mistrust is further exasperated by the fact that an audience mistrustful of you is less likely to be open to actions meant to regain this trust (Slovic, 1999).

The easiest way to maintain trust is to ensure you never lose it. Ideally, every action taken should be reviewed beforehand to ensure it will not likely be misconstrued to damage your trust. It is important that such steps as carefully choosing channels of communication (as discussed in the previous section) and ensuring that your communications are always clear and open (as discussed in the next section) are followed through with consistency. Being clear and open in your communications, as well as ensuring understanding, keeps you from hiding facts and motives from the audience. An audience that understands everything from your process to your information and motives will be much more likely to maintain trust with you than those kept in the dark (Hance, Chess, & Sandman, 1988).

Using fear in particular can increase your risk of losing trust from your audience. Fear is considered a very strong motivator and is frequently used in health communication campaigns to discourage unhealthy behaviors and reinforce good ones. People, however, tend to become desensitized to constant onslaughts of fear. As noted above, the media has tended to over

sensationalize risks and dangers frequently, leading to a loss in credibility from the public. Thus, over use of fear in a campaign may immunize the audience to the threat. According to R.F. Soames Job, PHD, “such campaigns may produce the opposite of the desired effects, making the target audience more likely to continue with the unhealthy behavior” (Job, 1988).

Without trust there is little if any communication possible. In order to achieve any form of behavior modification or attitude change, you need strong support from the audience you are reaching out to. As said by the New Jersey Department of Environmental Protection, “if you fail to ‘be credible,’ you will virtually guarantee people’s opposition” (Hance, Chess, & Sandman, 1988). Trying to change the behaviors of those who are not in agreement with you would likely lead to resentment and stall any progress you would potentially make.

Being Clear and Open

Once you know what your audience needs to know, you need to figure out what you are going to say and how you will do it. The first issue many communicators face is overcoming a knowledge gap. Assuming the members of your audience are not experts in the field you are informing them about, you have to make them aware of the risk without confusing them. It may be tempting to simplify the information being presented to get the point across. This must be done with great care. Regina Lundgren believes that leaving the overly technical information out may lead to audiences not having the information they need to make the right decisions. “Simplify language and presentation, not content” (Lundgren & McMakin, 2004, p. 101).

One frequently used method of quickly and easily communicating more technical data and statistics is to use a visual medium such as a chart or a graph. Visual information can be taken in and interpreted by people much quicker and accurately than with purely verbal messages (Lundgren & McMakin, 2004, pp. 213-214). Like all aspects of risk and health communication, it is important to know what information your audience has beforehand when preparing graphs and charts. Misinterpreted or misunderstood information can be quite easily obtained from improperly designed visual aids.

One must be very careful when designing charts or graphs for the public. You must be certain that the necessary information is contained in the chart and that the information is not

likely to be misinterpreted. Not all people are good at interpreting statistical data. Many people, for instance, have had much trouble with the distinctions between absolute and relative risks and charts utilizing these statistics for risk communication in the past have been unsuccessful (Kurz-Milcke, Gigerenzer, & Martignon, 2008). Charts and graphs that do not immediately communicate the information you want to people without strong statistical ability should not be used in public communication campaigns. While such charts are suitable for people in the field of the subject, simpler ones are needed for the public.

When ensuring the clearness and simplicity of the message, you cannot forget to include clear and simple advice for action. The effectiveness of a risk communication campaign will be diminished if there is no clear recommended action that one can take to prevent the risk (Job, 1988). Making it clear what the appropriate next steps are helps ensure the audience will not become frustrated with not knowing what to do.

The National Institute of Health is particularly interested in making health communication clear and easily understandable. It believes that the health literacy, the ability of individuals to learn and understand information concerning health decisions, is too low for many Americans. It addresses the importance of being clear and understandable in all health communications in order to both make it easier for people to learn about health concerns and to raise the health literacy of the country. Some of its key recommendations for the use of plain, understandable language include “Organizing information so that the most important points come first, breaking complex information into understandable chunks, using simple language and defining technical terms, and using the active voice” (National Institutes of Health, 2010).

Identifying Benefits and Costs

One of the key goals of health communication, more so than in risk communication, is changing the behavior of the audience. Of an audience’s knowledge, attitudes, and behaviors, the behaviors of the audience are usually the hardest to change. While knowledge can mostly be gained instantly and easily and attitudes are changed subtly over time, effort must be made to change one’s behaviors. Doing so, thus, requires incentive. An audience is more likely to change what they are doing if it will improve their life in some way, than if it is only an inconvenience.

Not all benefits, however, are good enough. Some may perceive, for instance, that not having to deal with a pesky tick bite is not worth the effort of applying bug spray. The incentive of not getting an infectious disease, however, may very well be enough of a benefit to encourage action. The timeframe of such benefits is quite important as well. According to the National Cancer Institute in their book, *Making Health Communication Programs Work*, “Short-term, high probability personal benefits generally are more effective than long-term population benefits (e.g., ‘stop smoking to smell better and be more attractive’ rather than ‘stop smoking to reduce your risk of developing lung cancer’)” (National Cancer Institute, 2003, p. 55).

Changing one’s behavior, even for such strong benefits as reducing the likelihood of disease, does not come without a cost. Every change of behavior, for starters, requires effort and inconvenience to happen. In order to cause a behavior change, you have to convince the audience it is worth it. You have to show that the cost of changing is outweighed by the benefits. It is comparable to trying to sell the new behaviors to the audience.

One of the few health communication theories to really explore the cost of behavior change is the Health Marketing theory used by the Center for Disease Control. Under this theory, communication with hopes to change an audience’s behaviors can be directly equated to marketing a product. You must address the “four Ps”: Product, Price, Place, and Promotion. The product is the behavior change and its benefits, the price is the cost of such behavior change, the place is the channels of communication, and the promotion is the communication campaign itself (Center for Disease Control and Prevention, 2006).

Evaluate the Program

Even after taking every important step to develop a public communication campaign carefully, you still cannot know how it will work with the public. Communications can be confusing, misunderstood, and sometimes even angering. Evaluating the campaign allows you to see the results of the program and determine if it was effective and what resulted. It is a vital part of the development and deployment of every communication campaign to evaluate everything being done.

Evaluating a communication campaign must start in the development process. It is very helpful to evaluate the effectiveness of each part of the creation process. From surveys used to understand the audience to the final pieces of communication to be disseminated, any weak or ineffective part can derail the effectiveness of the entire project. Only so much of the effectiveness of these types of materials can be judged by those creating and critiquing them. In order to gain a much stronger insight, pilot testing is needed.

A pilot test will allow you to use the materials created (whether they are surveys or actual communications) and judge the reactions of real users. Hopefully, this will demonstrate unforeseen problems or shortfalls in wording, presentation, or the message as a whole. Ideally, a pilot test will include a sample large enough to cover an effective range of possible reactions, but not too large as to influence the rest of the population or make studying it overly difficult. Especially when dealing with surveys you do not want to influence the main sample of people by using too many for your pilot. Based on the results, changes can be made or pieces added or removed before putting the final product out. Pilot testing will not be able to identify all of the problems that may be present in a survey or communication, but it will hopefully identify the biggest ones.

It is also imperative to evaluate the outcomes of any communication projects. Whether it was a onetime campaign or part of an ongoing communication, it is important to know the effectiveness of the methods used. You need to ask such questions as “Did the desired outcomes take place? How much did knowledge, attitudes, and behavior change? Are changes in outcomes due to the ... program?” (John Hopkins Bloomberg, 2008) The answers to questions such as these are imperative to understanding what was done correctly and what needs to be different in any future communications. It also will indicate whether the current communications should continue. An effective communication campaign would likely need to continue on for many years if not indefinitely. A population is slow and reluctant to change. Seatbelt usage and anti-smoking campaigns have been in effect for decades and while they have both made marked improvements, neither effort is near completion and will need to continue for the foreseeable future. Any effective health communication campaign will have to be long term and intensive.

Table 4: A Comparison of the Ideas Present in Various Risk and Health Communication Theories

	Communication Process Approach	Mental Models	Social Network Contagion Approach	Making Health Communication Programs Work (NCI)	Social Marketing (CDC)	NIH
Know Your Audience	✓	✓	✓	✓	✓	✓
Choose Proper Channels	✓		✓	✓	✓	
Maintain Trust	✓		✓	✓		✓
Be Clear / Open	✓			✓		✓
Identify Benefits				✓	✓	
Identify Costs					✓	
Evaluate the Program		✓		✓	✓	✓

Case Study: West Nile Virus

A number of the above common aspects of risk and health communication can be seen in the case of the communication efforts relating to the West Nile virus. This disease became widespread in the United States in 1999 and is primarily spread by mosquitoes. This disease turned the mild nuisance of a mosquito into a credible threat. Massive amounts of media coverage were devoted to West Nile virus, but still many people do not bother to take precautions from the mosquito bites. Emily C. Zielinski-Gutierrez¹ and Mary H. Hayden studied the communication efforts of two counties in Colorado and found some complicating factors. What these researchers found was that there were a few primary issues that prevented the people of these counties from reacting as hoped.

One of these factors was certain groups' perceptions of the dangers of the disease. They found that certain groups had very different perceptions of the disease than others. Messages that the elderly were the most at risk, for example, made teens believe that they were not in particular danger from the disease. The people who were most perceptive to the idea of the risk were those who knew people who suffered from it. They often felt that the disease was worse than the mild nature described by health officials. In both cases the people being informed were not properly served by the messages (Zielinski-Gutierrez & Hayden, 2006, p. 31). These findings demonstrate how important it is to tailor messages to your audience. A one-size-fits-all campaign will not be able to properly communicate a message to everyone. The fact that elderly are at more risk to the virus is a fact to advertise to the elderly, not teens. They should have had a message tailored to show their own risk factors in the problem. It is also demonstrated that messages aimed at those unaware of the problem, can conflict with the beliefs of those well aware of it. It is important to know your audience and make sure as many people as possible receive information relevant to them.

Another factor identified in the study showed that the credibility of the sources (the channels) of the dispersed information is crucial in the health communication attempt. In the case of West Nile, the media covered the virus very frequently on new programs, in papers, and in many other forums. Eventually, the public became saturated with warnings of West Nile. This led to a belief that the media was overhyping the danger of the disease. People in the counties stopped believing the threat posed by West Nile was as bad as they were led to believe. Ultimately, the studies found that people were much more likely to believe information received from trusted sources and people from within the community (Zielinski-Gutierrez & Hayden, 2006, p. 32). As can be seen, the media can be used very effectively to disperse a message quickly over a wide population, but is often treated skeptically by the people and should not be used alone.

A last factor brought forth through the study shows that there is a fine line between assuaging the people's fears by showing government action and dissuading people from protecting themselves. A lower perception of threat means there is smaller benefit to changing behavior and thus people are less likely to act. In the case of the Colorado counties, they found that the common knowledge that the government was taking steps to reduce the mosquito threat

(mainly by spraying areas with insecticide) caused people to abandon personal protection measures (Zielinski-Gutierrez & Hayden, 2006, p. 33). This is a tricky aspect to apply for ticks in Nantucket. While Nantucket wants to ensure tourists that the island is doing all it can to curb the problem so as to not scare away visitors, it must avoid deemphasizing the risk to the point in which people stop acknowledging the benefits of taking precautions.

This case study of the West Nile virus health education campaign in Colorado is particularly applicable to the Nantucket Island tick problem. Like how West Nile turned the mild nuisance of mosquitoes into a noticeable threat, Lyme disease and other tick-borne diseases have done the same to ticks. This case demonstrates several factors found in the risk communication theory described above. Specifically, knowing your audience, using proper channels, keeping communication clear and open, and emphasizing the benefits of behavior change are all key aspects in properly communicating health and risk information to the public. Health education campaigns on the island must learn from cases such as these in order to create as effective a campaign as possible.

Methods

The goal of this project was to help the Nantucket Tick-borne Disease Committee strengthen the effectiveness of its public outreach to the visitors and residents of Nantucket. We accomplished this by providing the committee with suggestions on ways to improve tick awareness and education programs that target visitors and residents. We outlined and executed four core objectives which we used to achieve our goal. The project: (1) Evaluated the successful and unsuccessful aspects of health and risk communication efforts made throughout the nation that had commonalities with tick and tick-borne disease awareness efforts made on Nantucket; (2) Assessed previous and current efforts made to educate the public on Nantucket about ticks, tick-borne diseases, and disease prevention; (3) Gauged the level of existing knowledge and awareness of ticks and tick-borne diseases in target segments of the population on Nantucket; and (4) Developed a health risk communication strategy regarding tick education on Nantucket, which we recommended to the Nantucket Tick-borne Disease Committee.

Evaluate Health and Risk Communication Efforts Made Elsewhere

Through continued review of the research literature, we analyzed health and risk communication efforts conducted in areas around the nation and identified key traits that caused the outcomes of these efforts to be successful or unsuccessful. We investigated efforts made to raise awareness of West-Nile Virus and seat belt safety along with others. We applied our knowledge of the Nantucket situation to determine the appropriateness of employing similar tactics to those employed in these efforts on the island to help improve health communication concerning the tick dilemma. These efforts are summarized in the literature review above.

Assess Previous TBD Education and Awareness Efforts on Nantucket

Building on the Literature Review on past education and awareness efforts on Nantucket, we decided to conduct in-depth interviews with key members of the Nantucket community who represent all different types of opinions. Some of these interviews were with town selectmen, Board of Health officials, scientists, doctors, hunters, anti-hunting groups, real estate agents, and local inn-keepers (See Appendix A for a list of interview subjects). These interviews were

designed to gather expert knowledge on certain aspects of ticks and tick-borne diseases as well as gathering attitudes and behaviors towards a number of topics ranging from risk communication to the controversy surrounding deer reduction. Additional topics that were also discussed included the factors of time, cost, 4-Poster systems, pesticide use, and public education campaigns.

Many interview subjects were chosen based on research from our literature review that identified the subjects or the groups they represent as key players in the tick and TBD topic on the island. We made sure to choose interview subjects that would represent different key opinions, from both sides of the topic that could help us further articulate and produce the final set of recommendations. Our interviews were designed to capture the full range of opinions present on the island. From each interview we aimed to obtain information about past, current, and possible future efforts on the island to curb the incidence of tick-borne diseases, specifically information about health communication. Our interviews were also meant to collect a wide variety of ideas and opinions concerning future education campaigns, which we made an effort to incorporate into our communication strategy. We created the questions for the interviews based on the interviewees respective backgrounds (e.g., we talked to tick experts about ticks and TBDs, real estate agents about communication and tourist relations, and hunting / anti-hunting groups about deer reduction as a means of tick control). All of our interviews were conducted in person with the exception of our interview with Sam Telford, which was conducted over the phone while the group members took notes on paper. Each interviewee was informed that they had the right to dismiss any question or stop the interview at any time. We always obtained approval to interview and quote interviewees prior to meeting with them. We informed them that we would allow them to review any of their quotations prior to publication. If they preferred, we agreed either not to quote them or to use an appropriate pseudonym. (See Appendix B for full preamble and a selection of common interview questions). Notes which we took during interviews were reviewed extensively toward the end of our project and we highlighted particularly relevant quotations and opinions which we felt could complement our final report. We received final approval for the incorporation of these materials directly from the interviewees.

Gauge Existing Knowledge and Awareness of Ticks and Tick-borne Diseases in Target Segments of the Nantucket Population

In order to assess the extent of knowledge of ticks and tick-borne diseases as well as tick awareness in the Nantucket community, we conducted a survey which we administered to the students of Nantucket High School. The survey was created to illuminate the strengths and weaknesses in specific areas of tick-related knowledge, attitudes, and self-protection behaviors. The survey was also meant to provide us with valuable statistical information which we were able to use in the quantification of certain aspects of the broader tick-borne disease issue.

Developing the Survey Instruments

We drafted our survey instruments over a period of three weeks. After several revisions of our survey instruments, we pilot tested the survey to help us detect any problems with the clarity and comprehensibility of the instructions, questions and response categories. The pilot test was conducted at Barnstable High School in Hyannis, Massachusetts, which we chose because the students at BHS are of a similar target audience to our student audience on Nantucket and would therefore allow us to see how well our survey instruments work. The pilot tests allowed us to learn what areas of our survey instrument needed to be changed before administering the actual survey instrument to Nantucket High School. These BHS pilot surveys were administered by us and were self-completed by the students. We distributed the pilot surveys to fifty-nine students in three separate Coastal Studies classes involving students of different ages, sex, ethnicities, and grade-levels. We received fifty-eight usable surveys back from which were able to perform some rudimentary analysis to determine questions and response categories that needed modification. We found that many students were reluctant to answer open ended questions and that several students failed to complete the questions on the reverse side of the survey instrument. Consequently, we modified the open-response questions to provide closed response categories and we added instructions at the bottom of the first page to encourage respondents to answer the questions on the reverse side. We also identified several small issues involving grammar and formatting which we corrected along with further advice from the Tick-borne Disease Committee. Our analysis of the data retrieved from our pilot survey allowed us to

get a glimpse of the types of responses that our Nantucket High School student surveys would retrieve.

The final student survey was meant to take approximately 5-10 minutes to complete. The survey targeted the students as residents of Nantucket and as such assumed that the students would have some basic familiarity with ticks and Lyme disease. The survey was primarily focused on determining the attitudes of students towards ticks and tick control methods as well as determining current behaviors of the students in personal tick prevention methods (see Appendix C for the final survey instruments used).

The Nantucket High School student survey helped us to gauge the levels of knowledge and awareness of ticks and TBDs on the island as well as the common behaviors of students concerning the ways in which they protect (or fail to protect) themselves from the risks of TBDs. Questions were almost exclusively structured (check-boxes or Likert scales), with one open-ended exception. No personal identifying information was collected from respondents or recorded by us. The survey results were entirely anonymous. Each survey had a preamble written on top informing participants that the survey was anonymous and that they had the right to stop at any time or refuse to answer any question. In developing our survey, we worked closely with members of the Tick-borne Disease Committee in the conceptualization, implementation (including the piloting of), and analysis of the survey.

Administering the Surveys

Upon completion of the survey development, the principal of Nantucket High School reviewed and approved the final survey instrument and arranged for the survey to be administered in the school during one of the weekly student advisory periods. The survey administration process took place over a period of two days during the course of which the project team had no direct interaction with the students. We delivered 399 surveys to the office of Nantucket High School on Monday, November 15, 2010, which in turn, distributed them to

teachers of the advisory period². Surveys were administered in every class/grade within the school (grades 9-12). The teachers then administered the surveys to students during the fifteen minute advisory period the following day and then collected and returned the surveys to the office. We retrieved the completed surveys from the office at the end of that second day. On the day of the survey, 377 students were present and we received 291 responses meaning that we achieved a 77.19% return rate.

Analysis of the Surveys

With the surveys completed, we conducted thorough quantitative and qualitative analysis of the data. Questions using a selection of pre-determined answers were entered into Microsoft Excel and tabulated for analysis through the development of digital charts and tables. Answers to open-ended questions were put into predefined categories so that we could analyze the survey results much more efficiently. Much of the analysis was dedicated to the identification of common areas of knowledge as well as common tick protection behaviors and prevention trends amongst the survey participants. We looked at knowledge, attitude, and behavior identifier questions and compared the responses from different subgroups of students to find different trends in knowledge, attitudes, and behaviors. The primary subgroups we used included those who have had Lyme disease in their family, those who hunt in their family, where on the island students live, and pet owners amongst others. The subgroups were determined by the responses to certain questions from the survey (see Appendix C for the final survey instrument).

Develop a Health Communication Strategy

Using the information we received during our numerous interviews as well as the results of the survey and of our knowledge of health and risk communication and current and past communication efforts instituted on the island, we formed a number of recommendations for various possible health communication strategies on Nantucket concerning ticks and tick-borne

² The Nantucket High School Advisory Period is the equivalent of a bi-weekly scheduled homeroom.

diseases. The recommendations utilized teachings from our research on health communication theory and past health communication campaigns. Health communication theory suggests that a key aspect of health communication is to tailor any campaign to the audience. Thus we used the results of the surveys to focus what it was that should be communicated and to whom; aspects which incorporated into our recommendations. In other words, knowledge gaps and false information evident on surveys illuminated areas in which improvement was needed, and was therefore an area which was incorporated into our health communication recommendations.

After we formed our list of recommendations, we presented our findings to the Tick-borne Disease Committee. We presented our statistical data, connotative and denotative analyses, key findings, and the recommendations that we developed for the committee and the Nantucket Board of Health. We then discussed the ways in which we believe our methods could be improved with the hope that it could be useful for the Nantucket Tick-borne Disease Committee in relevant future tasks. All work was completed in the time frame from October 23, 2010 to December 17, 2010.

Findings

In order to devise a strategy to improve communication with the public about ticks and tick-borne diseases we first had to understand the residential community's levels of knowledge, behaviors, and attitudes about the tick issue. The Nantucket Tick-borne Disease Committee and the Nantucket Board of Health need public communication campaigns both to encourage self-protective behavior amongst residents and visitors to reduce the occurrence of tick bites and the incidence of tick-borne diseases and to help the public understand the various tick prevention and reduction measures that will be considered and possibly implemented by the town. Creating an effective campaign requires a delicate balance between the knowledge, attitudes, behaviors, opinions, and interests of the residents, business owners, and government offices. In order to understand these various aspects, we surveyed high school students to gauge the public and conducted a series of interviews with various town officials, local business owners, leading tick experts, and community opinion leaders. From these efforts we have made a series of findings that we believe can be utilized to help craft an effective public communication campaign.

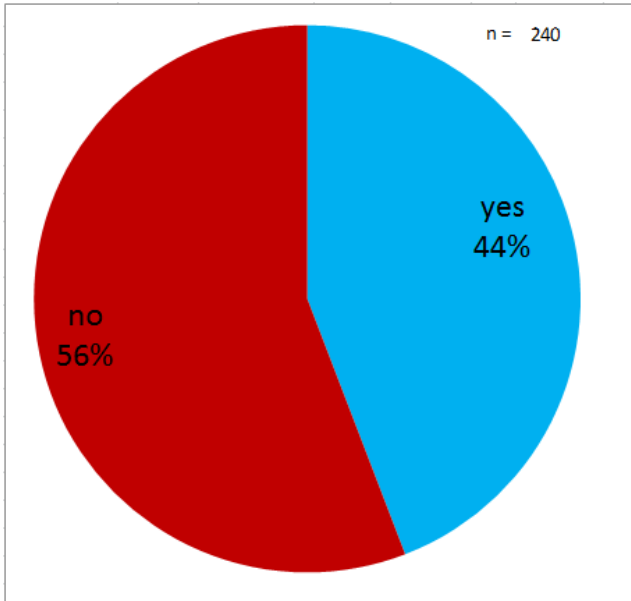
Public Knowledge, Attitudes, and Behaviors

As we found in our research of risk and health communication, the best way to develop an effective public education campaign is to begin with a thorough understanding of the knowledge, attitudes, and behaviors of your target audience (Morgan, Fischhoff, Bostrom, & Atman, 2001). We sought to accomplish this with our survey of Nantucket High School. Of the 377 students surveyed, we received 291 usable responses indicating a 77.19% response rate. The survey has an inherent bias in that it only canvases high school students and vicariously families with high school students. We believe, however, that these data give us a good picture of the current awareness, attitudes, and behaviors among a key segment of the population.

A startling initial finding from the survey is the extent to which the problem of Lyme disease has affected the community. Of the students who responded conclusively, 44% reported having or someone in their household having Lyme disease within the past three years.



Figure 6: Percent of Households with Reported Cases of Lyme Disease



Further, we see this number increase significantly in households with pets, which constitutes 75% of the families of the surveyed students. Conversely, there is a dramatic decrease in the number of households with reported Lyme disease of the students who did not own pets.

Figure 7: Percent of Pet Owning Households with Reported Lyme Disease

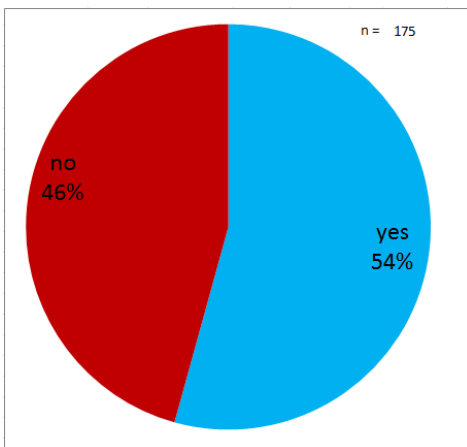
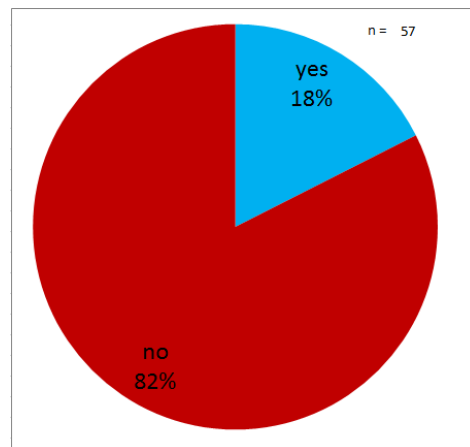
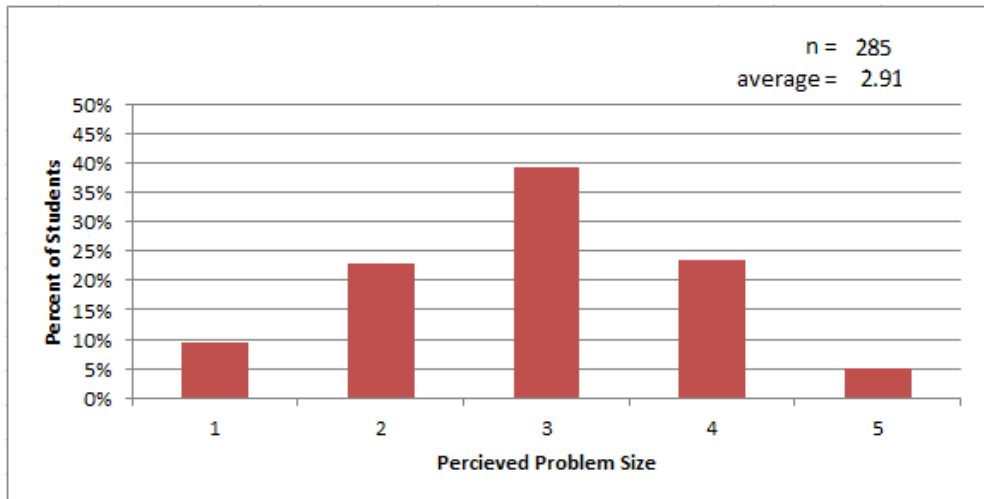


Figure 8: Percent of Non-Pet-Owning Households with Reported Lyme Disease



Oddly, despite the extent of this problem as shown above, students do not consider Lyme disease a significant problem on Nantucket. Having asked students to rate the problem of Lyme disease on Nantucket on a scale from 1 to 5 with 1 being ‘no problem’ and 5 being ‘a severe problem’, the average ranking returned was 2.92 based on 285 returned ratings. In fact, nearly 40% of students rated Lyme disease a ‘moderate problem’ as indicated in figure 9.

Figure 9: Perceived Problem Size



Upon additional analysis, we found that students’ perceptions of the size of the Lyme disease problem have a correlation to certain factors in their lives. Most noticeably amongst the results are the correlations with pet ownership and family history of Lyme disease. Looking only at students who do not have a pet, we see a skewing of the problem size ratings downward with an average of 2.7 (see Figure 10). Amongst students with a history of recent Lyme disease in their families we see an upwards skewing of problem size ratings. These students responded with an average rating of 3.24 (see Figure 11).

Figure 10: Perceived Problem Size of Those without Pets

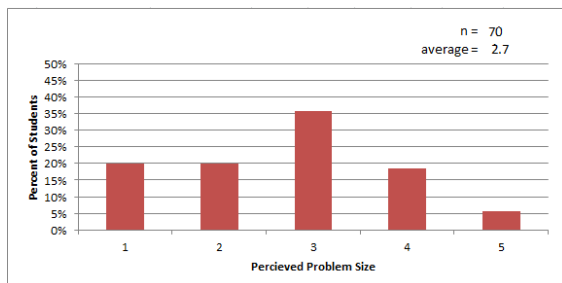
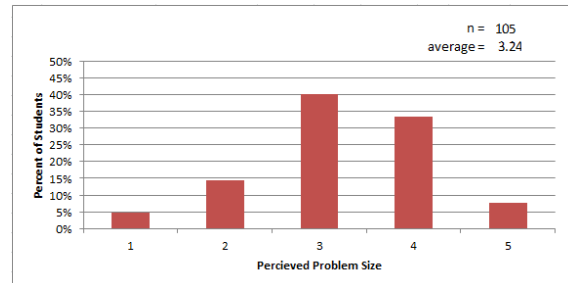
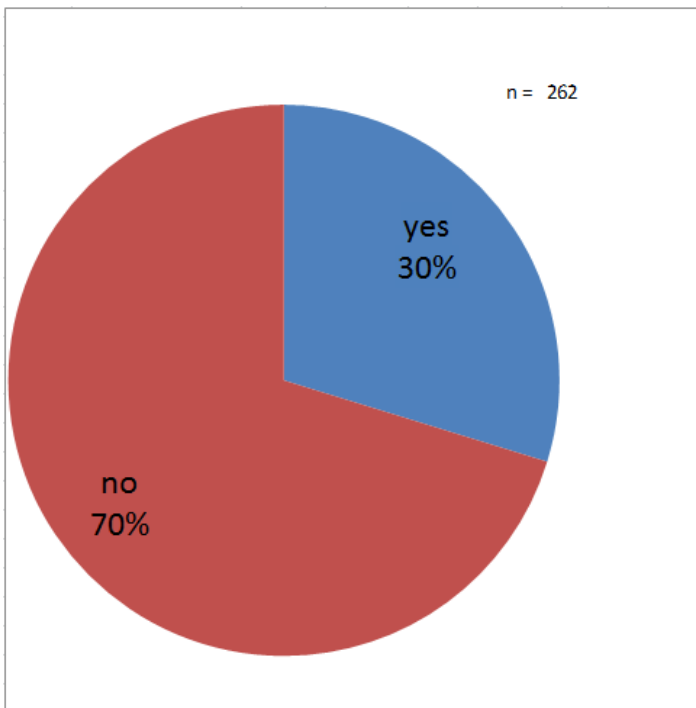


Figure 11: Perceived Problem Size of Those with Family Lyme Disease History



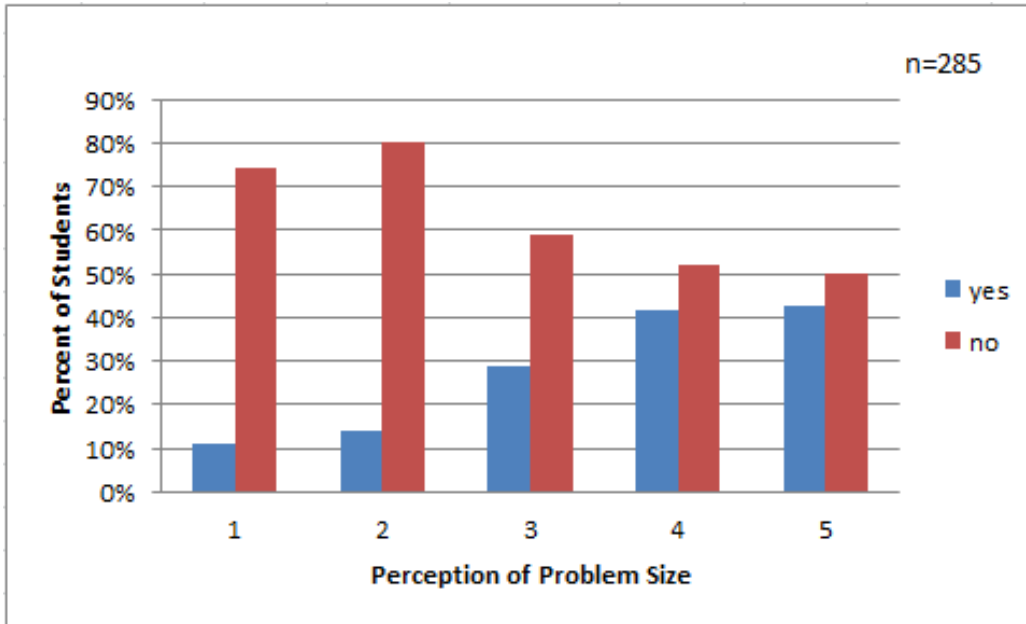
Consistent with this low level of public concern for Lyme disease, from our findings we see a relatively low percentage of the students surveyed reporting taking preventative measure to prevent tick bites. Of the 262 students who responded conclusively, 70% reported not taking measures to prevent tick bites (see Figure 12).

Figure 12: Percent of Students That Take Measures against Tick Bites



Analyzing the students who stake preventative measures to the students who rate Lyme disease as a greater problem, we see a strong correlation. We found that a higher percentage of students who rate the Lyme disease problem higher tend to take preventative measures against tick bites (see Figure 13). Conversely, the percentage of students who take measures to prevent tick bites amongst the students who score the Lyme disease problem lower is smaller.

Figure 13: Students Taking Preventative Measures by Perceived Problem Size



Logically, we also see that a family history of Lyme disease and household pet ownership have similar correlations to the percentage of students who take measures to prevent tick bites as they do to perceived problem sizes. Figures 14 and 15 demonstrate that students who have had Lyme disease within their household are more likely to take preventative measures against tick bites while Figures 16 and 17 demonstrate that students with pets in their household are more likely to take preventative measures against tick bites.

Figure 14: Percent of Students who Take Measures to Prevent Tick Bites with Recent History of Household Lyme Disease

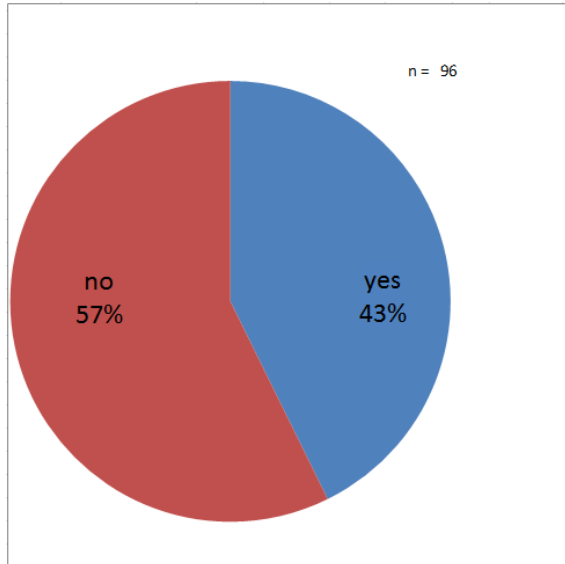


Figure 15: Percent of Students who Take Measures to Prevent Tick Bites without Recent History of Household Lyme Disease

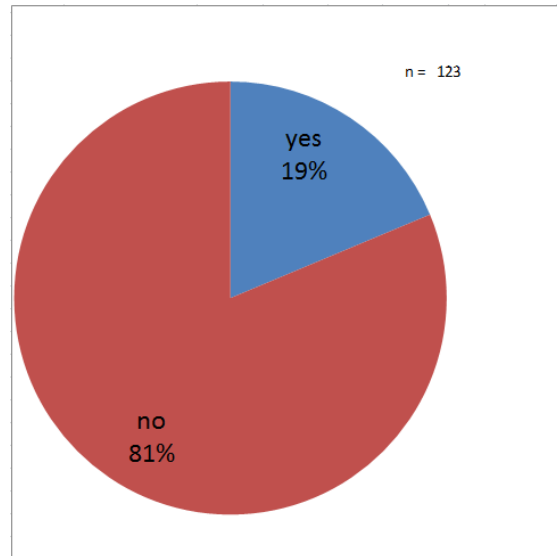


Figure 16: Percent of Students who Take Measures to Prevent Tick Bites with Household Pets

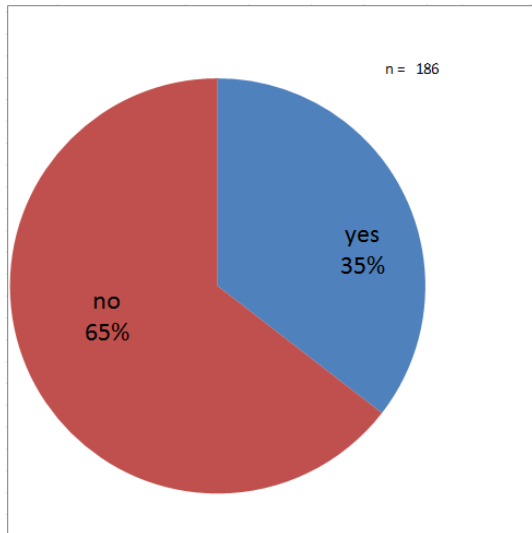
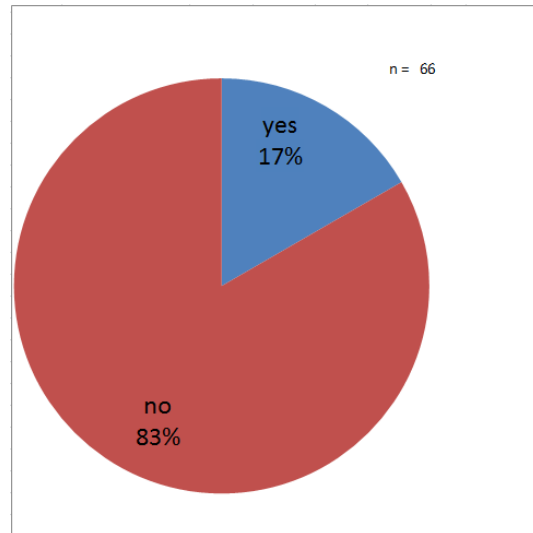
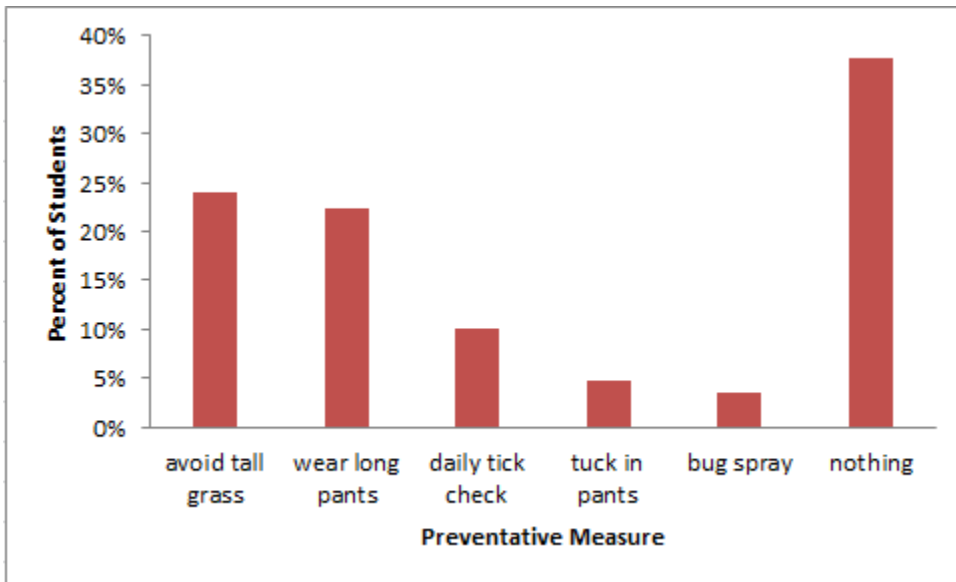


Figure 17: Percent of Students who Take Measures to Prevent Tick Bites without Household Pets



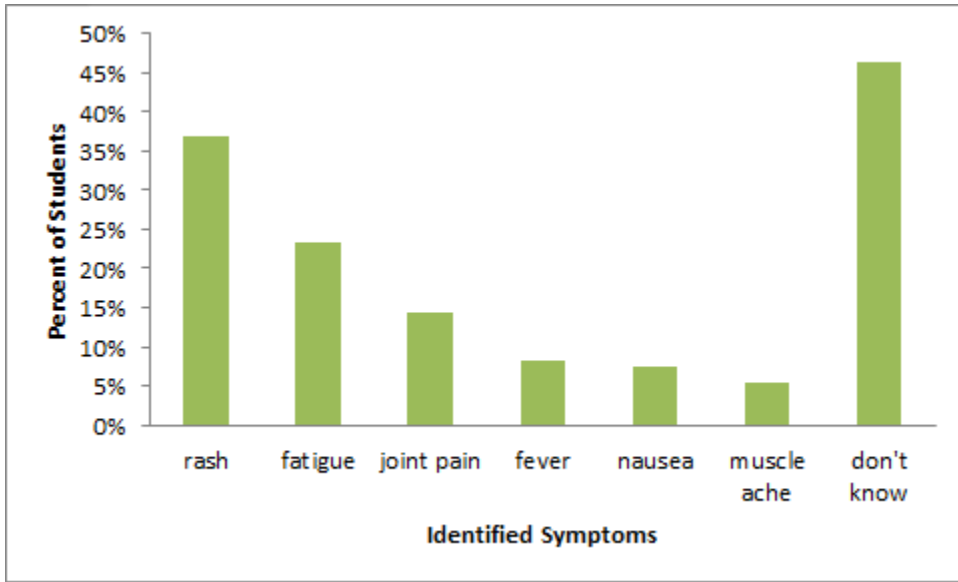
While we have seen that a low percentage of students actively take measures to prevent tick bites, we looked at the measures taken by those who do take measures. The following chart (Figure 18) shows the percentage of students who reported taking several actions regularly in order to prevent tick bites.

Figure 18: Percentage of Students That Take Measures



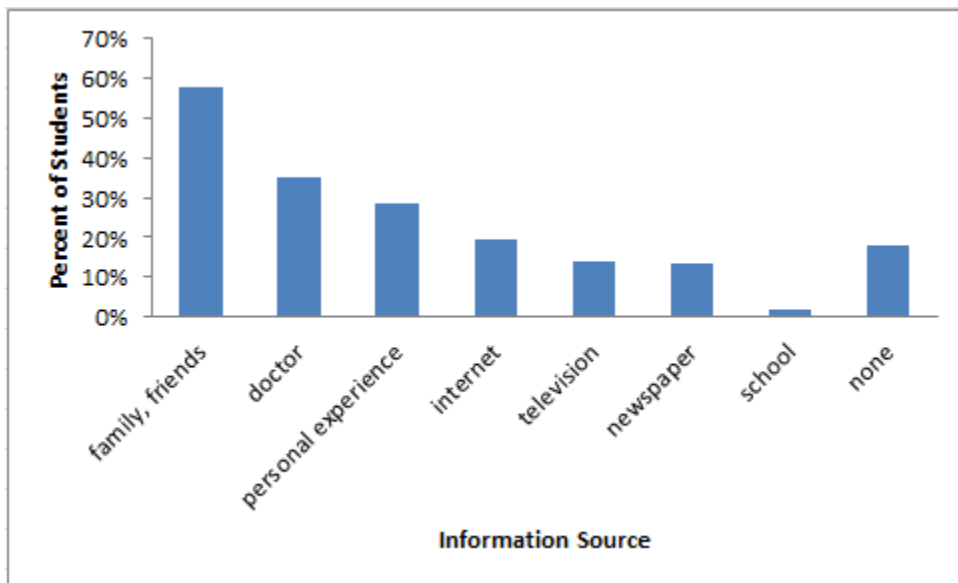
The top reported responses ‘avoid tall grass’, ‘wear long pants’, ‘daily tick check’, ‘tuck in pants’, and ‘bug spray’ are all effective tick bite prevention tactics. While not many students reported taking these measures, it is evident that those that do take effective ones. A possible inaccuracy in the findings, however, is that while ‘wear long pants’ and ‘tuck in pants’ were amongst the top responses, it is unclear if this is a year-round tactic including during the hot summer months or if they are exclusive to later seasons (during the timeframe in which the survey was administered).

Figure 19: Identified Symptoms



In analyzing the knowledge base of the students, we asked them to identify symptoms of Lyme disease. As seen in Figure 19, 46% of students were unable to identify a symptom of the disease. However, similar to the reported preventative measures, the top reported Lyme disease symptoms were valid. While 36.77% of students identifying ‘rash’ which isn’t always present in Lyme disease cases, fewer than 25% of students identified any other symptom.

Figure 20: Information Sources



As it is important to identify the best channels by which to reach your target audience, the preceding chart shows the most identified sources students reported receiving their knowledge about ticks and tick-borne diseases from. A relatively low percentage of students reported having no source of tick information with 17.87%. Conversely, family and friends was reported as a source by almost 58% of students. It should be noted that ‘school’ was the top reported write-in response with 1.72% of students reporting it.

Community Opinions about Tick Prevention Methods

Nantucket, though it is a small community, has a multitude of ideas, beliefs, and opinions that are undeniably present in the small town’s decision making process. This wide range of views is an important aspect that needs consideration in the crafting of any policy on the island. We conducted a series of interviews with town officials, tick and wildlife experts, local business owners, and community opinion leaders in order to expand on our survey findings with an understanding of the wide ranging and occasionally conflicting views present on the island. We found that the tick issue, in particular, has garnered significant passion amongst residents leading to island-wide debate over conflicting views on various tick and tick-borne disease prevention methods being considered and implemented. While certain methods have even become controversial in the community, there is a general consensus that improved public communication and outreach must be achieved. Specifically, this public outreach must be multi-pronged in its approach and address information about ticks, tick-borne diseases, and protective behavior; public and private pesticide use; and possible deer and tick control methods. In addition to our findings from the survey, our interviews presented us with findings relevant to the formation of public communication for each of these areas.

Ticks, Tick-borne Disease, and Protective Behavior

Public health education about ticks, tick-borne diseases and protective behaviors is perhaps the most important piece of the tick disease prevention effort and is generally uncontested by the community as a whole. Current efforts on the island include advertisements

such as tick awareness posters, publicized fliers, and wallet-sized tick identification and information cards. While these items are well-regarded by most people we talked to, the low level of perceived problem size and knowledge present in the survey results makes us believe more is needed. We spoke with many people interested or involved in possible public outreach programs, from whom we learned various intricacies involved in the process.

A commonly cited potential channel for communication that has yet to be fully utilized is the public school system. Ideally, such a campaign would raise awareness of the problem in the students and teach them protective behaviors they could share with their households and use through adulthood. While only 13.8% of students are school-age (U.S. Census Bureau, 2010), a number of our interview subjects expressed the point that these children would bring tick awareness to their households and would themselves constitute the future population of Nantucket. We spoke with John Buckey, the Principal of Nantucket High School, who expressed interest in the development of a tick education program which could be incorporated into the biology and/or personal health curriculum at the high school. He believed that lessons of the tick life cycle for example, could nicely complement the existing curriculum. Principal Buckey further explained that a curriculum based tick education program would be especially effective in presenting the information to students over a period in a setting that encourages actual learning of the subject (students would be graded on the material). He believes that such a program would be more useful than other short form programs such as an annual seminar on the subject, which would more likely serve more as an interruption and would be less likely to encourage learning and uptake of protective behaviors.

In addition to the residents of Nantucket, concern was raised over the seasonal visitors to Nantucket. According to Richard Ray, Director of the Nantucket Health Department, “One of the big problems we have here on Nantucket is the people who come visit here who don’t know everything about ticks or the island”. These people would likely be less informed about ticks and tick-borne disease before coming to the island and would likely be unaware of the risk. We discussed with our interviewees the best channels to exploit to reach tourists on their way to and on the island. The most common responses included targeting travel terminals such as the ferries and the airport, so as to get the attention of travelers before they become distracted on the island.

We also have received feedback saying that radio ads and educational programs on television have been effective in the past and would complement a campaign such as this nicely.

Town officials have also expressed desire to see tick information provided and distributed by inns and rental properties. Previous attempts to distribute information through these channels have proven difficult. Upon further interviews with several local innkeepers and real estate agents we found that educating their clients was not considered a priority. Dissemination of warnings about ticks to all clients would be detrimental to business in most cases. According to one real estate agent, “It doesn’t benefit us to place ticks as one of the main attributes of buying property”. Ticks are not a key aspect of Nantucket that innkeepers and renters want to try to promote to visitors as they are trying to enjoy their vacation. Inns may not, however, represent the target demographic for tick awareness campaigns. According to some innkeepers, “people who stay at these inns are not the type of people who will be venturing off into the woods; they will most likely be staying for only a couple of days and will spend the majority of their time around the Main Street and downtown area”. On the other hand, a renter we talked to who deals with long-term rental properties said that she does supply tick information to renters planning off-road excursions and always to guests travelling with pets.

One concern that has arisen on the island regarding the dissemination of tick education materials is the difficulty in communicating these materials to non-English-speaking members of the community. This is a problem because they cannot understand the information that is being relayed to the public. Concerns were voiced by town selectmen Whitey Willauer who said that it is an issue that needs to be addressed and dealt with. We found The Cape Cod Cooperative Extension offers free materials in Spanish and Portuguese about how to prevent tick bites.

One thing we learned about is the high percentage of misdiagnosed or late-diagnosed TBD cases in hospitals around the nation. This difficulty associated with TBD identification is often due to varying symptoms between individuals and the infrequency of TBD contractions in certain parts of the country. Fortunately, the expert physicians at Nantucket Cottage Hospital are highly experienced in dealing with TBDs, and most reported cases are discovered early on after individuals have been bitten. It is not known how many visitors are bitten by ticks and unknowingly contract a tick-borne disease before leaving the island. Ideally, a person bitten by a



tick would have it removed and talk to a professional about the possibility of Lyme disease. Unfortunately, several people we talked to reported that visitors in particular are likely to ignore the tick bite after removing the tick and end up at risk for contacting a TBD. Educating this audience or encouraging them to get medical treatment is a concern for the town. We gathered from some interviews an idea for a free tick clinic, which we believe could be operated similarly to the free AIDS clinic held in Provincetown, Massachusetts.

We therefore called the AIDS Support Clinic in Provincetown, Massachusetts which is involved with an organization called Health Innovations which runs free and anonymous AIDS screening programs several times per year on a green in Provincetown's high-traffic downtown area. This clinic is run by a nurse practitioner and professor from Northeastern University who recruits a group of around thirty people including nurse practitioners, registered nurses, nursing students and graduate students whom she brings to Provincetown. In the summer of 2010 on the 4th of July weekend, the clinic had 111 people attend for testing and the year before, they had 157; both times in a two-day period. The program runs on a grant from the Massachusetts State Department of Public Health and targets a high-risk population with which students can gain experience conducting blood work as well as experience in health communication by working with the public. The program is mainly concerned with looking at numbers and results and gathering data, but it also works to raise awareness about sexually transmitted diseases in Provincetown. The program also distributes materials to people on the street to help increase awareness of AIDS and other STDs, which is a part of the communication aspect of the clinic. We explained the details of our project briefly to the AIDS Support Clinic and it was agreed that establishing a similar program on Nantucket would be a great way to reach out to a population that might not know if they have Lyme disease and might not want to wait in a formal hospital setting to find out. We learned that Provincetown's Health Innovations mobile clinic is so successful because it is easy, quick and discreet and people take advantage of the clinic's complementary services, which might otherwise be expensive. We believe that it is likely that there are other groups similar to Health Innovations that are actively seeking communities in which they can find patients to conduct complementary blood-study and lab-work research. This recommendation could prove to be very helpful considering that from our findings it proved to be a large concern. The potential to run a free clinic for TBDs on Nantucket is strong and we

firmly believe that it would greatly improve communication, awareness and behavior toward ticks and tick-borne diseases.

Public and Private Pesticide Use

Pesticides, and in particular the 4-Poster Deer Treatment Bait Stations, can be an effective piece of an overall tick reduction campaign. The 4-poster device uses corn to attract deer and uses Permethrin-laced rollers to apply the pesticide to the deer as they reach their heads through to eat the corn. 4-Poster Stations have been installed in several locations around the island, notably on the Linda Loring Nature Preserve, where the units are currently part of an extensive two-year evaluation study. 4-posters require lots of maintenance applying the Permethrin and adding the corn, and cleaning the channel of build ups of corn. The yearly cost of corn and maintenance leads to nearly prohibitive costs for implementing the devices on a wide scale. Additionally, not just anyone can apply the pesticide; you need a licensed pesticide applicator to apply the Permethrin to the device. Even on a small scale, however we have seen that 4-posters can make an impact. In addition to the main use of the device, we found that their distinct shape and interesting purpose makes passerby hikers and townspeople curious about unconventional tick prevention efforts. Such curiosity often leads the public to become more interested or invested in the issue.

Another possible problem raised with 4-Posters and other pesticide-related materials is the potential for environmental pollution. Sarah Oktay pointed out that the groundwater on Nantucket ranges in depth from eighteen inches to six feet below the surface, generally separated from the air by only natural groundcover and sandy soil. Sarah explained that Hummock Pond has contaminant levels traceable to chemicals found in hand sanitizer while Sesachacha Pond has is being infiltrated with chemicals believing to be the resultant of lawn fertilizer products. Well-water can also become an issue for similar reasons. These examples of potential hazards are demonstrative of the island's fragile eco-system and some risks that may come along with increased pesticide usage. It should be noted however, that this is probably more of an issue with spraying than with 4-Posters, which use Permethrin in moderation above ground-level, as opposed to spraying or sprinkling chemicals directly onto an area. Concerns were also raised



about the coating of deer with Permethrin and possible contamination of the meat. As was pointed out several times, however, studies done on Shelter Island showed that so long as some sanitary measures were taken to prevent the Permethrin from the skin being mixed with the meat in the process of skinning, the meat will remain uncontaminated.

Although time, effort, cost and licensing are all obstacles associated with 4-Posters, there are ways to work around them with community support. Should the Linda Lorrington 4-Poster program yield positive results and media publicity, the units may raise in popularity on the island. From our interview findings the 4-Poster stations are generally well-received by the community although their high cost of operation makes the devices seem like a burden to some who would rather see finances allocated toward other prevention methods such as media advertisements. Their high costs are one of the primary reasons why they are not more widespread on the island; the expense necessary to implement 4-poster devices at the scale necessary to independently reduce the problem is prohibitive.

Through our interview process, we found that there may be some initial interest in private use of the 4-poster devices, which are currently unavailable to the public. Two homeowners in Tom Nevers explained that if they were allowed they would be interested in having their own 4-Poster station on their property which they would privately maintain, though it would still be necessary for a licensed pesticide operator to maintain the Permethrin. Private use of 4-poster devices would benefit both the homeowners who operate and maintain the devices, but the island as a whole as well. Such efforts would increase island-wide use of the devices while keeping town costs low.

Damminix Tubes were another popular option for tick prevention on personal property. These tubes, which apply Permethrin to mice, are considered cheap enough for property owners to purchase and use. Some interview subjects we spoke to reported being quite happy with the Damminix Tubes they had purchased and used and also reported an increase in discussion of the issue with neighbors after the purchase, leading neighbors to purchase the tubes as well. This type of grassroots promotion is seen as well in the Damminix Tubes Facebook page including 65 fans participating in active discussion of the tubes at the time of this report.

Deer and Tick Control Methods

According to Sam Telford III, a professor of Infectious Disease in the Department of Biomedical Sciences at Tufts University and leading tick expert, pesticides and 4-poster devices can be considered a short-term solution to tick control as they reduce ticks, but only while in constant use. Long term solutions, on the other hand, once completed would provide reductions in tick-borne disease occurrence even after the actions have been stopped. Such an effort would be to focus on the main carrier of the parasite, deer. Through interviews with experts such as Sam Telford, Tim Lepore, and Sara Oktay we found that deer are absolutely essential in the life cycle of deer-ticks. Though adult ticks have been known to feed on some other large mammals, deer are the main host for deer ticks and it is on these animals that ticks reproduce. While small mammals such as rats and birds are fed on in the tick's larval stage and serve as the source of Lyme disease, the levels of these animals do not influence the amounts of ticks. It is by this logic that the idea of deer reduction as a method of tick control is founded on.

The most controversial topic that arose during our interviews, the concept of reducing Nantucket's white-tailed deer population in attempt to reduce the tick population was an equally sensitive topic among experts and townspeople alike. Deer reduction was a popular point of conversation with our interviewees who were collectively bipartisan in the debate; though there were very few people that were neutral on the topic. Opinions on the topic were diverse and ranged from moderate to radical in supporters on both sides of the issue. A large number of the interviewees, including townspeople, were well-versed when speaking about the topic, which many had taken the initiative to research extensively. Almost everyone with whom we spoke agreed that deer play some sort of a role in the reproduction and life cycle of deer-ticks, but disagreement arose about how big a role the deer actually play. Some of the people interviewed said that there were other animals such as rabbits, dogs, and cats that also play a very large role in the deer-ticks if not larger, though this was debated by others. It became evident from our interviews that deer reduction is an extremely political topic. Proponents of extreme reduction or complete eradication of the animals mostly argue that drastic methods have worked elsewhere, of which there is some publicized documentation in support of their opinion. Those contesting deer reduction generally argue that the tick infiltration on the island is much too complex to be solved

with the tactic, explaining that deer are only a small portion in the grander scope of the issue—an argument for which there is also supporting evidence.

Aside from a handful of people who have taken extreme positions on the issue, most of the people that we interviewed were comfortable with the concept of hunting on Nantucket. Most people understand that hunting on the island has been an established practice for many years and for some, is a part of the island culture. There are a large number of people, some of whom we interviewed, that rely on local venison as a mainstay in their annual diet, which is something to be taken into consideration for people on both sides of the issue. Although drastically different from eradication or severe deer reduction, Nantucket's annual hunting season is an important specimen to examine in the culling of deer on the island. The amount of deer that hunters are allowed to take on Nantucket is theoretically limitless, but the fact that the herd is large and healthy year after year may be an indicator of no natural predators and good nutrition.

We found much of the opposition to deer reduction on the island stemmed from opposition to an extended hunting season as had been tried in 2005. In 2005, in order to increase the amount of deer taken, Nantucket extended the hunting season on the island an extra week into February. The event, being the only deer season open that week in the country, attracted over hunters from across the nation. This large influx of hunters in conjunction with bad weather that closed off the main hunting area on the island called the moors, leading the hunters to traverse through off limit back yards. According to Dr. Tim Lepore, one of the island's leading general surgeons and a renowned tick expert, "Too many permits were given out for the February Hunt of 2005". Most people we interviewed felt that the hunt had been poorly planned, managed, and executed. UMass Field Station director Sara Oktay, speaking on the issue of the extended deer hunt said, "I am pro-hunting, however I am also pro-thinking". While the extended hunt did succeed in culling more deer than originally hoped, it was seen as a failure by the Nantucket community due to the high presence of hunters in off-limit areas and some sense of controversy over the culling of pregnant deer.

The extended hunt could have been executed better, but the idea behind it, controlling the deer population, is not something that should be thrown aside. Out of the majority of people we

interviewed there were only a few who were against all deer hunting, but there was a general understanding that there has to be a way to control the population. There is a sense amongst town officials that another extended hunt would be unlikely due to the severe unpopularity the idea now faces in the public. As seen from our survey, even amongst high school students the idea of deer reduction faces heavy public opposition (Figure 21), though this opinion changes depending on the students' awareness of the Lyme disease issue (Figure 22).

Figure 21: Student Support for Deer Reduction

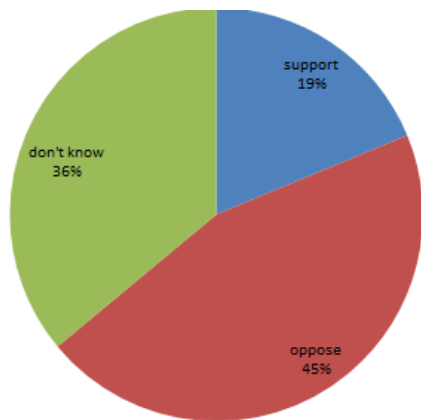
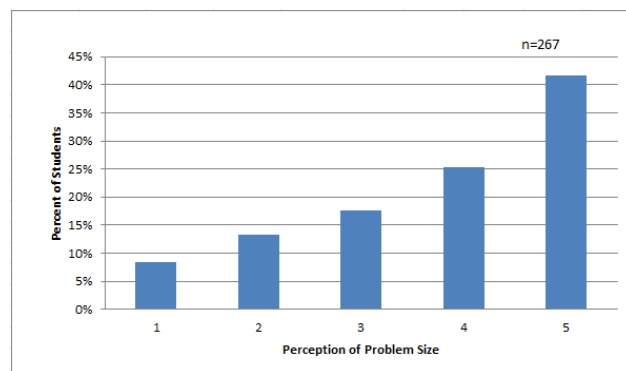


Figure 22: Support for Deer Reduction by Perception of Problem Size



Deer reduction, though, is considered necessary by a number of officials and tick experts and the regular deer season is not enough to bring about the necessary reductions. According to Oktay, “I don’t think everyone understands to what extent the deer would have to be reduced in order to reduce the herd”. She believes that in order to reduce the herd to desired levels 40-60% of the herd would have to be taken yearly. This idea is further explained by Dr. Lepore who says, “If you get the deer down to 8 to 10 deer per sq. /m the disease probably goes away”. Other options have also been suggested such as opening Sunday hunting during the normal season to increase the take.

In past years efforts were made to reduce the deer population by means of contraception. However this idea was never one that was able to be fully implemented due to high drug costs, extensive field and planning time, and the cost of hiring wildlife and veterinary specialists to administer birth control. The main problem with contraception was that does involved in the program would need to be recaptured and re-dosed according to a schedule in order to maintain infertility. Upon further investigation and interviewing we realized this is a fairly difficult

approach and most likely will not be very successful. It is because of these issues involved with administering contraceptives to females, we asked experts about the possibility of neutering males. However there was some disagreement amongst wildlife officials about how effective this might be. One expert had suggested that even if some males were neutered, others would be able make up for the deficiency, as it is not uncommon for deer to make fornication attempts several times with multiple partners. Also, reducing the number of fertile bucks would likely further reduce the island's already condensed gene pool, which could be problematic for future generations of deer.

Conclusions and Recommendations

After having completed the bulk of our research and analysis of findings about the knowledge, attitudes, and behaviors towards ticks, tick prevention, and tick-borne diseases on Nantucket, we were able to deduce a series of conclusions concerning communications with the public about the topic. After conducting numerous interviews we found that there is a consensus that public education is deserving of greater attention and our research findings and survey results affirm this logic. We have come to a series of conclusions involving the target audiences, message content, and optimal channels of communication that we believe should be focused on for a public communication campaign on the island. We believe that a strong, diverse communication campaign is a necessary and vital piece of any multi-pronged tick and tick-borne disease reduction plan.

Target Audiences

Of the many findings we gathered from the survey results, the most evident conclusion we can draw is that most students lack basic awareness and knowledge of ticks, tick-borne diseases, and protective behaviors. As discussed above, of the students surveyed, only 30% reported taking protective measures regularly and 46% were unable to identify a symptom of Lyme disease. Along with these numbers and our finding that the students on average believed Lyme disease to be either a ‘moderate problem’ or ‘no problem’ at all, we see that students need to be exposed to more tick information. We also found much support in the community over about bringing further tick education to the schools. Local officials believe that educating students is an effective way to reach a much larger general audience, and this belief is backed up by findings from the risk communication literature. In addition, students who are made aware of the issue now will become the aware adults in the years to come. These findings lead us to the conclusion that students should be one of the primary target audiences of a tick education campaign.

While the survey was conducted only on students, we feel that it led us to another target audience. According to our findings, while only 18% of students without pets reported a history

of household Lyme disease, 54% of students with pets reported a history of household Lyme disease. This leads us to the belief that pet owners tend to be more at risk of Lyme disease than others. This was further confirmed in our talks with an innkeeper who regularly advised guests with pets about ticks. She expressed her belief that guests with pets are more likely to walk outside of town in higher risk areas for ticks. Pets can also bring ticks into the home. From these factors we concluded that pet owners, being at a higher risk for tick bites, should be another target audience for tick education.

Tourists and visitors to Nantucket are considered another group at a higher risk for tick diseases by many on Nantucket. Several officials and experts voiced their concerns that tourists would be less likely than residents to be aware of the tick problem on the island and the proper protective behaviors. On the other hand, this concern is not shared by some that feel tourists mainly stay in town and do not often venture into high risk areas for ticks. Overall, though, there is concern because Lyme disease, not being prominent in many other parts of the country, is not always checked for by doctors when visitors return home with a disease. These concerns lead us to consider visitors and tourists an additional target audience.

Lastly, much concern was expressed in our interviews for the Hispanic population on the island. Concerns were expressed for those who do not speak English that much of the current tick education efforts are not reaching them. We believe this group constitutes one more primary target audience for tick communications. These specifically identified target audiences should be paid special attention to, but should not make up the sole audience for tick education. The larger number of English-speaking public is also in need of these education efforts and should not be overlooked.

Message Content

As noted in the findings above, only 30% of students reported taking preventative measures to protect against tick bites. Additionally, two of the top responses for types of measures taken: ‘wear long pants’ and ‘tuck in pants’, are not likely done in hot summer months. This, in conjunction with the high percentage of household Lyme disease reported, implies that



there are not enough preventative measures taken by those on the island. As reported in the literature, quick discovery and removal of deer ticks is quite effective in preventing tick-borne diseases. If the public would take up protective measures to prevent tick bites or quickly find and remove ticks from themselves, the occurrence of tick-borne diseases would likely be reduced significantly. Therefore, we conclude that protective behaviors should be a significant piece of the content of public education.

Certain experts believed that knowledge about ticks and tick diseases was lacking in the general public. Such knowledge would be necessary to increasing awareness of the severity of the problem on the island and the necessity to take action on both a public and private level. The school surveys backed these assertions up showing that 46% of students were unable to identify any Lyme disease symptom. Sam Telford believes that it is important for the public to understand the tick life cycle in order to fully understand the benefits of different tick reduction methods, since different methods target ticks in different stages. We conclude from these findings that in order to have a public making well-informed decisions, tick information such as tick life-cycles and tick-borne disease symptoms be part of a public education campaign.

There are a number of tick reduction methods that have been proposed for the town of Nantucket, which have received varying levels of support. One of the more frequently mentioned methods was the use of the 4-poster systems. These devices have been shown to be effective in other tick reduction attempts like the one on Shelter Island. The use of these was greatly supported by David Simser who was running the trial of the devices on the Linda Loring Foundation property. From our interviews, however, it became clear that the cost of maintaining and restocking the devices with corn becomes prohibitive with the amount of devices needed to significantly affect the problem. It was discussed, however, that 4-posters can help to maintain awareness of the tick issue in the community as the distinctive devices can be easily recognized. Dave Simser equated this effect to his observation that people recognize and respond to new signs more readily than to old ones (e.g., signs posted on golf courses and trails). Thus, we believe that while 4-poster devices would be too expensive to institute at a scale necessary to resolve the tick issue, they would very well complement a tick education campaign.

Tick control on personal property came up less frequently in our discussions. The primary recommended strategies are landscape management. Various tactics such as cutting back brush on personal property can help reduce ticks in that area. Currently, agricultural specialists like Bartlett Tree Experts offer custom anti-tick landscape planning for Nantucket homeowners. Damminix Tubes are also used frequently on the island. As was mentioned in an interview with a local homeowner, Damminix Tubes and other home tick prevention efforts can help to raise discussion of the issue in neighborhoods raising awareness and provoking similar proactive behavior. With increased interest in these measures and some initial interest in personal use of 4-poster devices, we came to the conclusion that home tick control methods such as these should be promoted.

The topics of Nantucket's white-tailed deer population and the idea of reducing it are a reoccurring theme and one that tends to gravitate toward the center of many tick-related conversations on the island. A large number of our interviewees expressed concern about the methods being proposed to curb the population of deer on the island in order to reduce the tick population. Many of these concerns stemmed from the 2005 extended deer season and worries that this particular method may be implemented again. A number of experts on ticks and wildlife management have stated that if deer on the island are reduced to much smaller numbers, the tick population would similarly decrease in following years. We heard many sides of the argument for and against this method, and have come to understand how complex the issue has become. We have concluded that if the town decides to implement a deer reduction method, it would require extensive prior public communication and education to achieve consensus and public support.

Channels of Communication

As we concluded above, students should be a primary target audience in a tick education program and as such, we believe that the school system would be an important channel of information. There is wide support for the inclusion of tick information into the school curriculum. John Buckey, the principal of Nantucket High School, showed initial interest in the inclusion of the tick life cycle into science classes or tick disease prevention in health classes. He



expressed belief that programs such as these would be better suited than short-form programs such as an annual seminar on the subject. As noted in the survey findings, ‘school’ was the top write-in response amongst students for their primary sources of tick related information. We believe this demonstrates the schools as a trusted source to students, which as seen in the risk communication literature, is a necessary trait for a communication source. We believe tick education can be instituted in all grades effectively, with tick life-cycles being taught to elder students and a basic tick awareness being taught to younger children. For example, we believe the dissemination of life size tick stickers to children would serve to raise awareness as the children would likely place the stickers around and become used to identifying the ticks. This would also bring awareness home as parents find the stickers as well. With the support in the school system as well as amongst town officials we spoke to, we believe that the school would serve as perhaps the strongest method of tick education in the community.

Another target audience we identified is that of the thousands of tourists who visit the island annually. As we discussed above, many of these visitors may likely be unfamiliar with ticks and tick protective behavior. As we found, the current efforts to educate tourists on ticks include putting tick information on ferries and other places tourists are likely to go, as well as some public places. We think these efforts should be expanded so that there is coverage on all of the ferries, airports, the shuttle, and possibly on trail and bike maps. There have also been efforts to place tick information in hotels and inns, although this has been met with reluctance. Innkeepers and rental agents are concerned that these warnings may potentially drive away tourists and hurt business; however these are key businesses that have the possibility to raise awareness amongst the visiting population. We believe that further effort should be taken to reach out to these inns and rental properties, as well as to other local businesses and museums.

Our survey showed that by far the most common source of tick information reported by students (54%) is ‘friends and family’. The risk and health communication literature shows that information spread amongst a network of people will be spread rapidly to others in the network and will be inherently trusted – this is known as ‘social contagion.’ The manufacturer of Damminix Tubes is employing a similar approach in its marketing strategy. The company is using a Facebook page to encourage a growing network of users to participate in frequent discussion spreading awareness and trust of Damminix Tubes and other tick prevention methods.

We firmly believe that it is important to get people together who have different knowledge about ticks and their unwanted presence on Nantucket. Diversity in knowledge can help provide the type of positive intervention that Nantucket needs at the community level in order to get neighbors talking about the issue. When the flu is going around people hear of it; they talk about how the cold is spreading, they cover their coughs, wash their hands and so on. This is the type of grass-roots communication that we would like to see more of on Nantucket. We believe a program such as a venison ‘pot luck’ dinner would bring together members of the public to discuss the tick issue. This would also serve to attract hunters to the issue and provide a venue to utilize extra venison. We conclude that an effective way to disseminate tick information is through encouraging networks of discussion like this either through forums such as these or on larger scales through social events.

One of our findings showed that there is a proclivity amongst both residents and visitors to avoid doctors and emergency rooms after tick bites. This often leads to undiagnosed or late diagnosed cases of Lyme disease, especially amongst visitors who return home to parts of the country not familiar with the disease. We concluded that an effective way to combat this would be to institute a free “Tick Clinic” as a first resort for dealing with tick bites. We realized that due to the island’s small medical community, recent town budget cuts and the subsequent plan to downsize the Nantucket Cottage Hospital, the idea of creating a satellite clinic might be infeasible in the current economic situation, but we believe a tick clinic modeled after the AIDS Support Clinic in Provincetown could be feasible and effective. Finally, we believe that further work should be done in gauging the knowledge, attitudes, and behaviors of people on the island. As our project was completed in late October through December, we did not have the opportunity to properly survey the knowledge, attitudes, and behaviors concerning ticks of tourists and visitors to the island. Visitors to the island so late in the season tend not to be concerned or at risk from ticks. We also believe, as supported by the health communication literature, that it will be very effective to perform further surveys on the island to evaluate the effectiveness of any campaign instituted on the island.

Based on our findings and conclusions, we recommend:

1. That the town target students as a primary audience for tick education by implementing a tick information program into the school curriculum;
2. That the town target visitors and tourists as an audience for tick education by increasing tick communications around ferries, the airport, and the shuttle as well as other public places tourists will likely congregate;
3. That the town work with local businesses to increase tick information dissemination through methods such as providing tick cards and placing information on bike and trail maps;
4. That tick communications be printed in multiple languages to better reach the non-English-speaking audience and increase the use of visuals to reach the non-reading public;
5. That efforts be made to educate residents on various home tick control methods available and provide an easy way to find professionals offering such services;
6. That before attempting to institute any public methods of tick control, efforts be made to educate the public on the township, social, and environmental benefits associated with it;
7. That local, trusted sources such as doctors, veterinarians, and schools be used to disseminate tick information;
8. That community events be implemented to increase public discussion and awareness of the issue such as a 'pot luck' dinner;
9. That the town pursue the institution of a free tick clinic similar to the Provincetown AIDS clinic; and,
10. That future efforts to survey visitors to the island be conducted as well as future surveys to gauge the effectiveness of any campaign instituted.

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Appendix A: List of Interview Subjects

David Boyce—Owner, Boyce Realty; Member, Chamber of Commerce

Principal John Buckey—Principal, Nantucket High School

Jim Cardoza—Biologist, Massachusetts Division of Fisheries and Wildlife

Brian Chadwick—Town Selectman

Richard Cooper—Vice President, Nantucket Hunting Association

Dr. John Tristram Coffin Dammin—Nantucket Tick-borne Disease Committee

John Daniels—Owner, Sherburne Inn

Susan Daniels—Owner, Sherburne Inn

Marion Larson—Outreach Coordinator, Massachusetts Division of Fisheries and Wildlife

Noah Learner—General Manager, Young's Bicycle Shop

Scott Leonard—Director of Operations, Marine Mammal Stranding Team

Dr. Tim Lepore—General Surgeon and Physician, Nantucket Cottage Hospital

Dr. Malcolm MacNab—Nantucket Tick-borne Disease Committee

Joanne Marcoux—Owner, Nesbitt Inn

Steve Marcoux—Owner, Nesbitt Inn

Beverly Mclaughlin —Nantucket Tick-borne Disease Committee

Dr. Sarah Oktay—Managing Director, UMASS Boston Nantucket Field Station

Michelle Perkins—Education Coordinator, Marine Mammal Stranding Team

Richard Ray—Director, Nantucket Health Department

Nurse Margaret Roberts—Nurse, Nantucket High School

David Simser—Barnstable County Entomologist



Dr. Samuel Telford III—Professor, Biomedical Sciences, Cummings School of Veterinary
Medicine, Tufts University

Elizabeth Trillos—Nantucket Tick-borne Disease Committee

Jose Trillos—Activist

Whitey Willauer—Town Selectman



Appendix B: Interview Preamble and Sample Questions

Preamble:

Thank you for taking the time to meet with us. All three of us are science majors in our junior year at Worcester Polytechnic Institute in Worcester, Massachusetts. We are fulfilling major requirements abroad as a part of WPI's Global Perspective Program. Our work on Nantucket involves researching the ways in which ticks affect the Nantucket community and suggesting ways on how to improve communication about ticks in attempt to mitigate the number of Tick-borne Diseases on the island. We are seeking a diverse group of townspeople, activists, business owners and wildlife experts who can offer us their opinions about ticks and issues related to tick prevention and tick-borne diseases on Nantucket. We have prepared some questions for you that will help us to better understand some of the knowledge, attitudes and behaviors toward ticks and tick prevention present in the Nantucket community. Please feel free to omit any question that you feel uncomfortable answering. We can stop this interview at any time that you wish. We can assure you complete confidentiality in your responses if you prefer anonymity and nothing will be published without your consent.

1. Do you think that ticks and tick-borne diseases are a problem on Nantucket?
2. Do you think that the tick issue poses an issue to property values or small business owners or Nantucket's tourism industry?
3. What are your feelings about the February Hunt of 2005?
4. What are your feelings on deer reduction?
5. How do you feel about administering birth control to the deer population?
6. What groups or businesses on the island do you feel might be the most helpful in trying to educate the public about ticks and tick-borne diseases?
7. What are your feelings about the use of approved pesticides such as Damminix Tubes?
8. What do you personally feel are the best ways to combat the tick issue on the island?
9. What are the programs and areas currently addressing the issue that you think need improvement? Why are these ineffective?
10. What do you think are the best forms of communication for spreading the word about ticks on Nantucket that are currently in order?
11. What do you think the least effective way of combating the tick issue on Nantucket has been in past years?
12. In your opinion, do you feel that the seasonal or the year-round residents are more concerned with the issue?



13. Do you ever think that year round residents feel burdened by the issue, if so why?
14. Do you feel that tick-education efforts should be focused more on informing the visitors or the residential (seasonal and year round) population or should the efforts be equal?
15. If you could choose one area in which to allocate more funding to help reduce Lyme disease on Nantucket, what area would that be?



Appendix C: Student Survey

Nantucket High School Tick Information Survey

The following survey was developed by three students from Worcester Polytechnic Institute who are collaborating with the Nantucket Tick-borne Disease Committee to improve the public communication strategy concerning ticks and tick-borne disease on the island. This survey is anonymous and voluntary. Please skip over any questions that you do not wish to answer.

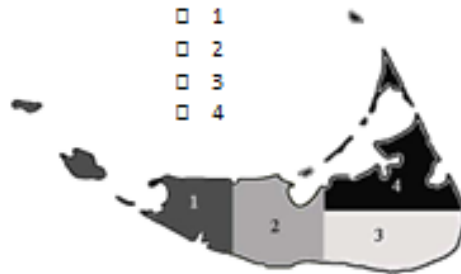
1. What are your Gender, Age, and Grade?

- Male 12 13 14 15 Freshmen Junior
 Female 16 17 18 19 Sophomore Senior

2. How long have you lived on Nantucket (in total years)?

- 0-1 Year 1-5 Years 5-10 Years 10-20 Years

3. In which of the four quadrants on the map below is your house located?



4. Have you or anyone else in your household had Lyme disease within the past three years?

- YES NO DON'T KNOW

5. Do you regularly take measures to prevent tick bites?

- YES NO DON'T KNOW

6. If so, what do you do to prevent tick bites? (Check all that apply)

- Daily tick checks Deet bug spray Tuck pants into socks
 Avoid long grass Wear long pants Nothing at all Other _____

7. On a scale of 1 to 5 (1= no problem at all, 5= a severe problem), how severe of a problem do you believe Lyme disease is on Nantucket?

- +—+—+—+—+—
 1 2 3 4 5

8. Would you support or oppose a plan to use approved pesticides in order to control ticks?

- SUPPORT OPPOSE DON'T KNOW

FLIP OVER FOR OTHER SIDE



9. Would you support or oppose a plan to reduce the deer population in order to control ticks?

SUPPORT OPPOSE DON'T KNOW

10. Do you or does anyone else in your household hunt game on Nantucket?

YES NO DON'T KNOW

11. Please indicate three early signs or symptoms of Lyme disease?

1) _____
2) _____ I don't know
3) _____

12. Since the beginning of last summer, how many times have you found ticks on your body or clothing that didn't appear to have bitten you?

0 1-3 4-6 7-10 11+

13. How many tick bites would you estimate that you have had since the beginning of last summer?

0 1-3 4-6 7-10 11+

14. Since the beginning of last summer, on average how many total hours per week (excluding organized sports) would you say that you spent outdoors in wooded areas, fields or in grassy dunes?

0-1 2-5 6-10 11-20 21+

15. If you have a furry pet that spends any amount of time outside, how often would you say that you find ticks on your animal?

OFTEN SOMETIMES NEVER DON'T HAVE A PET

16. Do you use a tick repellent on your furry pet (such as Frontline, K-9 Advantix, etc.)?

YES NO DON'T KNOW DON'T HAVE A PET

17. What have been the three most significant sources of information for you concerning ticks and tick bite prevention? (Check all that apply)

Family, friends Newspaper Doctor Internet Television
 Personal experience None Other _____

18. What protective actions does your household take against ticks? (Check all that apply)

Landscape Modification Tick checks Bug spray Pet repellent
 Kill ticks once found Damminix tubes None I don't know
 Other _____

