NEWTOWN TICK-BORNE DISEASE ACTION COMMITTEE

FINAL REPORT

SUBMITTED ON OCTOBER 17, 2011

TO

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EXECUTIVE SUMMARY

In September 2009 the Newtown Board of Selectmen created the Newtown Ad Hoc Tick-Borne Disease Action Committee (TBDAC) for the purpose of developing and implementing a Town-wide action plan to control, reduce and/or eradicate tick-borne disease (TBD). In accomplishing this task, the TBDAC was requested to (i) develop a personal health procedure for public dissemination; (ii) to determine whether TBD "hot spots" exist and if so, correlate variables such as population, open space and/or forest; (iii) to review efforts of neighboring towns to reduce TBD; (iv) to review documentation for limits and extent of deer impact to Newtown's public health and safety, natural resources and economic growth; and (v) to develop a definitive action plan for prevention and control of TBD in Newtown.

The TBDAC has conducted extensive research and data analysis. TBDAC members have met with, attended lectures by, or teleconferenced with experts in entomology, forestry, epidemiology, biology, public health and deer reduction/sterilization. Representatives from the Connecticut Department of Environmental Protection (DEP), Connecticut Agricultural Experiment Station (CAES) and the Connecticut Department of Public Health (DPH) have addressed the TBDAC, as have representatives of TBD and deer reduction efforts in neighboring towns (Appendix A).

CHARGE 1. Complete a review of all existing technical and medical data to develop a personal health procedure to be disseminated to the public.

- The rising TBD incidence indicates that currently disseminated preventative messages are ineffective.
- The TBDAC recommends that Newtown implement a new communication strategy based on scientifically sound methods to effectively communicate to Newtowners a four-pronged message: Newtowners are at risk of developing TBD; TBD presents serious health risks; TBD is preventable; and actions taken by an individual can effectively prevent TBD.
- Individuals are more likely to respond to a message if they believe that they are at risk and can take steps that will effectively reduce that risk.

CHARGE 2. Complete a review of all available Newtown health data to determine if there are areas of concentration of tick-transmitted diseases in the community. Detail the results, if any, on a map of Newtown to show the relationship, if any, between population areas, open space and/or forested areas.

- The TBDAC was unable to find a database for areas of concentration of TBD in Newtown. TBD is a problem throughout Newtown.
- Newtown has the highest reported incidence per population of Lyme disease in Fairfield County (DPH).
- The reported incidence of other TBDs is rising. The importance of acting to reduce of TBD cannot be overstated.

- Kirby C. Stafford III, Ph.D., Vice Director, Chief Entomologist, CAES, estimates that up to 75% of TBD is acquired in one's own backyard.

- Edge habitats attract rodents that transmit infection to ticks and medium- and larger-sized mammals that transport ticks. Tick-friendly environments are shaded, humid and sheltered. Forests and landscapes with ground cover and piles of wood and stone further enhance tick-friendly environments. Creating a "tick safe zone" markedly reduces one's risk of developing TBD (Stafford, 2007; Attachments 9 and 10).

CHARGE 3. Complete a review of data developed by neighboring towns in their effort to reduce or eradicate tick-borne diseases. Would any of the procedures be applicable to Newtown's problem?

- The TBDAC reviewed and summarized nine local municipal reports (Brookfield, Darien, Fairfield, Greenwich, New Canaan, Redding, Ridgefield, Weston and Wilton) and three regional reports (Bernards Township, NJ; Lower Makefield Township, PA; and Nantucket, MA). Similarities in their findings and conclusions included correlations between high deer densities and TBD, significant ecological impacts to forest and landscapes by deer, and significant and underreported deer-vehicle crashes (DVCs).

- Deer reduction was a major recommendation in all but one (Weston) municipal reports reviewed by the TBDAC. Deer density target goal in most municipalities is ten deer per square mile (d/mi^2) derived from Stafford's estimate that reduction of TBD through reduction of deer density can be achieved at this density.

- Additional municipal report recommendations included improved educational efforts, emphasizing personal protection and landscape modification techniques and building community exclosures to demonstrate the role that overabundant deer play in our environment.

CHARGE 4. Gather and review documentation for the limits and extent of deer impact to Newtown's public health and safety, natural resources and economic growth.

Public Safety:

- The TBDAC gathered data from the Newtown Police Department, the Fatal Analysis Reporting Systems of the National Highway Traffic Safety Administration (NHTSA), and the Connecticut Department of Transportation.

- From 2000 to 2009 DVCs steadily decreased, with an overall reduction rate of 39%. DVCs are highest during rut season (November and December). Property-only DVCs are underreported.

- The majority of DVCs occur on the most heavily traveled roadways (e.g. Routes 302 and 25), and otherwise are scattered throughout the town.

Natural Resources:

- Loss of forest understory and failure to regenerate are multifactorial. Loss of understory has been linked to deer browse; to fragmentation of forested lands; to impaired light penetration to understory because of mature forest canopy; and to prior use of the land, invasive plant species, soil conditions, pests and diseases of certain tree species, etc.

- High deer density results in over-browse of shrubs, woody and herbaceous vegetation, increase of invasive plant species, reduction of bird species and/or number, spread of black-legged (aka deer) ticks and their associated diseases, and forest regeneration issues.

- A 12-year-old deer exclosure at Highstead Arboretum in Redding CT demonstrates significantly increased tree seedlings inside the exclosure.

- Natural succession, human use of land and deer browse have affected the regeneration, abundance and distribution of species of trees, particularly in regenerating stands or those in early stages of succession. An active stewardship approach to the forests has been advocated by experts (Williams, Appendix D; Faison, Appendix A; Summary, Yale Management Plan for the Stone Bridge, Pole Bridge, and Pond Brook Properties, 2011, Appendix E).

- Forest fragmentation created by dividing large continuous forests into smaller blocks not only damages forest habitat, decreases biodiversity and reduces clean air and water, but also creates edge habitats that provide optimal conditions for deer, rodents and invasive species to thrive.

- According to DEP aerial surveys undertaken in 2009 and 2011, the deer density along a transect in Newtown is approximately 70 to 105 d/mi^2. Three to five surveys (6 to 9 years) will be required to accurately determine trend of change in deer density, given variables which must be taken into consideration that affect each aerial survey.

- Deer density greater than 20 d/mi^2 significantly reduces forest regeneration. The evidence suggests that a deer density of less than 20 d/mi^2 would be required in order to eliminate deer browse as a contributing factor to the forest understory loss in Newtown.

Economic Growth:

- The TBDAC could find no specific information regarding deer damage to agricultural crops in Newtown.

- Deer preferentially browse on ornamental species rather than native plants.

- The Fairfield County Municipal Deer Management Alliance (FCMDMA), in cooperation with the Connecticut Coalition to End Lyme Disease and the Connecticut Audubon Society, commissioned a report from New York Medical College Department of Health Policy and Management regarding the financial cost of deer overpopulation. Their 2010 report projects the estimated financial cost from environmental and landscape damage due to deer overpopulation in Newtown at $804 per household and cost for tick control of $135.33 per household. The estimates are based on a 2003 survey of residents in Bernards Township, NJ.

- The TBDAC has analyzed data from several sources regarding economic impact secondary to TBD. Analysis of Centers for Disease Control 2000 data (direct and non-direct medical costs, non-medical costs and productivity losses) indicates a median total cost for early-stage Lyme disease of $397 per case vs. $923 per case for late-stage Lyme, with an average cost of $8,172 per case. Adjusting for inflation, the median costs would be $503 and $1,169, respectively. The FCMDMA report referenced above estimates that early and late stages of Lyme disease cost $10,562 per case.

CHARGE 5. Taking into account all of the above findings develop a definitive action plan for the prevention and control of tick borne diseases in Newtown.

The TBDAC has developed a multifaceted approach to TBD reduction in Newtown (Tick-Borne Disease Management Plan) at both the municipal and individual levels which may be categorized as follows.

- Education strategies for school-age children, for adults working with school-age children in environments where they are at risk for TBD, and for Newtowners as a whole, particularly those at risk of exposure to TBD.
- Tick reduction/avoidance strategies.
- Vector treatment strategies (legal and non-lethal).
- Active support for development of TBD vaccine at municipal, state and national levels.
- Metrics recommendations to monitor effect of action items.

RECOMMENDATIONS PASSED BY THE TBDAC

EDUCATION: The TBDAC considered strategies to effectively communicate issues related to TBD to residents.

1. The TBDAC recommends that the Town engage in a public information and education campaign (PI&E) to run at least annually (with some periodic continuation of seasonally relevant messages). Ideas for such a strategy are contained in this Report. (11 yes, 0 no)

2. The TBDAC recommends that the PI&E campaign be designed to maximize its effectiveness by considering relevant theory related to health behavior modification (e.g., Health Belief Model). (11 yes, 0 no)

3. The TBDAC recommends that the messages included in the PI&E campaign include the topics described in the "Education" section of this Report. (11 yes, 0 no)

4. The Town should stress the relationship between deer and tick. (6 yes, 5 no)

5. The Town should stress judicious property spraying as described in the Report. (10 yes, 1 no)

6. The TBDAC recommends that the messages be disseminated in such a way to reach the maximum number of residents utilizing a wide variety of paid (e.g., billboards, radio) and free/minimum cost (e.g., banners, flyers, signs) media. (11 yes, 0 no)

7. The TBDAC recommends that coordinator(s) be appointed to help implement the recommendations from the committee adopted by the Town. (11 yes, 0 no)

VACCINE: The TBDAC considered whether Newtown should support development at community, state and national levels of a vaccine to prevent TBD.

1. It is the consensus of this Committee that a safe and effective Lyme vaccine offers the best hope to combat Lyme disease. (6 yes, 5 no)

2. The Committee recommends that the Board of Selectmen pursue state and regional cooperation to facilitate the development and deployment of said vaccine. This could include financial assistance, some form of legal protection and community education. (6 yes, 5 no)

DEER-VEHICLE CRASH RECOMMENDATIONS: The TBDAC considered recommendations to deter crashes between deer and motor vehicles.

1. The TBDAC concludes that the Town consider the use of temporary signage during rut season (mid-October through mid-January)—based on crash data present in Figure 6.3 to warn drivers of potential deer crashes. Sign placement should be based on high frequency crash sites. (11 yes, 0 no)

2. The TBDAC concludes that the Town consider engaging in some highly visible public information and education program to educate the public on the risk of DVCs during rut. This effort should be "rolled out" annually starting in October. (11 yes, 0 no)

2A. As part of this conclusion, we ask the Town to consider enhancing the awareness program by supporting a school-based contest to create the message to be rolled out. (11 yes, 0 no)

3. The TBDAC recommends that at high DVC locations, to the extent possible, the Town clear foliage from roadsides in an effort to increase available reaction time for drivers to avoid deer crashes. (11 yes, 0 no)

4. The TBDAC concludes that the Town consider engaging in some form of deer population control to reduce DVCs. Such control could be focused on high DVC sites. (8 yes, 3 no)

5. The TBDAC recommends that the Town consider the use of reflective lights (e.g., those produced by the Strieter Company) to deter deer from roadways. (10 yes, 1 no)

FORESTRY RECOMMENDATIONS: The TBDAC considered recommendations to improve the health of Newtown's forests.

1. Contract a forester for professional services to make assessments and recommendations of all major town-owned open space areas and develop a forest management plan for selected open space parcels. Develop metrics for evaluation of forest health to be used to assess any changes over time. (11 yes, 0 no)

2. Re-evaluate the parcels evaluated by CAES in March 2010 in five years to determine any changes. (11 yes, 0 no)

3. Discourage further subdivisions which create more edge habitat and implement cluster zoning regulations for future developments. (9 yes, 2 no)

4. Support efforts of newly-formed Invasive Species Work Group to eliminate/reduce barberry from Town open space, parks, schools and private property. Investigate possible State funding of such efforts. (11 yes, 0 no)

5. Encourage landscaping practices that reduce the presence of ticks and white-footed mice on private property (removal of barberry, use of wood chips, etc.). (11 yes, 0 no)

6. Build one or two deer exclosures (perhaps in Al's Trail and Orchard Hill Nature Center) for demonstration/education purposes. (7 yes, 4 no)

7. Continue to monitor biological controls of ticks, such as fungi, nematodes, etc. Of particular interest is the fungus *M. anisopliae* Strain 52, marketed as Tick-EX-EC, which is expected to be commercially available in 2011. (10 yes, 1 no)

8. Reduce deer herd to average density of 18 to 20 deer per square mile. (7 yes, 4 no)

9. Lobby the State of Connecticut to ban the use of lead in hunting ammunition. (10 yes, 1 no)

DEER-RELATED (NON-LETHAL): The TBDAC considered whether non-lethal deer strategies should play a role in preventing TBD.

1. Newtown should include 4-Posters as an element of its Tick-Borne Disease Management Plan. (11 yes, 0 no)

2. Newtown should adopt 4-Posters on a trial basis with a limited initial deployment focused on suitable sites in high-risk areas (i.e., sites in active recreational use in which high deer/tick densities are known or suspected). Based on Newtown's experience with this trial deployment, perceived need, funding and permitting issues, Newtown should revisit 3-5 years from implementation of this trial deployment whether a broader deployment may be appropriate. (10 yes, 1 no)

DEER-RELATED (LETHAL): The TBDAC considered whether lethal deer reduction should play a role in preventing TBD.

1. Newtown should include a deer population reduction program as an element of its Tick-Borne Disease Management Plan. (7 yes, 4 no)

2. Newtown should take measures to promote recreational hunting. Newtown should inform the public of the regulations regarding hunting on private property in an effort to promote such activity. (6 yes, 5 no)

3. Newtown should implement controlled-hunts on Town-owned property (where not prohibited by deed or transfer agreement). (7 yes, 4 no)

4. Newtown should encourage and organize controlled-hunts on private property. (7 yes, 4 no)

5. Newtown should hire professional "sharpshooters." (7 yes, 4 no)

6. Messages that TBDAC recommends be included in all deer strategies:

A. Life cycle of the tick: The message should include a description of the life cycle of the tick and describe how the deer are the primary host for the adult tick and provide its best chance of a blood meal adequate to produce offspring. Such discussion should include that alternate food sources are of insufficient population or physical size to sustain the current tick population. That is, the reduction of deer to a low level may "break" the life cycle of the deer tick. Thus treating or adequately reducing deer is expected to reduce tick population in the Town.

B. Home range patterns of white tailed deer: Residents should also be informed regarding the home range patterns of the deer such that they understand how a local only deer reduction or treatment strategy can still be effective despite the lack of geographic/natural barriers preventing deer from other towns from entering Newtown.

C. Encourage property owners to open their land to hunters, sharpshooters, or 4-Poster devices.

(7 yes, 3 no)

7. Messages that TBDAC recommends be included in deer reduction strategies:

Several general topics should be included in the discussions. The list below outlines some sources of information and some topics. All of these are described in some detail in this Report.

A. Refer residents to the "Managing Urban Deer" brochure from the DEP to educate homeowners so they can make their own decisions. The *Tick Management Handbook* (Stafford, 2007) may also be helpful.
B. Describe the deer reduction programs already in place in surrounding towns.
C. Disseminate the FCMDMA Economic Impacts estimate report (Attachment 4).
D. Disseminate the DVC statistics/Forestry Impacts.
E. Residents should be made aware that very low densities may be possible to achieve even if it will take time and extensive efforts.
F. Refer residents to the CT DPH Website on Lyme disease (http://www.ct.gov/dph/cwp/view.asp?a=3136&pm=1&Q=395590&dphNav_GID=1601&dphPNavCtr=|#47046)

(7 yes, 3 no)

8. Other strategies to improve the effectiveness of hunting programs (excluding sharpshooting).

A. The Town's Parks and Recreation Department can offer courses to support the deer management effort:

- Youth and adult archery training/education programs;
- Venison preparation from field dressing to dinner table;
- Sponsor the DEP-mandated firearms and/or bow hunting conservation and safety program. Note: These courses are often filled to capacity.

B. The Town can offer a voucher for meat processing (or other expenses) for deer that are legally harvested in Newtown and donated to a food bank. Obviously, any voucher will not cover all expenses; however, it is a tangible recognition that the Town values the service.

C. Stimulate the demand for deer by promoting "Venison Thursdays" (for example). This free range protein source is locally grown and harvested and is consistent with the current green movement. This provides a mechanism for the Newtown residents who want to make a contribution by putting venison on the table once a week.

(7 yes, 3 no)

9. Strategy to improve the effectiveness of sharpshooting: The Town should consult with the DEP or other professional regarding the potential interactions of simultaneous programs. For instance a "controlled" hunt program may interfere with professional sharpshooters if it makes the deer "skittish" or "smart." It is very likely that current recreational hunting can continue. (10 yes, 0 no)

10. Recommendations to encourage public support of some deer strategies.

A. The Town can officially recognize and extend thanks to the hunters for providing a valuable public service. A simple proclamation from the selectman's office would send a powerful message.

B. If the Town implements the surveys described in the Metrics Chapter of this Report, dissemination of those results may provide all residents with information regarding attitudes of their neighbors. To the extent that other residents are concerned and affected directly by TBD, those less concerned and affected may recognize the need for the Town to act. In general people tend to believe that the opinions and attitudes held by them are shared by the majority. It is possible that pointing out attitude differences may prompt people to recognize the frequency of other opinions and gain some tolerance for opposing views.

(7 yes, 3 no)

DEER-RELATED (MIXED LETHAL AND NON-LETHAL): The TBDAC considered whether combination lethal and non-lethal deer strategies should play a role in preventing TBD.

1. Newtown should accept the DEP's offer to work with the Town to develop, coordinate and implement a deer management program. (11 yes, 0 no)

2. Newtown should commission a professional, scientific survey to evaluate the attitude of Newtown residents toward the deer population, costs associated with various TBD mitigation options and other purposes. (8 yes, 3 no)

3. Public information dissemination. Recommend that Newtowners be fully apprised of any TBD plan with clear explanations regarding costs, benefits, and likelihood of success via open forum, mailing, website, some other means or a combination. Research suggests that a message explaining both pros and cons of contemplated actions is most persuasive for an educated audience. The TBDAC suggests the Selectmen consider addressing complex topics the TBDAC struggled with, including questions of how low deer population can be feasibly reduced in Newtown, what is known /not known about various deer density levels, and contemplated long-term success of achieving target deer density level with adopted strategies. Recommend that Selectmen provide rationale behind the TBDAC's majority and minority votes to provide a fair and balanced argument. (10 yes, 0 no)

METRICS: The TBDAC considered methods to track the impact of programs implemented in Newtown.

1. Newtown should implement an active surveillance program among local physicians to monitor tick-borne disease in a more systematic manner. (11 yes, 0 no)

2. Newtown should conduct periodic scientifically reliable annual surveys of Newtown residents to track relevant issues. The survey should ideally be administered annually. (11 yes, 0 no)

3. Newtown should conduct periodic (at least annual) tick drags using accepted scientific protocols that are sufficient to monitor changes in tick density in response to Newtown's Tick-Borne Disease Management Plan. (11 yes, 0 no)

4. Newtown should conduct periodic (at least biennial) deer counts using accepted scientific protocols that are sufficient to monitor changes in deer density in response to Newtown's Tick-Borne Disease Management Plan. Multiple methods for the first few counts may allow future measures to use the cheapest method assuming the methods produce comparable results. (11 yes, 0 no)

5. Newtown should monitor DVCs in a systematic manner that pulls together relevant data maintained by its Police and Highway Departments and the State. (11 yes, 0 no)

6. Available performance metrics should be publicly reported on an annual basis. (11 yes, 0 no)

RECOMMENDATIONS REJECTED BY THE TBDAC

FORESTRY

1. Encourage predators of mice by developing a program for building and distributing owl boxes—a possible Scout project. (2 yes, 9 no)

DEER-VEHICLE CRASHES

1. The TBDAC recommends that the Town considers installing fencing along some roadways with particularly high rate of DVCs. (2 yes, 9 no)

NON-LETHAL DEER STRATEGIES TO REDUCE TBD

1. Newtown should pursue non-lethal deer reduction measures by seeking to participate in Dr. Rutberg's deer contraception study. (5 yes, 6 no)

2. Newtown should implement a Town-wide 4-Poster deployment at the earliest time (subject only to site availability limitations and similar unavoidable constraints). (1 yes, 10 no)

3. Newtown should defer 4-Poster implementation for 3-5 years in order to evaluate need after other aspects of Newtown's Tick-Borne Disease Management Plan have been introduced and evaluated. (4 yes, 7 no)

TABLE OF CONTENTS

CHAPTER 1. DEFINING THE PROBLEM

A. Tick-Borne Disease: A Major Public Health Threat

Tick-borne disease (TBD) poses a significant public health threat to residents and animals in Newtown. Newtown is situated within a hyper-endemic region of Lyme disease. Although 36 years have passed since it was first identified in Connecticut, the Lyme epidemic has not been arrested. It continues to grow and spread, and is both the most commonly reported vector-borne disease in the United States (CDC website, 2011) and the leading arthropod-associated disease in the U.S. (Stafford, 2007, p. 21). Twelve states (Connecticut, Rhode Island, Pennsylvania, New York, Massachusetts, New Jersey, Delaware, New Hampshire, Wisconsin, Minnesota, Maine and Maryland) account for 95% of reported Lyme cases nationwide (Centers for Disease Control [CDC], 2011), with Connecticut consistently ranking at or near the top of the states with the highest incidence rates in the nation (Steere et al., 2004, CDC website, 2011). Two other very serious diseases can be transmitted along with Lyme in the same tick bite: babesiosis and human granulocytic anaplasmosis (formerly known as human granulocytic ehrlichiosis) (further discussed in Chapters 2 and 3). There are other TBDs also.

Moreover, according to a number of experts Lyme disease may be under-reported by a factor of 10 (the CDC estimates that only 10-20% of diagnosed Lyme cases are reported). Most cases of Lyme disease are not reported by physicians for a variety of reasons. For 2009, the latest year for which figures are available, Connecticut reported a total of 4,156 Lyme cases (confirmed and probable) (CDC website, 2011). Thus, this could represent as many as 41,000 cases of Lyme in Connecticut.

According to the Connecticut Department of Public Health (DPH), the incidence per population of Lyme disease cases in Newtown exceeds the Fairfield County average (Dr. Nelson, DPH, Attachment 11). According to the Newtown Health District, not only are the cases of Lyme disease in Newtown rising at alarming rates (Culbert, Appendix A), but Newtown residents are also contracting babesiosis and anaplasmosis from tick bites.

It is important to note that the CDC reports that Lyme disease cases represent only 10-20% of *diagnosed* cases. Since the CDC criteria are very strict, the number of cases not found under that umbrella is unknown. The Newtown Health District agrees that cases are underreported, making the actual number of TBD cases much higher in Newtown than what has been reported.

The 2007 Survey of *The Way Things Are in Newtown* conducted by the Harrison Group demonstrates that Lyme disease and ticks are a major concern to Newtown residents.

- The prevalence of ticks and Lyme disease was considered an urgent/major problem by 51% of residents and scored in the top tier of major concerns for residents.
- 8/10 households reported someone in the family receiving a tick bite while living in Newtown.
- 48% of households reported that at least one household member had been treated for Lyme disease while living in Newtown.

B. Tick Infection Rates

Ticks in Newtown are known to be infected with Lyme, babesiosis and anaplasmosis, and possibly other diseases. The estimated infection rate of these ticks varies according to the laboratory that tests them.

- Black-legged ticks submitted to the Connecticut Agricultural Experiment Station (CAES) by local health districts have been tested for infection with *Borrelia burgdorferi* (the causative agent of Lyme disease) for more than 15 years. Statewide, over the last 10 years, an average of 29% of ticks (adults and nymphs combined) tested positive (range= 22-39%). Over the same time period, the infection rate of ticks from Newtown averaged 28% (range 14-44%).

- Statewide, from 2005-2008, the infection rate of adult ticks was higher (31%) than for nymphs (24%). This is expected because adult ticks have had one more blood meal and therefore are more likely to have fed at least once on an infected rodent. There is no evidence that infection rates changed when CAES stopped testing un-engorged ticks, starting in 2006. CAES has tested only for *Borrelia burgdorferi*, not for the presence of other TBDs (see Appendix C for full results).

- In 2009, the Newtown Health District participated with the Fairfield County Municipal Deer Management Alliance (FCMDMA) in conducting a 2-year study with the University of New Haven's Eva Sapi, Ph.D. The purpose was to collect and test ticks from CT towns such as Newtown that annually have the highest number of cases of Lyme disease in CT. Ticks were collected in Newtown, Redding, Bethel and Ridgefield. Ticks in Newtown were collected from specific locations such as Head of Meadow School, Al's Trial and Orchard Hill Nature Center (see Appendix C for full results).

  University of New Haven Study*:* Newtown results:

  2008: 70% of ticks tested positive for *Borrelia* (Lyme disease)

  2009: 96% of ticks tested positive for *Borrelia* and 28% for *Babesia*.

- Drs. Stafford (CAES) and Telford (Tufts University) subsequently tested adult ticks from similar Newtown locations in December 2009. Their Lyme infection results were consistent with previously reported CAES results (Stafford results: 31%, Telford results 26%). In addition, *Babesia microtti*, also tested by Stafford, was positive in 1% of the ticks. Drs. Stafford, Telford and Ostfeld have expressed doubts about the validity of the high infection rates reported from Dr. Sapi's laboratory results (personal communications). Dr. Sapi stated that the higher infection rates reported by her laboratory are the result of using a more sensitive methodology (quantitative real-time PCR); however, see Bastien et al., Quantitative Real-Time PCR Is Not More Sensitive Than "Conventional" PCR, 2008.

C. Bottom Line

Despite disagreements among the experts on tick-infection rates, the TBDAC considers that even the lowest infection rates reported are high enough to pose a substantial risk of infection to humans. This is especially true as Newtown has the unfortunate distinction of the highest incidence per population of

Lyme disease in Fairfield County. Consequently, the TBDAC recommends that the public be advised that all tick bites should be handled with the assumption that the tick is infected.

D. Economic Implications of Lyme and Tick-Borne Disease

1. 2006 Study of the Economic Impact of Lyme Disease

The CDC reported that the total costs of early and late stages of Lyme disease averaged $8,172 per case in the year 2000 (Zhang et al, 2006). This included direct and indirect medical costs, non-medical costs and productivity losses. The median total cost for early stage Lyme disease was $397 per case while the median total cost for cases of late-stage Lyme disease was $923 per case.

- Adjusting for inflation, estimated current 2010 costs would run $10, 256 per case for early and late stages of Lyme disease (Arno & Viola, 2010).
- Adjusting for inflation, in 2010 the median total costs of early Lyme disease cases would be $503 per case: the median total costs of late stage Lyme disease would be $1,169 per case.
- The estimated costs vary considerably depending in part on whether treatment is associated with early or late Lyme disease or a tick bite (for example). The data suggested that a small number of patients accounted for a large proportion of the total costs.
- The consequence of the substantial underreporting of Lyme disease cases on these average and median cost estimates is unknown.

2. 2010 FCMDMA Study of the Economic Impact of Deer in Newtown

The most recent economic impact study (Arno & Viola, 2010) was done by New York Medical College in May 2010. The study was sponsored by the FCMDMA, in cooperation with the Connecticut Coalition to End Lyme Disease and the Connecticut Audubon Society.

The objective of the study was to analyze the economic losses that result from deer overpopulation, including deer vehicle crashes, vegetation and landscaping damage, and Lyme disease prevention and care. The researchers used 2008 data and found that estimated costs in Newtown were nearly $9.7 million. Table 1.1 provides these costs broken down by source. Environmental and Tick Control results are estimates for Newtown that are from a comprehensive residential property survey conducted in Bernards Township, NJ. Expenditure and cost data reflect averages and are considered by the authors to be conservative estimates. The original article describes additional costs for each category that may be considered based upon availability of local data (see Attachment 4 for full results of estimated costs of all Fairfield County towns).

Environment/ Landscape	Motor Vehicle	Tick Control	Tick-borne Disease	Total	Population	Single-Family Households	Cost per Capita	Cost per Single-Family Household
$6,212,245	$445,910	$1,045,560	$1,981,410	$9,685,124	26,011	7,726	$372	$1,254

Table 1.1: Economic Impact of Deer in Newtown
Source: Arno & Viola, 2010

CHAPTER 2. HISTORY OF TICK-BORNE DISEASE

Lyme disease existed for decades (Stanek & Strle, 2003) before it was diagnosed as an entity in the 1980s after cluster cases began to develop in the Northeast. Dr. Kirby Stafford, Chief Entomologist of the Connecticut Agricultural Experiment Station, explains in his Tick Management Handbook (Stafford, 2007, Attachment 1) that the explosion of tick-borne disease (TBD) in the 1970s relates to changing landscape patterns. Journals by contemporary naturalists and entomologists indicate that ticks were abundant in the densely forested habitat of 1748, while they were nearly extinct in the 1872 landscape of cleared agricultural tracts, which Stafford attributes to elimination of deer due to habitat loss and unregulated hunting. The decline of agricultural use led to re-establishment of forests, creating a suitable habitat for ticks and animal hosts to proliferate. Subsequently, forest fragmentation through human development created edge habitats, hospitable and inviting to ticks, rodents and deer.

The black-legged tick (in the common vernacular also known as the deer tick), *Ixodes scapularis,* is the primary vector for the Lyme spirochete bacterium (*Borrelia burgdorferi*) and other TBD pathogens, including *Babesia microti* and *Ehrlichia chaffeensis*. Ticks acquire bacteria from rodent reservoir hosts (primarily white-footed mice, chipmunks, and two shrew species) and transmit them to other mammals. Some mammal hosts are relatively impervious to the disease; other hosts become infected and symptomatic.

Stafford (2007) cites several factors that have increased human-tick interactions and TBD incidence rates, including increased tick abundance, overabundant deer population, increased recognition of TBD, residential site choices (wooded areas), and increased potential for contact with ticks.

A. Life Cycle of the Black-Legged Tick

Black-legged ticks feed on a wide variety of mammals and birds. In the Northeast, deer are the principal adult tick host, but do not infect feeding ticks with Lyme disease bacteria. Deer feed ~90% of adult ticks (each of which may lay 3,000 eggs) and transport them. Stafford correlates the abundance and distribution of the black-legged tick to the size of the deer population, and states "deer are the key to the reproductive success of the tick" (Stafford, 2007).[1]

Black-legged ticks live two years. Eggs are laid in May, uninfected larvae hatch mid-summer, and peak larval activity occurs in August. Feeding on reservoir hosts infects larvae. Larvae drop from the host after feeding and molt into nymphs, appearing late spring. Peak nymph activity occurs in May, June and July. Nymphs precede larvae seasonally and infect a new generation of animal hosts prior to larval feeding. Larvae become infected when feeding on reservoir host animals.

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[1] Ostfeld (2010) disagrees with this statement, noting that studies show a range of relationships between deer and tick abundances from strong to weak to nonexistent, and positing that multiple hosts and factors are responsible for regulating numbers of black-legged ticks.

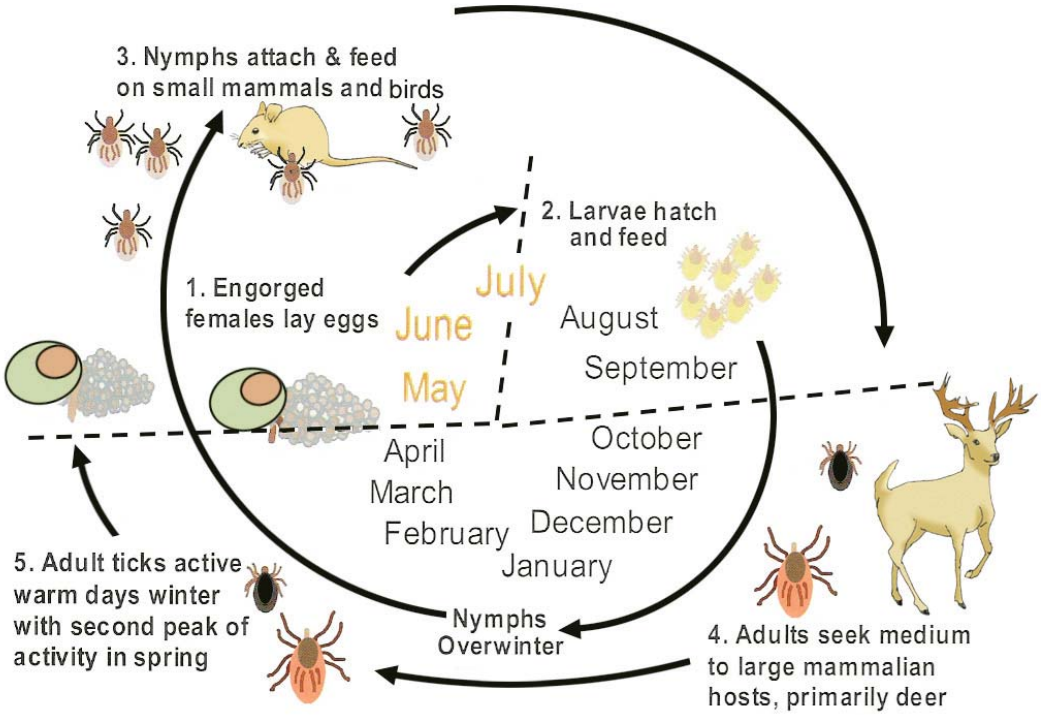

Figure 2.1. Life Cycle of the Black-Legged Tick
Source: Stafford (2007), p. 10

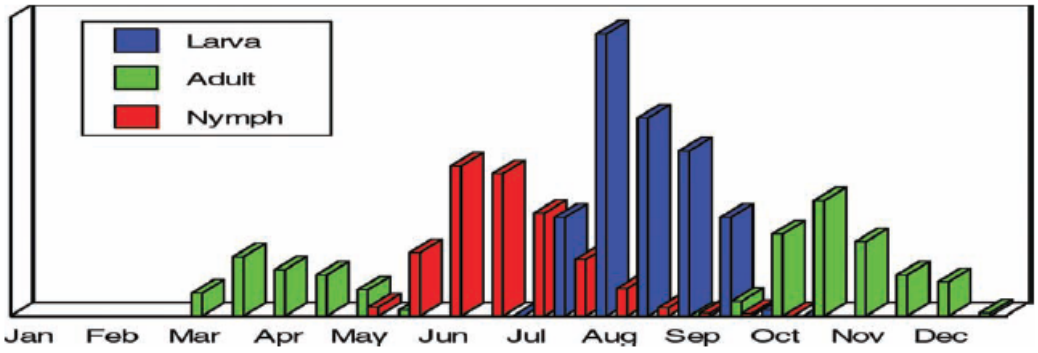

Figure 2.2. Seasonal activity of *Ixodes scapularis* larvae, nymphs, and adults.
Source: Stafford (2007), p. 10

Nymphs molt to adults after feeding and appear in fall of the same year. Adults do not hibernate and may be active on warm winter days and the following spring. Adult infection rates are higher than nymphal rates because the tick has had two opportunities to become infected, once as a larva and once as a nymph.

Although nymphs feed mostly on small mammals and birds, they can feed on any suitable host, including humans. Most cases of TBD occur in the summer resulting from nymph bites. The high level of outdoor activity of humans and the difficulty in seeing the minute nymphs combine to cause this TBD spike.

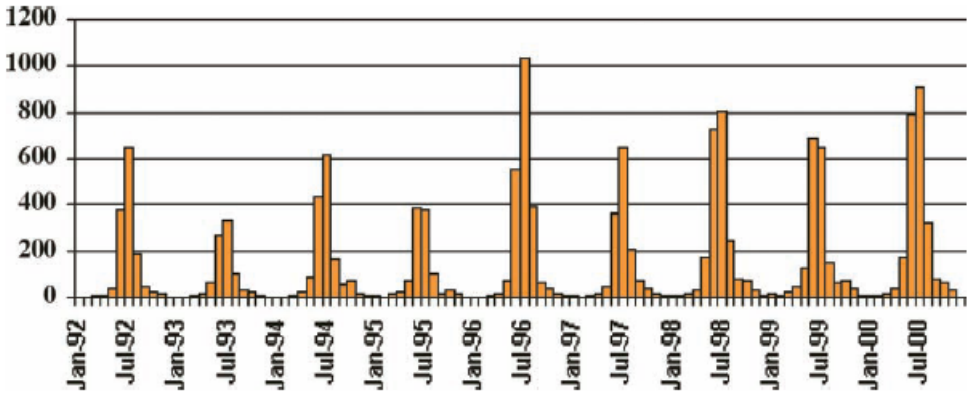

Figure 2.3. Month of Onset of Lyme Disease Symptoms
Source: Stafford (2007), p. 23

Figure 2.3 shows the month of onset of Lyme disease symptoms over a 9-year period in Connecticut. The pattern is relatively consistent from year to year with the greatest number of cases occurring in the summer months when nymphs of the blacklegged tick are active (CT DPH).

B. Tick Varieties in the Northeast

Deer tick/black-legged tick (*Ixodes scapularis*). Transmits agents of: Lyme; babesiosis; ehrlichiosis (anaplasmosis); Powassan encephalitis; and may transmit tick paralysis, tularemia, bartonella.

Figure 2.4. Black-legged/deer tick: nymph and adult
Source: Stafford (2007), p. 11

American dog tick/wood tick **(***Demacentor variabilis*). Transmits agents of: Rocky Mountain spotted fever; tularemia; and may transmit ehrlichiosis (anaplasmosis). Although a small percentage of dog ticks carry the Lyme bacteria, no transmission has been proven.

Lone Star Tick (*Amblyomma americanum*). Transmits agents of: ehrlichiosis (anaplasmosis), Lyme or Lyme-like illness, tularemia, and may transmit tick paralysis and Rocky Mountain spotted fever. This tick rarely is found in Connecticut and lives in coastal areas.

CHAPTER 3. CLINICAL PRESENTATION, DIAGNOSIS AND MANAGEMENT

Lyme disease represents both the leading arthropod-associated (Stafford, 2007) and the most commonly reported vector-borne disease in the United States (CDC website, 2011). Ticks transmit at least eleven diseases including Lyme, and individuals infected with Lyme may be co-infected with one or more diseases. The same tick that carries the Lyme bacteria can simultaneously transmit other illnesses such as babesiosis and anaplasmosis (HGA, formerly known as human granulocytic ehrlichiosis) (Stafford, 2007). A Danbury Hospital antibody research study of Lyme disease patients found a 27% co-infection rate in those patients (Merayo-Rodriguez et al., 2006, p. 1382).

Lyme disease officially was defined and described in 1977 after studies of a cluster of Connecticut children who developed arthritis. Lyme disease has a broad spectrum of manifestations and over time the multi-organ-system nature of Lyme infection has become recognized.

A. Clinical Stages

The clinical manifestations of Lyme disease can generally be divided into stages (early localized, early disseminated, late), as described below. (If the reader finds the following discussion too technical, an excellent basic discussion of the clinical manifestations of tick-borne diseases may be found in Kirby Stafford's Tick Management Handbook, pp. 22-24, Attachment 1.) The clinical features of each stage can overlap and some patients may present in a later stage of Lyme disease without a history of prior signs or symptoms suggestive of earlier Lyme disease. Lyme disease has been called the great imitator, and Lyme disease may go undiagnosed and untreated. It is estimated that only 10-20% of Lyme cases are reported (Stafford, 2007) because of reporting issues and guidelines and failure of diagnosis.

1. Early Localized Disease

Early localized disease may be readily identified with the erythema migrans (EM) ("bull's-eye") rash and nonspecific findings that resemble a viral syndrome. There are estimates that EM rashes occur in approximately 80% of patients, usually within one month following the tick bite. Other estimates note that the classic "bulls eye rash" accounts for less than 20% of all EM cases (Smith R et al, Ann Intern Med. 2002;136, pp. 421-428, Tibbles C, JAMA 2007;297, pp. 2617-27) and 30% of patients never have a rash (MMWR 56(23), pp. 573-576). Less than 25-50% of patients with Lyme disease recall a tick bite. EM lesions typically are found in or near the arm pits, groin, behind the knee, or at the belt line. They are not particularly painful, although EM lesions may occasionally burn or itch, and are hot to the touch. They typically expand slowly over the course of days or weeks, often with central clearing, and may reach a diameter of more than 20 cm. During the first days, EM lesions may be uniformly red. The classic "bulls eye" description of the EM rash usually requires several days to develop. Much less frequently one may see multiple EM lesions at presentation. This is a sign of the spirochetes invading the bloodstream and not multiple tick bites! With the presence of an EM rash, no further verification is needed to start treatment. Other manifestations of early localized disease include fatigue (54%); poor appetite (26%); headache (42%); neck stiffness (35%); muscle aches (44%); joint pains with redness or swelling (44%); lymph node swelling near the bite (23%) and fever (16%) (Piesman & Hayes, 2009).

Note that upper respiratory and gastrointestinal signs and symptoms are uncommon in Lyme disease. Also note that a skin lesion indistinguishable from EM occurs in Southern tick- associated rash illness (STARI), an illness principally found in the southeast and south central regions of the United States. Maryland, Delaware and New Jersey are states in which both Lyme disease and STARI are endemic. Diagnosis of early localized Lyme disease is clinical, i.e., signs and symptoms characteristic of Lyme trigger treatment without corroborative lab studies because antibody studies may not yet be positive.

2. Early Disseminated Disease

Early disseminated Lyme disease with acute neurologic or cardiac involvement usually occurs weeks to several months after the tick bite and may be the first manifestation of Lyme disease. The most frequent neurologic finding is Bell's palsy, presenting with varying degrees of weakness or paralysis of half of the face. It can take weeks to several months to recover, and recovery is often incomplete. Other cranial nerves, especially those involving eye motion, can occur. Other less common neurologic abnormalities include meningitis, balance instability and varying presentations of tingling, extremity weakness and radiating pain. The most frequent cardiac manifestation consists of conduction abnormalities in the form of varying degrees of heart block, sometimes associated with heart inflammation. This can present as dizziness or near fainting. Heart muscle inflammation affecting heart contraction may also occur. In addition to neurologic and cardiac symptoms, various eye and skin manifestations can occur in early disseminated Lyme disease, the latter much more common in Europe.

3. Late Disease

Late Lyme disease occurs months to a few years later after the onset of infection and may not be preceded by a history of early localized or disseminated Lyme disease. Arthritis in one or a few joints is the most common feature of patients with late Lyme disease, but neurologic manifestations due to brain or peripheral nerve involvement may occur. Various neurologic conditions, neuropsychiatric problems and cognitive impairment can also occur. These features are becoming less common, since the majority of patients are diagnosed and treated during the early phase of Lyme disease. Lyme arthritis is characterized by intermittent or persistent arthritis in a few large joints, especially the knee. Fibromyalgia can occur in the aftermath of Lyme disease, perhaps triggered by infection with *B. burgdorferi,* but fibromyalgia is not a feature of Lyme disease itself. The neurologic manifestations of late Lyme disease are different from those in early disseminated disease. A neurologic syndrome, called Lyme encephalopathy, has been reported, manifested primarily by subtle cognitive disturbances. One can also experience shooting pain from the spine and tingling of the distal extremities.

B. Post- Lyme Disease Syndrome and Chronic Lyme Disease

Post-Lyme disease syndrome and chronic Lyme disease deserve special mention. Post-Lyme disease syndrome patients describe symptoms such as headache, fatigue and joint pains that may persist for months after full treatment of documented Lyme disease. For the majority of patients, these symptoms improve gradually over six months to one year. Its etiology is uncertain. Chronic Lyme disease is a term that is used by some practitioners and patient advocacy groups. In its typical usage, it includes the aforementioned post-Lyme disease syndrome as well as illnesses and symptom complexes including fatigue, muscle aches, fibromyalgia and neurocognitive impairment. The controversy over the existence or lack thereof of chronic Lyme disease is not in the domain of the TBDAC.

C. Children at Risk

Lyme disease affects all age groups, but the greatest incidence of disease is in children under the age of 14 and adults over the age of 40. Children often do not take the proper precautions and ticks can be very difficult to spot. In general, the clinical manifestations of Lyme disease in children are similar to adults. The most common manifestation of late Lyme disease is arthritis.

An area generating much interest in the world of Lyme disease is the role that the disease might play in behavioral and psychiatric manifestations in children, both young and old. While the traditional view is that this is not common, the well-respected physician Columbia University professor Dr. Brian Fallon (Director of Lyme Disease Program, Columbia University) has published numerous articles describing Lyme associated behavioral changes in children. Clinical manifestations may include behavioral changes, declining school performance, headache, fatigue, forgetfulness and complex partial seizures. Depression, ADHD, irritability and increased separation anxiety or fears, mood swings and anxiety attacks may also occur. Cognitive problems such as trouble with visual and auditory attention and slower mental processing speed are described. Research is ongoing to better understand this issue.

D. Diagnosis

Lyme disease may be diagnosed clinically (e.g., patient presents with classic EM rash and empirically is treated) or serologically. True Lyme disease incidence is unknown, but estimates suggest that only 10-20% of actual Lyme cases are reported (Stafford, 2007). Factors involved in under-reporting include early laboratory false negatives (i.e. antibodies have not yet formed when test is performed—see below), inconsistent/ineffective reporting mechanisms, provider lack of compliance with cumbersome paperwork, and variation of medical provider familiarity with subtle Lyme symptoms.

Laboratory evaluation of potential Lyme disease involves a two-tier conditional strategy (enzyme-linked immunosorbent assay [ELISA] followed by a Western blot [immunoblot]). A less frequently used C6 peptide ELISA test is comparable to the two-tier Elisa/Western Blot testing. The ELISA essentially is a screening test and is associated with a high rate of false positives. A negative ELISA obviates the need for further serologic testing. All positive or equivocal specimens should be subsequently tested using the

Western blot. The Western blot detects antibodies to individual components of the spirochete (bands) and provides more information regarding which antigens of *B. burgdorferi* are reacting with serum antibodies than the whole cell-based ELISA. Lyme antibodies form in response to spirochete presence in bloodstream (signaled by EM rash). Early antibodies (IgM) typically are produced within one to two weeks of rash; late antibodies (IgG) appear two to six weeks following rash onset. Both types of antibody may remain elevated for years despite successful antibiotic therapy, resolution of symptoms and full cure. Serologic testing for early localized Lyme is not indicated because antibodies may not yet have been produced.

If clinical assessment does not suggest high probability of Lyme disease, serologic screening of asymptomatic patients is not recommended because of false positives and persistence of antibodies despite prior fully treated or spontaneously resolved infections. At least 5% of the normal population will test positive for antibodies to *B. burgdorferi* by ELISA due to cross-reacting antibodies (Piesman & Hayes, 2009). It is not recommended to repeat antibody testing to prove successful Lyme treatment.

E. Tick Co-infection

There are at least eleven tick-human transmitted diseases in the United States (Lyme, HGA, babesiosis, human monocytic ehrliochiosis, Rocky Mountain spotted fever, Colorado tick fever, Southern tick-associated rash illness, Powassan encephalitis, tick-borne relapsing fever, tularemia and tick paralysis). Most relevant in the Northeast are Lyme, HGA and babesiosis. Tick transmission to humans of the bacterium *Bartonella* is controversial. Ticks may be co-infected with one or more organisms and transmit multiple diseases simultaneously.

1. Human Granulocytic Anaplasmosis

A. phagocytophilum (agent of HGA) may be transmitted by *Ixodes scapularis*, the tick that is also the vector of Lyme disease and babesiosis. Like Lyme disease, white tail deer and the white-footed mouse are the principal animal hosts. HGA may present with fever, headache, muscle aches, nausea, vomiting and joint aches. Its symptoms may overlap with those of early Lyme disease. Low white blood cell count, low platelet count and elevated liver tests can help differentiate HGA from Lyme disease. Occasionally, especially when fever is high, a special blood smear and stain may demonstrate the organism in white blood cells. HGA may rarely be associated with significant consequences if treatment is delayed. As many as 33% of ticks in some areas are infected with the agent of HGA. As is the case with Lyme disease, HGA responds to treatment with doxycycline. Unlike Lyme disease, it is not responsive to treatment with amoxicillin or Ceftin. Ticks may be co-infected with the agents of Lyme and HGA, transmitting both diseases simultaneously.

2. Babesiosis

Babesiosis, caused by the parasite *Babesia microti* and other *Babesia* species, can present with fever, fatigue, chills, gastrointestinal symptoms and hemolytic anemia (bursting of red blood cells). It is

transmitted by infected *Ixodes* ticks and is usually found where Lyme disease is also endemic. It may also be acquired by blood transfusion and individuals who have ever been diagnosed with babesiosis are excluded from donating blood. Often asymptomic or presenting with only mild flu-like symptoms, it can cause significant illness, especially in people without spleens or with other significant illnesses. It can be diagnosed by detecting the organism in specially stained blood smears. PCR-based amplification of the babesial 18S rRNA gene is more sensitive than blood smear examination and results can be available within 24 hours if necessary. Treatment of babesiosis is not always indicated. (i.e., treatment with antimicrobial therapy is not deemed appropriate in symptomatic individuals with no babesial parasites on blood smear and no babesial DNA detected by PCR; and in asymptomatic individuals within the first three months following detection of babesial parasites on blood smear or by PCR. Treatment is given to symptomatic patients with babesial parasites on blood smear or PCR; and in asymptomatic individuals with babesial parasites on blood smear or PCR for ≥3 months.

Tick co-infection with Lyme, babesiosis and HGA can result in transmission of more than one illness and can render identification and treatment more difficult.

As discussed in the Metrics Chapter, the TBDAC believes that it is essential to establish a reporting system to more accurately assess the true incidence of Lyme disease and consequently measure the effect of any intervention to reduce Lyme disease with a high confidence interval.

CHAPTER 4. DEER AND TICK-BORNE DISEASE

A. The Association between Ticks and Deer Overabundance

Historical data shows that the resurgence in ticks and Lyme disease is correlated with a high deer population density. Over the last hundred years, deer populations in Connecticut increased from near extinction to an estimated population today that is believed to exceed 120,000. Combined with increased forestation and development patterns, the increased deer population has helped ticks to become more numerous, resulting in increased human cases of tick-borne diseases in recent decades.

Kirby Stafford III, PhD, CT Agricultural Experiment Station (CAES), reports a direct correlation between deer density and tick density (Stafford, 1987). "The abundance and distribution of *I. scapularis* has been related to the size of the deer population. It has been estimated that over 90% of adult ticks feed on deer, each laying ~3,000 eggs. Therefore, deer are the key to the reproductive success of the tick" (Stafford, 1987).[2] As is discussed in this Report, various other hosts also play a role in the life cycle of the tick, particularly the white-footed mouse, but host-targeted intervention studies have generally focused on deer due to the difficulties in targeting rodent populations on a scale broader than individual properties.[3]

White-Tailed Deer Facts (excerpted from Kilpatrick & LaBonte, 2007)

- Most female deer can breed as fawns (6-7 months of age) and produce young at 1 year of age.
- On average, healthy adult does produce 2 fawns annually.
- Deer can live up to 18 years of age
- Deer populations can double every 2-3 years in certain circumstances.
- Deer eat 5-10 lbs. of food daily.

Numerous studies have shown that abundance and distribution of ticks are correlated with deer densities (as cited in Kilpatrick & LaBonte, 2007). Large-scale geographic variation in tick density is correlated with deer density (Rand, 2003), and small-scale deer distribution patterns are also correlated with tick density (Wilson, 1990). However, Ostfeld (2010) makes the case that deer-tick density relationship is sometimes strong, sometimes weak, and sometimes non-existent. We have been unable to confirm,

[2] However, see Ostfeld (2010).

[3] Some products targeting mice, such as the MaxForce bait boxes, have been introduced and proven to be effective in reducing tick populations, and Newtown has used these devices at some public schools. The large number of boxes required to cover a particular area makes them a costly approach (e.g., the cost-per-acre treatment cost of bait boxes has been estimated at $400-600 as compared to approx. $200 for acaricidal sprays and $21 for 4-Posters in their first year of use and $11 thereafter) (Pound, 2009). The long-term availability of bait boxes is also in doubt because their manufacturer has discontinued production of the devices.

however, that geographic variation in tick-borne disease (TBD) incidence is correlated with variation in deer density.

B. Deer Density: Current status in Newtown

Like most of Fairfield County, Newtown's fragmented forests create edge habitats favorable for deer to proliferate. For the last ten years, the deer population statewide has been relatively stable (DEP, 2009). In DEP Deer Management Zone 11, the deer density was estimated to be 81 d/mi^2 in 2000, 51 d/mi^2 in 2003, and 59 d/mi^2 in 2007. DEP Zone 11 aerial surveys of the deer population in Fairfield County performed in 2009 and 2011 (Attachment 3) estimated an average deer density level of 62-75 d/mi^2. Transect 4 of these surveys went mostly through Newtown and estimated the deer density to be ca. 70-105 d/mi^2. Herd health, as estimated by antler beam diameter of yearling males, is considered "fair" (mean=17.5mm) from 1999-2008 in Zone 11. During the last 10 years, the number of deer-vehicle crashes (DVCs) reported to the Newtown Police Department (NPD) has decreased by ca. 20% (though accidents have actually increased by ca. 5%) (unpublished data provided by NPD). Collectively, this information suggests that the deer population in Newtown is overabundant but relatively stable. This stability may be attributable at least in part to the fact that state deer-hunting regulations have been liberalized over the last two decades, especially for deer management in Zone 11, which includes Newtown.

Although the DEP evaluated deer densities four times per transect in 2009 and 2011, there are limits to the usefulness of these large-scale estimates. Because a single transect went through Newtown, the geographic variation in the deer density within Newtown is unknown. It is likely that there are areas where deer densities are higher (e.g., large tracts of prime deer habitat where little or no hunting occurs) or lower (e.g., commercial areas) than 70-105 d/mi^2. As a result, the precise total number of deer in Newtown cannot be estimated accurately based solely on this data, although there are definite indications of overabundance.

C. Deer Reduction Goals

There is no universal deer population density *per se* that should be used as a goal to attain. Rather, deer population density targets and appropriate management methods are a function of the problems caused by deer that a town aims to address. Accordingly, before implementing a deer management plan, it is essential to 1) clearly define the objective(s) of the deer management plan and 2) to carefully monitor the variables of interest (e.g., TBDs, DVCs, landscape damage).

Conducting detailed deer population surveys in Newtown would be desirable for any program to manage the herd, although such surveys are not a necessity given that the true objectives of any deer managements plan are to reduce the conflicts caused by overabundant deer, rather than to reduce the deer numbers *per se*. There are a variety of approaches for measuring deer density ranging in cost from quite expensive to relatively inexpensive. With resources limited, funds and efforts may be better invested in monitoring the desired outcomes (TBD incidence, DVCs, landscape damage) rather than measuring deer numbers. Options for tracking the performance of any deer management programs are discussed at greater length in Chapter 11.

Deer-reduction goals typically address multiple objectives to improve the health and safety of both people and the environment. Those objectives can include reducing TBDs as well as DVCs and promoting the regeneration of growth in the understory of local forests. Towns adopting deer management programs typically combine all three of these objectives in establishing town wide goals in deer reduction.

D. Deer Reduction and Tick-Borne Disease

Because deer are a key species to the reproductive success of ticks (Stafford, 2007), a possible method of reducing ticks and the diseases they can transmit to humans may be to reduce deer populations. If one of the goals of a deer reduction plan in Newtown is the reduction of TBD, the scientific consensus is that deer density must be reduced to a much lower level than the current population to accomplish this goal. A reduction in deer density to 10 d/mi^2 has been demonstrated to result in a reduction in TBD in some studies, although the extent to which marginal reductions in TBD can be realized at intermediate densities has not been scientifically documented. As is discussed below, deer reductions to around this ca. 10 d/mi^2 level have been successful at reducing the incidence of TBDs on islands or small geographically-isolated communities. It should be noted that there is no example to date of a residential community comparable in size and geography to Newtown where a deer population has been reduced and maintained to that level, or where a reduction in deer density has led to a decreased incidence of TBDs.

The main studies that have investigated the effects of deer reductions on ticks and TBDs are summarized below. Overall, the studies show that reducing deer density to below 10 d/mi^2 results in measurable and substantial reductions in the incidence of TBDs.

- Great Island, MA (0.9 mi^2 Peninsula with narrow causeway connecting to Cap Cod). Deer reduction from 32 to 5 deer over a period of 2 years failed to result in a reduction in ticks (Wilson, 1984), possibly because insufficient time had elapsed for the reduction to impact the tick life cycle. A further reduction (Wilson, 1988) to a single surviving deer on the peninsula resulted in decreases of 80% in larval and 55% in nymphal ticks. A continued maintenance of the deer density at ca. 6 d/mi^2 has reduced the cases of TBDs to only 3 cases (for 220 people) in 6 years (Telford, 2002, as cited in Stafford, 2007).

- Ipswich, MA (2.2 mi^2 barrier island, Crane Memorial Reservation) (Deblinger, 1993). Deer reduction from 160 to 27 d/mi^2 over a 7-year period resulted in a decrease in larval and nymphal ticks of 50 and 41% respectively. Because the study was done on a wildlife preserve, the effect of the deer reduction on the incidence of TBD could not be evaluated.

- Monhegan Island, ME (0.9 mi^2 island) (Rand, 2004). Deer were eradicated over a period of 28 months, from an initial population of ca. 96 d/mi^2. The result was the gradual disappearance of ticks (all life stages). The island had too few year-round residents to have meaningful results on disease incidence, but Lyme disease was essentially eliminated.

- Mumford Cove, Groton, CT (0.4 mi^2 coastal community) (Kilpatrick & Labonte, 2003). Deer reduction from ca. 100 d/mi^2 to 10 d/mi^2 was associated with a decrease in Lyme disease cases from 30 to 2 cases out of ca. 100 households actively surveyed. Since the publication of the study, the Mumford Cove deer committee has continued to monitor the incidence of TBDs, and has

reported less than 3 cases per year (the number of households surveyed is unknown). Incidence of Lyme disease has thus decreased by more than 90%.

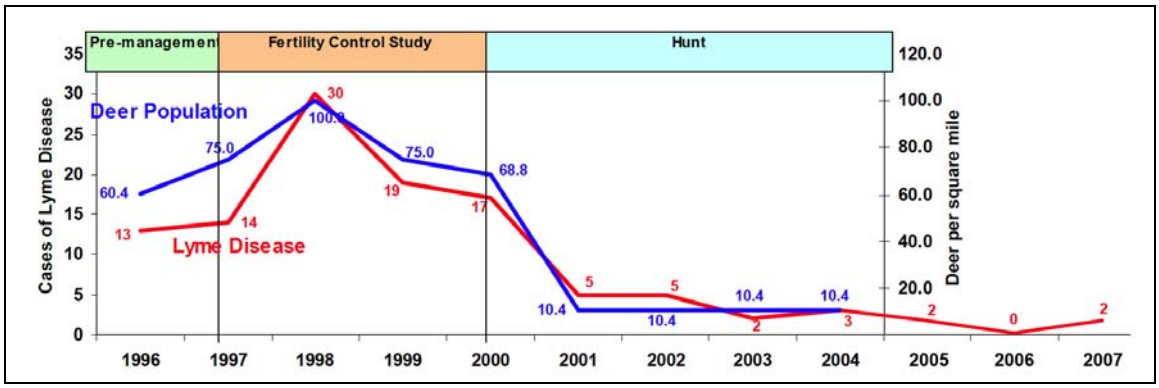

Figure 4.1. Changes in deer density and cases of Lyme disease in Mumford Cove, CT 1996-2004
Source: Kilpatrick & Labonte, 2003

- Bernards Township, NJ (24 mi^2, suburbia) (Jordan et al., 2007). Deer reduction from 119 to 63 d/mi^2, over a period of 3 years failed to detect changes in tick density or incidence of Lyme disease. Because of the 2-year life-cycle of ticks, there may not have been sufficient time for the deer reduction to produce measurable effects on ticks and diseases. The deer population has been further reduced since the publication of the study, and a follow-up study on tick density and disease incidence is in progress. Because the follow-up study will provide a scientific assessment of the results of a community-scale deer reduction program that has been underway for several years in a municipality that is geographically similar to Newtown, its results will be of significant interest when available. A 2011 aerial survey estimated that there were 46 d/mi^2 in Bernards Township (Bernards Township Aerial Survey, 2011; Bernards Township Deer Management Advisory Committee Minutes, May 9, 2011) and it appears that the deer reduction did not affect ticks or TBD as of Summer 2011 (Dr. Jordan, personal communication).

- Bridgeport (0.7 $mi^{2)}$/Bluff point (1.25 mi^2) CT (Stafford, 2003). The study was conducted at two sites: an enclosed business park in Bridgeport and a coastal preserve in Bluff Point. Both sites had very high deer (>230 d/mi^2) and tick densities before the start of the study. Deer reduction programs at these sites, from 1992 to 2002, reduced deer densities to 25-45 d/mi^2. Tick densities declined by 90% and were correlated to deer density 2 years prior at the Bridgeport site (but not at the Bluff Point site). The deer density and tick density were reduced to levels similar to the surrounding towns. Because these studies were done in uninhabited parcels of land, the effects on disease incidence could not be evaluated.

Expert opinion varies on the suitability of deer management as a tool for TBD reduction. The CT DEP's *Managing Urban Deer in Connecticut* pamphlet states that "Deer population management must serve as the main tool in any long-term strategy to reduce human incidences of Lyme disease," citing remarks by Dr. Sam Telford of Tufts (Kilpatrick & LaBonte, 2007, p. 3). However, Dr. Richard Ostfeld, Cary

Institute of Ecosystem Studies, has suggested that it would be "false advertising" to promote deer hunting as a tool for reducing TBD (his remarks to committee members indicated that this comment related to the practical difficulties of reducing deer density to a sufficiently low level) (Ostfeld, personal communication).[4] Other researchers have similarly questioned whether deer populations can be reduced to a level sufficient to reduce TBD (Schulze & Jordan, 2006; Fish & Childs, 2009).

Stafford, generally acknowledged as one of the leading experts on the spread and control of TBD, has made differing statements regarding deer reduction and TBD concerning his viewpoint that deer reductions also reduce tick populations, although it may difficult to reduce deer populations sufficiently to reduce TBD significantly:

- "Although deer and tick reductions have been successfully carried out on some islands, peninsulas or some other defined geographical tracts, it is not clear if a deer population can be reduced sufficiently to achieve a satisfactory level of tick control in more densely populated areas on the mainland. Conversely, unregulated deer populations may potentially lead to an increasing tick population. Lethal management options for deer are effective, though controversial, while the use of anti-fertility agents remains experimental and labor intensive. A community that wishes to implement a deer management program, especially in densely populated urban and suburban areas must deal with hunting restrictions, real or perceived safety or liability concerns, and conflicting attitudes on managing wildlife. Since most land in the northeast is privately held, homeowner views and hunter access are important to deer management. Any deer population control program would require an initial reduction phase to lower high densities of deer and a maintenance phase to keep the deer population at the desired targeted level. Deer capacity for reproduction is high and deer herds can potentially double in size in one year. Management would be an ongoing process" (Stafford, 2007, p. 56).

- "With the exception of some islands, it is unlikely deer numbers can be reduced and maintained at a level sufficient to impact the rate of tick-borne disease" (Stafford, 2001, p. 4).

- "Deer are important hosts for the ticks. The adult tick feeds primarily on white tailed deer; an estimated 95% of adult female ticks that are laying eggs are coming off white tailed deer. There are other hosts the adult tick feeds on, but they do not play a major ecological role. When you reduce the deer population, and numerous studies have shown this, you will reduce the tick population and therefore your risk of encountering a tick. If the tick population drops below a certain threshold, you won't have a sufficient number of ticks feeding on the mice carrying the Lyme disease spirochete to maintain transmission between the ticks and the mice and you actually break the disease cycle. The overabundance of deer clearly affects the Lyme disease issue. If you reduce the deer, you will reduce ticks" (Stafford, undated video).

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[4] Dr. Ostfeld has stated that deer management may be an appropriate vehicle for addressing forest diversity goals, however.

- "A deer density below 10 to 12 deer per sq mile could decrease the tick population to a level that would reduce the burden of Lyme disease in a community" (Stafford, 2008 letter).

The Lyme disease web page of the Centers for Disease Control until recently also discussed the management of deer population and movement as a Lyme disease prevention technique. The CDC's web page cited the studies discussed above that: (1) the complete eradication of deer on certain islands had been shown to greatly reduce tick populations; (2) the incremental removal of deer in certain coastal communities had been shown to reduce tick populations, though it remained unclear to what level deer populations needed to be reduced to substantially reduce the risk of TBD; and (3) that an incremental reduction of deer population in a mainland community did not correspond to a reduction in tick populations, although it was unclear whether the study had allowed sufficient time to elapse to measure an impact. The CDC also cites Stafford's *Tick Management Handbook* (Attachment 1).

These differences of expert opinion primarily concern the question of the practical ability of municipalities to reduce deer populations to the low density level associated with a reduction in TBD. There is little disagreement on the basic proposition that reducing deer density to 10 d/mi^2 or so would result in a significant reduction in tick populations and thus TBD risk. However, the impact of incremental deer reduction on TBD is less clear. Dr. Telford suggested that any reduction in deer density may have beneficial effects on reducing TBD incidence by reducing tick numbers in marginal habitats but there is no empirical data to support his hypothesis (personal communication). Other experts have instead suggested that, "the complete elimination of deer as hosts for ticks seems to be required for effective vector reduction and subsequent Lyme disease prevention" (Fish & Childs, 2009, p. 361) (although Fish and Childs do not acknowledge Great Island, MA and Mumford Cove where there are continuing deer populations that remain at low densities 6-10 d/mi^2).

E. Deer Reduction Programs in the Fairfield County and the Northeast

Many towns in Fairfield County and the broader region have considered questions of TBD and deer-related concerns and implemented programs to reduce deer populations. Newtown thus has the advantage of drawing on the experiences of these other communities.

Deer reductions to approximately 10-12 d/mi^2 have been successful at reducing the incidence of TBDs on islands or small geographically-isolated communities, but there is no example of a residential community comparable in size and geography to Newtown where a deer population has been reduced and maintained to that level, or where a reduction in deer density has led to a decreased incidence of TBDs. It is possible that it is impracticable to reduce deer to the requisite level in suburban/exurban landscapes like Newtown. Anthony DeNicola, PhD, President, White Buffalo (Appendix A), has advised that deer reductions tend to become substantially more costly and increasingly difficult exponentially beginning at density levels of ca. 40 d/mi^2). Alternatively, since most municipal deer management programs in the region were implemented within the last 10 years or less, it may be too early to evaluate their success against TBD. The towns with established deer reduction programs realize that it will take many years to accomplish the goal of ca. 10 d/mi^2. For example, a recent Tick Borne Disease Committee on the island of Nantucket estimated that their recommended deer management program would take 12-18 years to reduce deer to

the desired level. The representatives of nearby deer management programs who addressed our Committee feel they are on the right track and each year continue/renew their deer reduction programs.

There are multiple examples of residential communities geographically similar to Newtown (although smaller in surface area) where deer reductions, usually attained through sharpshooting programs, have led to substantial decreases in DVCs, as is discussed below. Examples of sharpshooting programs resulting in significant deer reductions (DeNicola & Williams, 2008) include:

- Iowa City, IA (6 mi^2). Deer density reduced from 62 to 15 d/mi^2 in 3 years.
- Princeton NJ (14 mi^2). Deer density reduced from 115 to 32 d/mi^2 in 6 years.
- Solon OH (20 mi^2). Deer density reduced from 70 to 33 d/mi^2 in 2 years.

Other sharpshooting programs under way include: Mt. Lebanon, Upper Saint Clair and Solebury Townships in PA, conducted by the Wildlife Services division of the USDA; Fox Chapel, PA, by the local police; and Sea Pines, SC conducted by the resident wildlife biologist. There is also anecdotal evidence that such programs have made progress in creating conditions for a healthier forest and reemergence of plants and animal species.

Some of the most notable deer reduction programs outside Fairfield County have taken place on coastal regions, including Mumford Cove, CT, Monhegan Island, ME and Great Island, MA. As discussed above, Mumford Cove, CT (ca. 0.5 mi^2) was able to reduce its deer density from 77 to 10 d/mi^2. This was associated with a reduction in TDB from 30 cases per year to less than 2 cases per year (out of ca. 100 households). By reducing deer populations below the 10 d/mi^2 level, these communities have demonstrated success in reducing ticks and the human incidence of TBDs, although the small size and relative geographic isolation of these communities makes it uncertain whether their results can be replicated in more challenging terrain.

In terrain more similar to that of Newtown, Bernards Township NJ (24 mi^2) has been able to substantially reduce its deer population, from 118 d/mi^2 in 2002 to 46 d/mi^2 today through a controlled hunting program. There is no indication that the Bernards Township program has had any effects on ticks or TBD. An evaluation three years into the program found no reduction in ticks or TBD (Jordan et al., 2007). A follow up study is in progress and it appears that the deer reduction did not affect ticks or TBD as of Summer 2011 (Dr. Jordan, personal communication). Bernards Township is a typical suburbia with double the human and housing density than Newtown, with open spaces concentrated into well-defined areas.

At Shelter Island, NY, an island at the east end of Long Island with an area of about 12 mi^2, a form of controlled hunting program was initiated in 2006 and has harvested nearly 1,400 deer during its first four seasons of operation (an annual average of more than 28 d/mi^2, which compares favorably to the harvest results from professional sharpshooting programs), resulting in an estimated deer density between 33-46

d/mi^2 as of Spring, 2008.[5] The program is administered by the chief of police and uses entirely local volunteer hunters. The program makes extensive use of "Deer Damage Permits" issued by the New York Department of Environmental Conservation, allowing deer to be harvested out of season, at night, over bait, and with spotlights. The deer-reduction program's main expense is paying a part-time clerk.

Specifically within Fairfield County, several other towns have considered issues associated with deer overpopulation, whether through dedicated committees or otherwise,[6] including:

- Darien (committee formed 1997)
- New Canaan (committee formed 1998)
- Wilton (report published 2003)
- Greenwich (report published 2004)
- Ridgefield (report published 2005)
- Redding (deer management plan adopted 2005)
- Weston (report published 2006)
- Brookfield (deer management plan adopted 2008)
- Fairfield (report published 2009)

With the exception of Weston, each of these town committees recommended and adopted some form of lethal deer reduction program. These deer management programs have generally focused on opening town-owned land to controlled hunting. Greenwich also conducted a one-time sharpshooting hunt in 2005 and a private group of individuals in Redding has also started a program to increase hunting on privately held land, as is discussed below. The findings and results from these committees are summarized in Chapter 10 and discussed in detail in Appendix B. The underlying committee reports are available online and in our Committee records. Regional groups such as the Housatonic Valley Council of Elected Officials (HVCEO), a regional coordinating body, and the Fairfield County Municipal Deer Management Alliance (FCMDMA), a group dedicated to the promotion of deer reduction programs, are also involved with deer management and/or TBD reduction efforts.

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[5] A recent study (Curtis et al., 2011) estimated that deer density increased to about 160-300 d/mi^2 by 2010 in some areas of the island, but the TBDAC preliminary analysis suggests that those estimates may be seriously flawed.

[6] The other Fairfield County towns that have formed relevant ad hoc committees generally constituted them as deer management committees rather than tick-borne disease committees. Not all committees produced formal reports.

Ridgefield offers an example of a tightly run, low-cost deer management program. The Ridgefield program is run by volunteers. Hunters provide their own bait, stands, etc. Ridgefield has the highest deer harvest in the State, has reportedly never lost a deer, and has a perfect safety record with no accidents. Ridgefield sets much higher level of expertise for hunters to participate in their controlled hunt than the State does for license certification. Currently there are more hunters applying to the Ridgefield hunt program than Ridgefield is willing to accept (Belote, Appendix A). The only cost incurred for the program was the cost of reusable signage on the properties being hunted (approximately $1,000). Controlled hunts are also regularly being conducted in Weston, Redding, and Brookfield, at minimal cost. In addition, Fairfield, CT and Westchester County, NY will now be starting controlled hunts. They are both looking to Ridgefield for guidance and direction.

There is no direct evidence to date concerning the effectiveness of these programs in reducing TBD because no Fairfield County town has conducted formal monitoring programs on TBD incidence, tick density or deer density since adopting their respective deer management plans, presumably due to the cost of such monitoring. Members of the municipal deer management groups in Wilton (Pat Sesto, Wilton Director of Environmental Affairs) and Ridgefield (Tom Belote) indicated to the TBDAC that they do not believe that deer populations to date have been reduced to the level associated with a reduction in TBD. However, they reported anecdotally that other beneficial changes have resulted from their programs (such as forest regeneration) and that they believe that reductions in TBD may result in the future, possibly with regulatory changes and/or permissions designed to allow additional hunting (Appendix A).

Data collected by the CT DEP can be used as a rough (though imperfect) barometer of deer population in the absence of more precise data. The DEP conducts periodic aerial deer density surveys, and the last such surveys in 2009 and 2011 focused specifically on Fairfield County due to its high incidence of deer-related problems. The surveys included six transects, each of which included portions of two or three towns. Estimated deer densities for the various transects averaged 62-75 d/mi^2 and ranged from a low of 48 d/ mi^2 for a transect including portions of Monroe and Shelton in 2009 to a high of 105 d/ mi^2 in 2011for a transect including portions of Newtown and Bethel. The transects including towns with established deer management programs did not show deer density levels that were significantly different from the County average. A transect including portions of Ridgefield and Redding, for example, had 62-64 d/mi^2, and a transect including portions of Greenwich, Stamford and New Canaan had 60-83 d/mi^2. These transects are only snapshots of a portion of each studied area, and thus are an imprecise gauge of actual deer population levels.

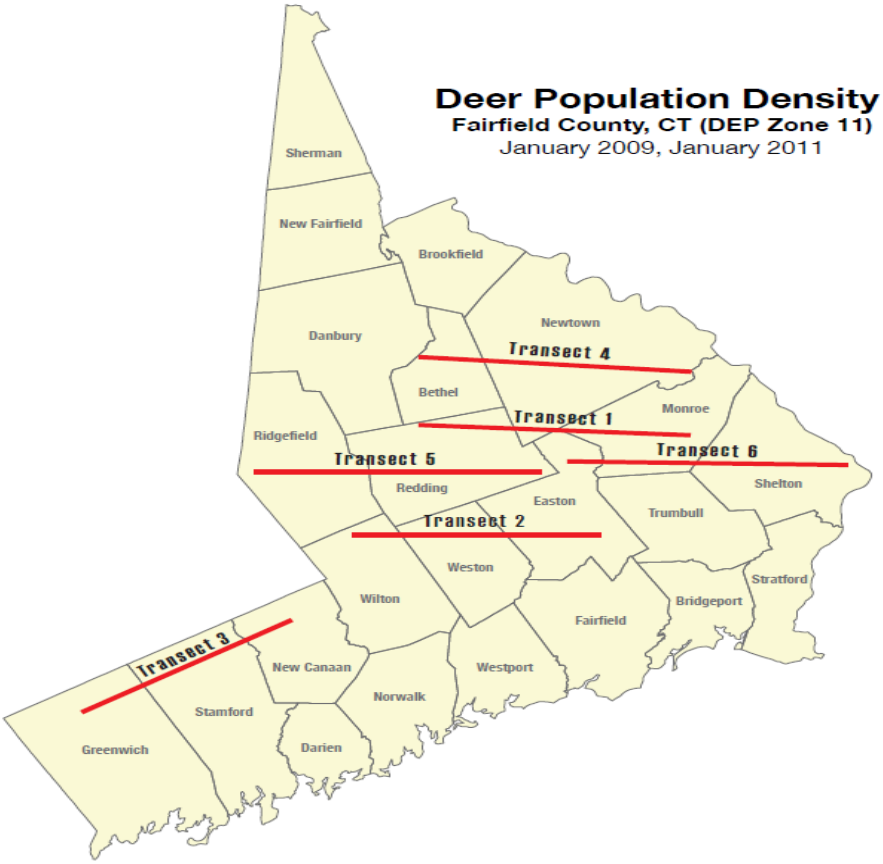

Table 1. Observed and estimated (corrected) deer density estimates for Deer Management Zone 11 (Fairfield County), January 2009.

Mean Deer per sq mile	Transect							90% Confidence range
	1	2	3	4	5	6	Overall	
Observed	31.8	33.8	29.8	34.8	31.8	24.0	30.9	26.9 - 34.8
Corrected	63.6	67.6	59.6	69.6	63.6	48.0	61.8	53.9 - 69.7

Table 2. Observed and estimated (corrected) deer density estimates for Deer Management Zone 11 (Fairfield County), January 2011.

Mean Deer per sq mile	Transect							90% Confidence range
	1	2	3	4	5	6	Overall	
Observed	37.2	28.5	41.25	52.25	30.75	36.75	37.7	30.8 - 44.76
Corrected	74.4	57	82.5	104.5	61.5	73.5	75.4	61.6 - 89.5

Figure 4.2. Data from CT DEP aerial surveys 2009 and 2011.
Source: Connecticut Department of Environmental Protection, Franklin Wildlife

"The transect that included Newtown and other towns in 2009 indicated a deer density of approximately 70 deer per square mile. In 2011 approximately 105 deer per square mile were observed on this same transect. Based on a statistical analysis of deer counted on all transects in 2009 compared to 2011, deer densities in Fairfield County did not change. A third survey planned for 2013 should provide more insight to trends (increasing, decreasing, stable) in the Fairfield County deer population.

"Winter conditions were more severe in 2011 compared to 2009, which appeared to cause deer to group into larger herds. With only 2 data points (2009 and 2011) it is difficult to conclude if the increased deer count in 2011 was due to an increase in the deer population or due to the 'grouping effect' caused by deep snow conditions." (Dr. Kilpatrick, DEP, personal communication)

The DEP also collects data on annual hunting activity in each town that can be used as a rough proxy for the intensity of deer reduction efforts, although the DEP data understates actual deer hunting for each town because a substantial amount of hunting activity in each town is believed to go unreported (Kilpatrick, personal communication). The DEP data shows that the towns with deer management programs generally see an increase in annual deer harvested of roughly 2-3 d/mi^2. Figure 4.2 compares the average annual deer harvest in Newtown with neighboring towns that have adopted deer management programs:

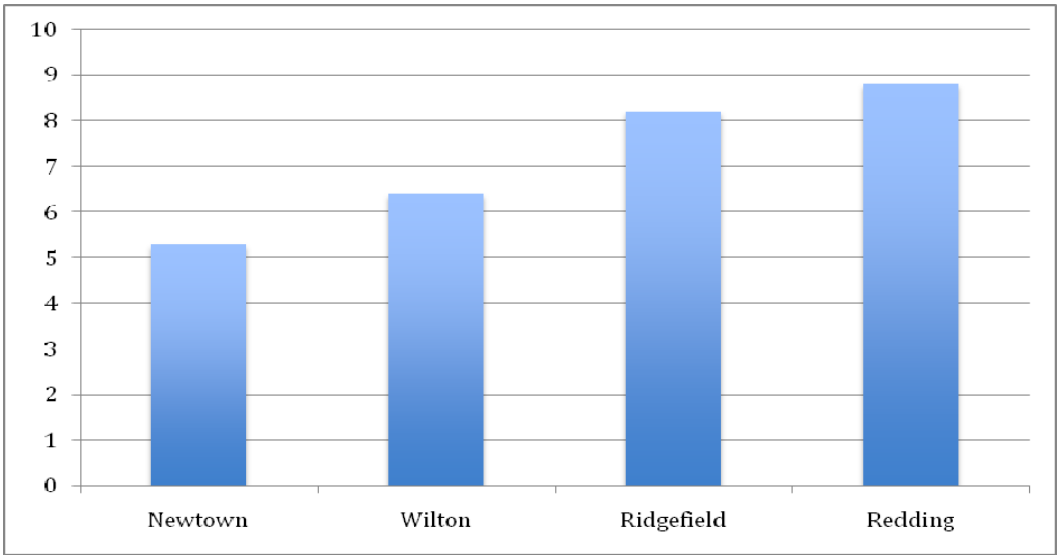

Figure 4.3 Deer Harvest per Square Mile, 2005-2009 **(**from CT DEP data)

It is unclear whether this level of increased hunting is likely to result in an eventual reduction of deer density levels to the point where reduced TBD would be expected. If so, it would require a long-term and sustained effort.

F. Deer Management & Community Values

Deer management is a controversial issue that often generates strong views from all sides. DeNicola (Appendix A) emphasized that an effective deer reduction plan inevitably requires large monetary and time investments and will never occur unless Newtown residents are seriously concerned by the consequences of deer overabundance. Sesto, emphasized that people may not be aware of the relationship between deer populations and TBD, DVCs and the condition of the forest (Appendix A). Dr. Randall Nelson, Epidemiologist, Connecticut Department of Public Health (DPH), stated that whether any town adopts a deer management program (or any other effort to mitigate TBD) depends on the particular values of that community (Appendix A).

Other towns have assessed community concerns about TBD and deer management through professionally conducted community surveys, including New Canaan in 2000 and Wilton in 2002. These surveys showed that the citizens of those towns had serious concerns regarding TBDs, DVCs and damage to their forests and that substantial majorities (approximately 75%) supported a lethal or nonlethal deer reduction

program. In the 2007 The Way Things Are in Newtown survey, Lyme disease ranked in the top tier of concerns that the town was facing, with 8 in 10 households reporting someone receiving a tick bite and 48% reporting that someone in the household had been treated for Lyme disease.

Before deciding to implement any of the options outlined below, the TBDAC recommends that a professional, scientific survey be conducted to evaluate the attitude of Newtown residents toward the deer population, costs associated with various TBD mitigation options and other purposes (as discussed further in other Chapters of this Report).

G. Options for Deer Management

1. Prefatory Notes

Note 1. Land access is a key issue for any deer management program. Most of the land in Newtown is privately owned by individuals or corporations (ca. 50 mi^2); the remainder (10 mi^2) is qualified as open spaces. Hunting can be conducted on private land subject to the approval of the landowner, but some landowners may be unaware that hunting is legal on their property, or may prefer not to allow hunting on their land. According to David Streit (BeSafeRedding.org, a volunteer group that promotes hunting on private property) and Dr. DeNicola (White Buffalo, a professional deer management entity), many landowners who would have never considered allowing hunting or sharpshooting on their property can be persuaded to do so by being educated about the hunting process and the potential benefits of deer population reductions (Appendix A).

The largest public open space in Newtown is the Paugussett State Forest (ca. 3 mi^2), where hunting is already allowed. The largest private landowner of open spaces in Newtown is the Newtown Forest Association (multiple parcels totaling ca. 2 mi^2) that currently prohibits hunting on its properties, although its Board of Directors is open to the possibility of allowing deer reduction measures on its properties. Hunting is also allowed on the Aquarian Water Company property now managed as part of the Centennial Watershed State Forest. Newtown Town-owned open spaces account for a total of ca. 2 mi^2; an unknown number of these parcels cannot be hunted because of deeds with no-hunting clauses (the actual number of such deeds has not been enumerated).

Note 2. The ease/difficulty of reducing deer density is not a matter of simple arithmetic, and the efforts and costs required are difficult to estimate. Reducing a deer population from a density of 70 d/mi^2 to 40 d/mi^2 is substantially easier than reducing it from 40 d/mi^2 to 10 d/mi^2, even though the absolute number of deer removed is equal in number. The lower the deer density, the more difficult it becomes to reduce the density any further because the man-hours required to capture or kill each deer increases in an exponential manner as the deer density decreases and volunteer hunter participation declines as hunting difficulty increases (DeNicola, 2010; Van Deelen & Etter, 2003). The ability of deer to increase population quickly under normal circumstances also contributes to this phenomenon.

Note 3. While there are various difficulties and uncertainties concerning the practical ability of towns to reduce TBD significantly through deer management programs, some have suggested that the most difficult step toward this goal is to initiate a management program.

Note 4. The options outlined below are not exclusive of each other. They can be and often are combined to complement each other to accommodate the different human activities and the different restrictions associated with various private and public land parcels.

Note 5. Any deer management program must be maintained continuously and methods can be adjusted to suit changing conditions.

Note 6. The relationship between TBD and deer management is discussed in various governmental materials available online, including the CT DPH (http://www.ct.gov/dph/cwp/view.asp?a=3136&q=395590), the CT DEP Wildlife Division (http://www.ct.gov/dph/lib/dph/urbandeer07.pdf) and the CAES (http://www.ct.gov/caes/lib/caes/documents/publications/bulletins/b1010.pdf)

2. Non-Lethal Options

Option 1: Trap and transfer: This method consists of trapping deer and transporting them to a remote location where they can be released into the wild. This method is unfeasible, because, among other issues, most states (and Canada) will not allow the importation of deer. In addition, studies show that significant percentages of the deer do not survive the stress of the trapping operation, or have a very high mortality rate after being released.

Option 2: Deer Contraception: Although progress has been made in about 30 years of research and development, deer contraception has not reached the stage where even its proponents consider it an effective method for reducing a population of free-ranging deer to the level at which reduced TBD would be expected. The primary difficulty is that while reasonably effective contraceptive agents have been developed, it is extremely difficult and expensive to attempt to treat an entire population.

There are two leading types of deer contraceptives. One is GonaCon™, developed by the United States Department of Agriculture (USDA). It gained EPA approval in late 2009. The USDA advises its use only when a deer herd has been reduced significantly. The other is PZP (porcine zona pellucida), which has been under development by the Humane Society of the United States for many years and is expected to be submitted for EPA approval in 3-5 years.

In field tests at relatively small sites using PZP, suburban deer populations have been stabilized and modestly reduced (20-50%) over periods of 5-10 years. In these tests, stabilization of deer populations was achieved relatively quickly, but populations were reduced only gradually (5-10% per year) (Rutberg & Naugle, 2008; Rutberg, Attachment 6a-b). The effectiveness of any contraceptive program will be subject to the limits of both the efficacy of the contraceptives themselves (the current contraceptives are only about 80 to 90 percent effective, leaving 10 to 20 percent of the treated deer able to continue to reproduce) and the ability to treat as many does as possible (because it is extremely unlikely that 100 percent of the population would be caught and treated, the untreated population continues to reproduce and increase, as though it were a miniature herd). Tests of PZP on wild horses have required treatment of 45-84% of the population to achieve population reductions when using a 95% effective contraceptive agent (Kirkpatrick, 2009.) Even with success at treating an entire herd, deer can live 12 or more years

(and contraception could extend deer lifespan by contributing to better health), so actual reduction of the population would take years.

Contraception is expensive. Depending on the formulation used, contraceptive dosages can range from as low as $20 to as high as $230 per dose, although the labor involved in capturing and treating the deer makes up the bulk of costs (when treating deer with current contraceptives, it has been necessary to capture the deer). The cost of treating a deer population the size of Newtown's would rise into the millions of dollars over the life of a program, entailing initial costs in the mid six figures at minimum in the program's initial years and continuing costs in the six figures annually thereafter. The current contraceptives are considered effective for 3-5 years, so "booster" shots would be needed at some point. In order to identify which deer have been treated, all captured deer would need to be tagged or otherwise identified. (Rutberg, Appendix A)

As with other methods of deer management, any contraceptive efforts would rely on gaining access to the land. In Newtown, this would mean obtaining permission from hundreds of private landowners.

Potential Contraception Field Test: The leading proponent of PZP contraception in deer is Dr. Allen Rutberg, a Tufts University professor and consultant for the Humane Society of the United States (HSUS). For more than 15 years, he has been conducting field trials at various sites such as Fire Island, NY, NIST in Gaithersburg, MD and Fripp Island, SC. Rutberg is preparing to conduct an additional PZP field trial and is in the process of exploring potential sites (ca. 2-4 mi^2) in several towns in the Northeast, including Newtown. Dr. Rutberg visited several Newtown sites in 2010 and advised the TBDAC that the Fairfield Hills campus is potentially suitable for his field trial if Newtown is interested in hosting such a trial. While the bulk of the funding for such a field test would come from the HSUS, it would also require an annual contribution from the town of approximately $10,000 (possibly through a mix of public and private sources). The study site could not be hunted while the trial is being conducted, although other TBD mitigation efforts such as 4-Posters (discussed below) could be used on the site. Rutberg estimated that it might be possible to reduce the deer population in the study area to around 40 d/mi^2 over several years. He estimates that a PZP vaccine will be ready for EPA approval in 3-5 years. (Rutberg, Appendix A)

Option 3: Deer Sterilization: Surgical sterilization is effective in preventing reproduction, and it has been practiced in some limited situations. It is the most expensive of any method of deer management, since it requires capture and anesthesia, veterinary surgery and release. Unlike contraceptives, which can lose effectiveness, sterilization is a permanent method of defeating reproduction.

Notable examples of deer sterilization include Cornell University's campus at Ithaca, NY; Highland Park, IL; and a suburb of St. Louis, MO (the City of Town & Country). At Cornell, deer on campus were captured and underwent surgery at the veterinary school on campus. However, the veterinary school has not been able to keep up with the number of deer that can be captured (Curtis, private communication). In Cornell's lands just off-campus, the university uses controlled hunting for deer management (Curtis & Boulanger, 2010). In a 4-year project at Highland Park ending in 2005, some 67 does were sterilized (MacLean et al., 2006). At St. Louis in 2009, 112 deer were sterilized (Allington, 2010).

At Highland Park and St. Louis, the surgeries were performed in mobile operating facilities, such as a specially equipped ambulance or a trailer. Dr. DeNicola, who conducted the St. Louis program, estimates that sterilization is only about 20 percent more expensive than contraception, yet it means the deer will never need recapture or booster treatments. (DeNicola, Appendix A)

Sterilization of an entire deer population the size of Newtown's would not be feasible, as the cost would certainly run into several million dollars (costs of the Cornell sterilization program were approximately $1,075 per deer even with no cost for the donated veterinary services). Where sterilization may be effective are circumstances when a herd can be geographically isolated or kept in captivity (e.g., the Milwaukee Zoo was successful in reducing 12 deer to two, using sterilization).

As with other methods of deer management, any sterilization efforts would rely on gaining access to the land. In Newtown, this would mean obtaining permission from hundreds of private landowners.

3. Lethal options for deer reduction

Option 1: Promote recreational hunting: State deer-hunting regulations have been liberalized over the last two decades, especially for private land in Deer Management Zone 11, which includes Newtown. The harvest of antlerless deer (does and "button bucks") is theoretically unlimited, although a practical limitation is the requirement to bring the harvested deer to a check station to obtain replacement tags (there is no check station in Newtown; the closest ones are in Danbury, Oxford and New Milford). The use of bait is allowed on private land.

On private land, the bowhunting season is 5.5 months long (Sept. 15 to Jan. 30); the firearms (Nov. 17-Dec. 7) and muzzleloader (Dec. 8-30) seasons are 3 weeks long. The liberalized hunting regulations contributed to the stabilization of the deer population since 2000 (Kilpatrick, personal communication). The number of deer harvested by recreational hunters in Newtown, as reported to the DEP, is ca. 300/year, which is among the highest totals in Connecticut on an absolute basis, although Kilpatrick (personal communication) estimates that the actual harvest is probably 3 times higher due to underreporting by hunters.

Recreational hunting in Newtown may be limited by a number of factors, the most important one being access to land where deer are abundant. Bowhunting range is limited to 30-40 yards and generally results in a lower success rate and higher wounding rate than firearms hunting (Pederson, 2008). Deer often travel more than 100 yards after being fatally shot by an arrow (Nat. Bowhunter Ed. Assoc., 2001). As a result, deer shot on properties less than 3 acres have a high probability of dying on a neighboring property (3 acres = 120 x 120 yards). Recreational firearms hunting in Newtown is limited by property size; State regulations forbid the use of firearms within 500 feet of a building and limit the use of center-fire rifles to properties 10 acres or more.

Because most of the land in Newtown is privately owned, a significant increase in the deer harvest by recreational hunters must include an active recruitment of private landowners. Some options already exist to match recreational hunters with property owners (e.g., http://www.findahunter.com, whitetailsolutionsllc.com), but these options are not well known by the public and, while available to Newtown residents, are not specific to Newtown. Programs such as BeSafeRedding and WhiteTail

Solutions LLC (a deer management consulting organization) have reported success in gaining access to properties from many landowners whom had been reluctant to allow unknown hunters onto their land. Other logistical difficulties that may also limit the harvest of deer through recreational hunting are the lack of a local deer check station and of local educational resources that can encourage hunting.

Newtown could adopt a variety of measures designed to increase the harvest by recreational hunters on private land. For example, the Town could maintain its own website to match hunters with landowners and actively recruit landowners (the Town should carefully screen and monitor the participating hunters to maximize safety and obtain the confidence of landowners to allow the hunters on their property). The Town could seek to reduce the cost and time commitments required to hunt by establishing a local deer check station and/or by subsidizing the cost of venison processing (i.e., the Town could pay butchering costs for meat to be donated to local food banks). The Parks and Recreation Department could offer courses that would help recruit new hunters (e.g., archery classes, "how-to-hunt" classes, venison butchery classes, DEP-mandated hunter safety education courses). The Town could also engage in public promotional campaigns to encourage hunting (e.g., by characterizing hunting as a public service) or to encourage venison consumption (e.g., by promoting "Venison Thursdays" on which residents are encouraged to consume venison from locally hunted deer).

Advantages

1. Low cost, but not necessarily free. Need a program manager (may be a volunteer), a hunter screening process and other administrative costs.

2. Pleasing to local hunters. Satisfactory for some landowners and perhaps to the Newtown Forest Association.

3. Potential for positive effects (reduced DVCs and browse damage) on hunted properties and their neighboring roads/properties.

Disadvantages

1. Relatively low harvest of deer by recreational hunters may result in negligible decrease in deer population density. There is no example of a residential community comparable to Newtown where the promotion of recreational hunting has led to a reduction in deer density. However, recreational hunting has achieved deer reductions in smaller towns in Connecticut and elsewhere.

2. Alone, it may have minimal, if any, impact on TBDs, DVCs or landscape damage

Option 2: Controlled hunts: Controlled hunts consist of allowing and promoting hunting, following current state hunting regulations, but with additional constraints designed to maximize harvest and public safety. For instance, hunting may be limited to weekdays when children are in school and the number of adult hikers and dog-walkers is low, hunting may be limited to archery from fixed elevated positions (tree stands) that minimize the risk of hitting unintended targets, and hunters may be subjected to strict screening to ensure that they are skilled, reliable, safe and effective. Typically, controlled hunts are administered by a committee or manager appointed by the town. Excess venison can be donated to food banks; some towns subsidize the processing costs. The hunters that are recruited for controlled hunts are

often highly dedicated individuals who perform a task that goes above and beyond what is generally considered to be "recreational hunting." They harvest proportionally more females than recreational hunters; they hunt at specific and predetermined dates, times and locations; and they are carefully screened before the hunt and monitored during the hunt. Such hunters sometimes have to be recruited out of town, even out of state, because few recreational hunters agree to imposition of such conditions.

Controlled hunts entail shooting over bait from tree stands with shot range between 10-20 yards, resulting in a lower wounding rate than traditional recreational hunting. Controlled hunts, with screening but without bait, resulted in most shots at less than 20 yards with 3/11 unrecovered losses (Kilpatrick & Walter, 1999). The Ridgefield controlled program reports zero lost deer due to its rigorous control; the Brookfield controlled hunt program reports losing only one deer in two years.

Large deer reductions have been achieved through controlled hunting at Bernards Township, NJ (town-estimated level of 46 d/mi^{2,}) and Shelter Island, NY (33-46 d/mi^2)[7] using entirely volunteer hunters at a fraction of the cost of a sharpshooting program. Dr. DeNicola estimates that the typical impact on deer density from controlled hunts will be minimal, however, and that controlled hunts (whether on public or private land, or a combination) may, at best, be able to reduce deer density to 40-50 d/mi^2 if the hunt is very well managed, with 4 baiting sites per mi^2 (DeNicola, Appendix A). DeNicola also said that controlled hunts alone could not maintain a deer population to 20-30 d/mi^2 if it had been initially reduced to that level by a sharpshooting program (Appendix A). The relatively low typical success of controlled hunts (or recreational hunting) is influenced by the limits imposed by the methods (daytime hunting), the increasing difficulty of locating deer as density decreases, the weapons (mostly bows, firearms on the few properties that are large enough) that can be used legally, and land access limitations.

Option 2a. Controlled hunts on Town-owned land:

Advantages:

1. Many towns in Fairfield County (and beyond) have comparable programs. Therefore the protocols are well established.

2. Low cost, but not necessarily free. The Ridgefield program reports that the only cost incurred for Ridgefield was the cost of signs, which was under $1,000, while the Bernards Township, NJ controlled hunt program incurred costs of approximately $28,000 for the 2008-09 season. The following costs are not required for a controlled hunt program, but can impact its effectiveness:

    a. Program management. Effective controlled hunts require a skilled, trained manager. Many towns recruited a volunteer for this purpose.

    b. Subsidies for the processing costs of venison.

[7] A recent study (Curtis et al., 2011) estimated that deer density increased to about 160-300 d/mi^2 by 2010 in some areas of the island, but the TBDAC preliminary analysis suggests that those estimates may be seriously flawed.

c. Deer population surveys.

d. Indirect/administrative costs (e.g., increased law enforcement).

3. Does not require special permit from the state or changes in Town regulations (according to Rob Sibley).

4. In some programs, hunters are required to provide their own liability insurance.

5. Controlled hunts on Town land may also encourage hunting on private land.

6. Potential for positive effects (reduced DVCs and browse damage) on hunted properties and their neighboring roads/properties.

Disadvantages:

1. Has not been demonstrated to reduce TBD in a residential community comparable to Newtown

2. Low availability of Town-owned land in Newtown suitable for controlled hunts. This is critical, especially when combined with the relatively small home range of deer. The effects of a deer reduction on Town properties will be limited to the parcels themselves and to properties and roads in the immediate surroundings. Baiting can increase the area impacted by hunting on any specific property somewhat.

3. Relatively low success of controlled hunts if it is the sole method.

4. Conflict with other recreational activities. The hunted parcels must be closed to other uses during hunting.

5. Potential opposition by animal welfare groups and by some local recreational hunters who object to the recruitment of out-of-town and out-of-state hunters.

6. If combined with sharpshooting, could impact sharpshooting effectiveness by making deer skittish and "smart."

7. Because the Connecticut statute holding landowners harmless from liability for allowing hunting on their property has been held not to apply to municipal landowners (see Conway v. Town of Wilton, 238 Conn. 653, 680 A.2d 242 (1996)), controlled hunts on public land might create liability or insurance issues that should be evaluated by the Town Attorney.

Option 2b: Controlled hunts on private land: A unique program in Fairfield County is BeSafeRedding.org. This organization was created and is operated by private individuals, not by a town. The main objective of the organization is to maximize deer harvest on private land by matching suitable landowners with qualified, carefully screened and monitored hunters. This is basically similar to a controlled hunt, as described above, but on private land.

Advantages:

1. No direct cost to Town (volunteers donate a considerable amount of time to manage the program).

2. Does not require permission from State or Town.

3. Most of the land in Newtown is privately owned. Therefore the impact on the overall deer population is potentially greater than controlled hunts of Town land.

4. Satisfactory for private landowners that may be reluctant to allow unknown/unscreened hunters on their property; may be satisfactory to the Newtown Forest Association.

Disadvantage:

1. In its current form, it is not a Town operation and not a Town decision. The Town has no control over it (although it can promote and support such a program).

2. Relatively low effect of controlled hunts on overall deer populations (see above).

3. Can potentially antagonize local recreational hunters (as has been the case in Redding) because a) many out-of-town and out-of-state hunters are used in the program and b) unsuccessful local recreational hunters blame the effects of the controlled hunt.

It is too soon to formally assess the success of BeSafeRedding.org because it started in 2009. The Town of Newtown (or private residents within it) could implement a program similar to BeSafeRedding.org. Because this is a new program, this has not been replicated anywhere in Fairfield County, although many deer committee reports mentioned it as a possible solution. Based on DeNicola's estimate of needing 4 bait sites per square mile to successfully reduce the deer density to ca. 40 d/mi^2, such a program would require coordinating hundreds of hunters and a total of ca. 200 sites (assuming that 50 out 60 mi^2 in Newtown are suitable).

Option 3. Professional deer reduction ("sharpshooters"): This method consists of hiring professionals who can harvest many deer in a short amount of time, and provide additional deer management services such as evaluating deer densities and/or training of Town employees/volunteers to perform deer density estimates, and the management of controlled hunts that may be established in concert with a sharpshooting program.

The deer harvested by this method are not killed using standard hunting methods or regulations. Rather, a special permit is obtained from the state to allow shooting deer at night, over bait, from elevated positions on vehicles or tree-stands, using rifles with sound suppressors. The highly skilled marksmen typically shoot the deer in the brain, causing instantaneous death. They carefully select which deer to shoot, in what order, to maximize the effectiveness of the harvest (DeNicola, Appendix A). They also carefully survey the baiting areas to insure that there is no risk to humans or domestic animals. Each bait site typically requires 3-4 weeks of pre-hunt baiting, followed by harvesting for a period that is typically less than a week. The harvested venison is usually donated to food banks.

This process would require recruiting many private landowners. Ideally, recruiting should be done by someone who knows the community, and who is known and respected by the community (e.g., a police officer). The deer management professionals would suggest properties and the local contact would approach the landowners in person. The selling point to landowners should be landscape damage and DVCS, and should not be a reduced risk of acquiring TBD, as deer reductions typically plateau at a level above what is associated with TBD risk reduction (DeNicola, Appendix A).

Establishing the contacts would be very time-consuming during the first few years. Towns such as Princeton, NJ and Solon, OH that have implemented sharpshooting (and/or controlled hunts) are typically successful at recruiting enough private landowners to meet the objectives of the program. Such programs require aggressive support from town leaders to sell it to the population because of the high upfront cost and the public preconception and misconception of the methods.

Dr. DeNicola estimated that a realistic objective for Newtown may be a deer density of ca. 20-25 d/mi^2. This does not necessarily mean that reaching lower deer densities could not be achieved but rather that there may be inadequate desire or financial resources to achieve that goal. Labor costs increase exponentially below 20-25 d/mi^2 because of the increased time required to kill each deer. For example, Dr. DeNicola estimated that the cost of reducing the deer density from 20 to 10 d/mi^2 would be double the cost of reducing it from 60 to 20 d/mi^2. The typical deer population densities that have been achieved by sharpshooting programs have been in the range of 25-30 d/mi^2 in communities that are typically smaller than 25 mi^2, or less than half the size of Newtown.

Advantages:

1. The most effective harvest of deer and accepted as the most humane method to kill deer.
2. Less intrusive than controlled hunts (done at night, little sound, less time spent on property).
3. Professionals are highly accountable for their work and provide their own liability insurance.
4. Has been demonstrated to reduce DVCs in residential communities comparable to (although smaller in area than) Newtown.

Concerns/Issues:

1. There are no examples of towns similar to Newtown where a sharpshooting program has resulted in a reduction in deer density sufficient to reduce TBD.
2. High upfront cost. To achieve and maintain a deer density of ca. 25 d/mi^2, the initial annual cost is likely to be several hundred thousand dollars, and maintenance cost once deer density is reduced is likely to be in the tens of thousands of dollars, perhaps up to $100,000. Additional costs will occur in the form of law enforcement, administrative costs, venison processing, etc.
3. Likely to antagonize recreational hunters and animal welfare groups.
4. The potentially negative effect on recreational hunters should be considered carefully as their collaboration is essential to minimize the long-term costs of the control of the deer population. A

possible compromise is for the sharpshooters to harvest deer after the regular hunting season, so that sharpshooters harvest only the number required to keep the population at the desired level after the recreational hunters had their chance. The disadvantage of this compromise is that the deer become "educated" during the regular hunting season and are therefore more difficult to harvest by the professional sharpshooters. (DeNicola, Appendix A)

5. Because the Connecticut statute holding landowners harmless from liability for allowing hunting on their property has been held not to apply to municipal landowners, sharpshooting on public land might create liability or insurance issues that should evaluated by the Town Attorney.

4. 4-Posters: An Emerging Tick Control Option

The 4-Poster is a deer self-treatment station that is designed to kill ticks by positioning food so that deer will brush against acaricide-treated rollers as they eat (similar to Frontline used on pets). The 4-Poster was invented by Dr. J. Mathews Pound, a U.S. Department of Agriculture scientist, to protect cattle herds in Texas from TBD transported by deer, and has since been studied in various locations in the Northeast and elsewhere as a potential tool for combating TBD in people.

Numerous studies have shown that 4-Posters can be effective in controlling ticks. A study from 1995 to 1998 at the Kerr Wildlife Management Area in Hunt, Texas, found tick control in the 90%-range within two years of 4-Poster deployment (Pound, 2010, see Attachment 7). A study at the Goddard Space Flight Center in Greenbelt, Maryland using permethrin as the active acaricide similarly found greater than 90% control of nymphal black-legged ticks (Solberg, 2003).

Most recently, a series of studies conducted with federal funding in seven Northeastern sites (Old Lyme, CT; Earle, NJ; Bedford, NY; Beltsville, MD; Gibson Island, MD; Loch Raven, MD and; Narragansett, RI) found that the 4-Poster reduced nymphal tick populations by 60-80% (Pound, 2009).[8] The lead researchers of these studies, including two scientists who presented to the TBDAC (Drs. Pound and Stafford), concluded in their summary article in the August 2009 issue of the medical journal *Vector-Borne and Zoonotic Disease*, that "the 4-Poster technology was safe, efficacious, economical, and environment friendly." An additional 4-Poster study was recently completed in Shelter Island and Fire Island, NY (Curtis et al., 2011; http://wildlifecontrol.info/ TickStudy/Pages/Study%20and%20 Posters.aspx) which showed significant declines in tick populations where 4-Posters were deployed. Another study is in progress on Mason's Island, CT.

Stafford's *Tick Management Handbook* explains that computer modeling exercises indicate that applying acaricide to deer is, in theory, the most effective means of controlling Lyme disease apart from an effective vaccine, and that the 4-Poster approach could, in principal, provide the greatest reduction in

[8] The Connecticut study showed a decline in tick populations that was not statistically significant compared to the control site. The other sites, however, found tick reductions that were statistically significant. Dr. Pound advised the TBDAC (Appendix A) that technical issues led to less than optimal effectiveness of the devices in CT.

Lyme disease with the least direct community involvement as compared with other options (Stafford, 2007). The *Tick Management Handbook* also says, "The use of the 4-Poster will probably be most practical as part of a neighborhood or community coordinated program to reduce ticks and the risk of Lyme disease, managed under state use regulations, and combined with some form of deer management program" (Stafford, 2007, p. 57).

Each 4-Poster device covers an area of 50-100 acres, depending on deer density and other factors. 4-Posters must be carefully positioned on flat surfaces and diligently maintained. The 4-Poster studies indicate that tick control benefits take 1-3 years to materialize following initial deployment.

Despite the extensive testing of the 4-Poster, there is no real experience concerning ongoing municipal deployments of 4-Posters on which Newtown can draw. The other Fairfield County towns that have considered deer-related problems neither recommended 4-Posters nor evaluated them in their written reports (which were for the most part published before many of the recent 4-Poster studies were available). A TBD committee in Nantucket recommended in late 2009 that Nantucket implement a trial deployment of 4-Posters as part of its integrated TBD management program, but this trial program has yet to begin.

Balanced against the 4-Poster's potential tick-control effectiveness are various negatives and uncertainties, which include:

- Cost. A town-wide deployment would be expensive, running into the mid-six figures in the first year, with ongoing costs for each year thereafter of about half the first-year costs. These include not only costs for equipment and recurring consumables (corn, acaricide, etc.), but also costs for the significant amount of labor involved in maintaining a 4-Poster program. The devices would need to be deployed in two distinct seasons each year, and in the intervening periods would need to be warehoused, cleaned and repaired. During deployment periods, each unit would need to be checked and resupplied at least weekly. The Shelter Island 4-Poster program is costing the town almost $200,000 a year, raised through a combination of public and private sources.

A more targeted deployment within selected areas of particular concern would be less expensive both on an absolute basis and relative to some alternatives (4-Posters are less expensive on a per-acre basis than acaricidal sprays), but would provide tick control only in the home range of deer in those targeted areas. Some costs might be defrayable through private grants and funding (as is the case on Shelter Island), but this possibility is speculative.

- Permitting. The CT DEP has statutory authority pursuant to Connecticut General Statutes §26-70 to license the use of 4-Posters. The DEP has not issued formal rules concerning the requirements for 4-Poster permits at this time, but has provided informal guidance concerning 4-Poster permitting. (Susan Frechette, DEP Deputy Commissioner, personal communication.) The DEP views the evidence concerning the 4-Poster's effectiveness as "controvertible," and has expressed the concern that "there is reason to believe that use of the device will lead to increased deer abundance when used in the absence of regulated hunting." The DEP believes that the increased availability of a food supply from the devices would benefit deer survival and reproduction (see "Potential Unwanted Consequences" below); however, Dr. Pound disagrees, advising that the

volume of corn is not sufficient to affect the herd nutrition. The DEP has therefore advised that it will "condition[] any permits authorizing the use of 4-Poster devices to areas where hunting is allowed in order to fully assess the effects of the use of such devices on deer and tick populations." The DEP's communication also makes reference to the possibility of "a study" of 4-Posters, though it is unclear whether this reference was intended to suggest that the additional restriction of a formal study (which would add substantial cost) would be imposed as a condition of a permit, at least in areas where hunting is allowed. These requirements could limit the usefulness of a 4-Poster program. For example, there are various locations in Newtown where deed restrictions prohibit hunting. Ironically these are the areas where efforts to reduce ticks via deer reduction cannot be implemented.

While guidance provided by the CT DEP to date can be assumed (for planning purposes) to reflect the conditions that would be associated with a 4-Poster permit, the precise requirements of a DEP permit will be somewhat uncertain unless and until Newtown or some other entity actually seeks such a permit in the absence of formal rules. An element of give-and-take in any permitting negotiations between the Town of Newtown and the DEP could be expected both as a matter of customary regulatory process and as a function of the important public health concerns surrounding TBD.

- Potential Unwanted Consequences. There are questions as to whether 4-Posters might cause unwanted negative effects, such as increased deer birth rates triggered by supplemental feeding or the spread of illnesses like chronic wasting disease (CWD) or rabies. The published studies concerning 4-Posters to date generally do not support these concerns. For example, the recent Northeastern 4-Poster studies evaluated the effect of deer feeding on deer populations and concluded that "while increases in deer populations in both Core Treatment and Control areas were identified by helicopter census, there was no evidence suggesting that populations of deer fed corn increased in number more so than those that were not fed corn" (Pound, 2009). Dr. Pound believes that studies indicate that the corn fed to deer in 4-Posters has inadequate protein to result in improved deer health or reproduction (Pound, Appendix A; Lewis & Rongstad, 1998).

To the extent CWD is present in an area, 4-Posters could potentially help spread that disease, although Pound observed that it is unproven whether transmission rates through shared feeding stations would exceed transmission rates from other deer behavior (such as deer-to-deer grooming); there have also been no reported CWD cases in Connecticut to date. Dr. DeNicola also suggested that localized environmental damage could result in the area immediately surrounding any 4-Poster devices as a consequence of the increased deer activity in that area.

Because 4-Posters rely on a toxic acaricide, their use could also generate concerns about environmental consequences. That said, permethrin, the agent approved for use in 4-Posters, is a commonly used pesticide that is minimally toxic to humans. Permethrin binds to the soil if spilled and thus does not leach into groundwater (Pound, 2010). Permethrin residue in venison was monitored as part of the Shelter Island and Fire Island studies (Curtis et al., 2011) and the results indicated a very low risk to human health from the consumption of venison from deer harvested in areas treated with 4-Posters.

- Negative Relationship with Acorn Abundance. Studies have shown that 4-Posters are less effective in seasons with unusually large acorn crops. Periodic reductions in tick control effectiveness in years with bountiful acorn crops over the life of a 4-Poster program can therefore be expected.

- Limitations. 4-Posters offer a means for the reduction and control of ticks and TBD. They would do nothing to reduce other problems associated with deer (e.g., forest damage, DVCs), and could exacerbate those problems by supporting the health and reproduction of an overabundant deer population (although, to date, there is no evidence to support this concern related to 4-Posters). 4-Posters are also an open-ended commitment: if 4-Posters are discontinued at any point in the future, their tick reduction benefits will cease in due course thereafter.

H. Recommendations Passed by the TBDAC

DEER-RELATED (NON-LETHAL): The TBDAC considered whether non-lethal deer strategies should play a role in preventing TBD.

1. Newtown should include 4-Posters as an element of its Tick-Borne Disease Management Plan. (11 yes, 0 no)

2. Newtown should adopt 4-Posters on a trial basis with a limited initial deployment focused on suitable sites in high-risk areas (i.e., sites in active recreational use in which high deer/tick densities are known or suspected). Based on Newtown's experience with this trial deployment, perceived need, funding and permitting issues, Newtown should revisit 3-5 years from implementation of this trial deployment whether a broader deployment may be appropriate. (10 yes, 1 no)

DEER-RELATED (LETHAL): The TBDAC considered whether lethal deer reduction should play a role in preventing TBD.

1. Newtown should include a deer population reduction program as an element of its Tick-Borne Disease Management Plan. (7 yes, 4 no)

2. Newtown should take measures to promote recreational hunting. Newtown should inform the public of the regulations regarding hunting on private property in an effort to promote such activity. (6 yes, 5 no)

3. Newtown should implement controlled-hunts on town-owned property (where not prohibited by deed or transfer agreement). (7 yes, 4 no)

4. Newtown should encourage and organize controlled-hunts on private property. (7 yes, 4 no)

5. Newtown should hire professional "sharpshooters." (7 yes, 4 no)

6. Messages that TBDAC recommends be included in all deer strategies:

A. Life Cycle of the tick: The message should include a description of the life cycle of the tick and describe how the deer are the primary host for the adult tick and provide its best chance of a blood meal adequate to produce offspring. Such discussion should include that alternate food sources are of

insufficient population or physical size to sustain the current tick population. That is, the reduction of deer to a low level may "break" the life-cycle of the deer tick. Thus treating or adequately reducing deer is expected to reduce tick population in the Town.

B. Home range patterns of white tailed deer: Residents should also be informed regarding the home range patterns of the deer such that they understand how a local only deer reduction or treatment strategy can still be effective despite the lack of geographic/natural barriers preventing deer from other towns from entering Newtown.

C. Encourage property owners to open their land to hunters, sharp shooters, or 4-poster devices.

(7 yes, 3 no)

7. Messages that TBDAC recommends be included in deer reduction strategies:

Several general topics should be included in the discussions. The list below outlines some sources of information and some topics. All of these are described in some detail in this Report.

A. Refer residents to the *Managing Urban Deer* brochure from the DEP to educate homeowners so they can make their own decisions. The *Tick Management Handbook* (Stafford, 2007) may also be helpful.

B. Describe the deer reduction programs already in place in surrounding towns.

C. Disseminate the FCMDA Economic Impacts estimate report (Attachment D).

D. Disseminate the DVC statistics/Forestry Impacts.

E. Residents should be made aware that very low densities may be possible to achieve even if it will take time and extensive efforts.

F. Refer residents to the CT DPH Website on Lyme Disease (http://www.ct.gov/dph/cwp/view.asp?a=3136&pm=1&Q=395590&dphNav_GID=1601&dphPNavCtr=|#47046)

(7 yes, 3 no)

8. Other strategies to improve the effectiveness of hunting programs (excluding sharpshooting).

A. The Town's Parks and Recreation Department can offer courses to support the deer management effort:

- Youth and adult archery training/education programs;
- Venison preparation from field dressing to dinner table;
- Sponsor the DEP-mandated firearms and/or bow hunting conservation and safety program. Note: These courses are often filled to capacity.

B. The Town can offer a voucher for meat processing (or other expenses) for deer that are legally harvested in Newtown and donated to a food bank. Obviously, any voucher will not cover all expenses; however, it is a tangible recognition that the Town values the service.

C. Stimulate the demand for deer by promoting "Venison Thursdays" (for example). This free range protein source is locally grown and harvested and is consistent with the current green movement. This provides a mechanism for the Newtown residents who want to make a contribution by putting venison on the table once a week.

(7 yes, 3 no)

9. Strategy to improve the effectiveness of sharpshooting: The Town should consult with the DEP or other professional regarding the potential interactions of simultaneous programs. For instance a "controlled" hunt program may interfere with professional sharpshooters if it makes the deer "skittish" or "smart." It is very likely that current recreational hunting can continue. (10 yes, 0 no)

10. Recommendations to encourage public support of some deer strategies.

A. The Town can officially recognize and extend thanks to the hunters for providing a valuable public service. A simple proclamation from the selectman's office would send a powerful message.

B. If the Town implements the surveys described in the Metrics Chapter of this Report, dissemination of those results may provide all residents with information regarding attitudes of their neighbors. To the extent that other residents are concerned and affected directly by TBD, those less concerned and affected may recognize the need for the Town to act. In general people tend to believe that the opinions and attitudes held by them are shared by the majority. It is possible that pointing out attitude differences may prompt people to recognize the frequency of other opinions and gain some tolerance for opposing views.

(7 yes, 3 no)

DEER-RELATED (MIXED LETHAL AND NON-LETHAL): The TBDAC considered whether combination lethal and non-lethal deer strategies should play a role in preventing TBD.

1. Newtown should accept the DEP's offer to work with the Town to develop, coordinate and implement a deer management program. (11 yes, 0 no)

2. Newtown should commission a professional, scientific survey to evaluate the attitude of Newtown residents toward the deer population, costs associated with various TBD mitigation options and other purposes. (8 yes, 3 no)

3. Public information dissemination. Recommend that Newtowners be fully apprised of any TBD plan with clear explanations regarding costs, benefits, and likelihood of success via open forum, mailing, website, some other means or a combination. Research suggests that a message explaining both pros and cons of contemplated actions is most persuasive for an educated audience. The TBDAC suggests the Selectmen consider addressing complex topics the TBDAC struggled with, including questions of how

low deer population can be feasibly reduced in Newtown, what is known /not known about various deer density levels, and contemplated long-term success of achieving target deer density level with adopted strategies. Recommend that Selectmen provide rationale behind the TBDAC's majority and minority votes to provide a fair and balanced argument. (10 yes, 0 no)

I. Recommendations Rejected by TBDAC

1. Newtown should pursue non-lethal deer reduction measures by seeking to participate in Dr. Rutberg's deer contraception study. (5 yes, 6 no)

2. Newtown should implement a Town-wide 4-Poster deployment at the earliest possible time (subject only to site availability limitations and similar unavoidable constraints). (1 yes, 10 no)

3. Newtown should defer 4-Poster implementation for 3-5 years in order to evaluate need after other aspects of Newtown's Tick-Borne Disease Management Plan have been introduced and evaluated. (4 yes, 7 no)

CHAPTER 5. DEER IMPACTS ON LOCAL LANDSCAPES (FORESTS, AGRICULTURAL AND RESIDENTIAL)

A. Impact of Deer on the Forest

The increase in Connecticut's deer herd over the last several decades has given rise to concerns about the impact of deer on the State's landscapes—specifically that: 1) forests are losing their understory and regenerative capacity; 2) wildflowers and birds are losing habitats; 3) there is a deterioration of water quality due to run-off; 4) there are negative economic impacts on agricultural pursuits; and 5) there are financial impacts for loss of ornamental plantings for property owners.

Concerns about over-browsing of seedlings, saplings and the understory, spread of invasive plants, reduction of bird habitat, as well as the spread of ticks are all well documented. Such concerns have merit and cannot be ignored. At the same time it should be noted that there are many factors that influence forest ecosystems. Some of these factors include but are not limited to: land use decisions resulting in fragmentation of forested lands; the role of light (how much reaches the forest floor); invasive plant species; the history of the land; soil conditions; pests and diseases of certain tree species; and weather events.

Deer numbers in Connecticut have risen dramatically from nearly 0 in 1900 to approximately 20,000 in 1975 and a minimum estimate of 152,000 today. In Fairfield County (DEP Zone 11) deer density is estimated to be 62-75 d/mi^2; the DEP estimates deer density in Newtown to be between 70 to 105 d/mi^2 (DEP 2009 and 2011 aerial surveys). Left unchecked deer herds can double every 2 to 3 years. Although deer can multiply quickly, this is not happening in Zone 11, the population here being more or less stable for the last decade. "Increased harvest efforts appear to have stabilized deer population in many areas of the state" (LaBonte et al., 2009, p. 23).

Nevertheless, this high deer density is cited for a number of impacts on the forest and its ecosystem including over-browse of shrubs, woody and herbaceous vegetation, increase of invasive plant species, reduction of bird species and/or number, spread of deer ticks and their associated diseases, and forest regeneration issues with decline in seedlings and saplings. Browse damage by large deer herds is a problem throughout much of the United States, including Connecticut (Conover, 1995).

Deer are not migratory animals. They spend their life within a home range of less than a square mile (640 acres), with most of their activity in a core area of 40-60 acres (Burnett, 2010). They eat whatever is palatable within their core area.

Deer are grazers by choice, browsers by necessity. During the spring and summer they feed primarily on herbaceous plants and the leaves of woody plants. In the fall acorns and fallen fruits are favored. Browsing of woody stems is prevalent in winter, when other food sources are usually in short supply (Rawinski, 2008). Deer consume an average of 5-15 pounds of vegetation per day (Alexander, 1980). Their normal (grazing) diet consists of leaves, twigs, forbs (any non-woody, non-grassy flowering plant), acorns, grass, lichens, and fruit. Deer prefer to browse on sugar maple, oak, hickory, white pine, hemlock, and ash tree seedlings and saplings. Suburban deer will often preferentially browse on ornamental species rather than native plants (Swihart et al, 1995).

White-tailed deer have been described as keystone species in forest ecosystems (McShea & Rappole, 1992; Rooney, 2001; Rooney & Waller, 2003), implying that their over feeding can directly and indirectly affect many other species. Deer have also been described as ecosystem engineers (Faison, Appendix A).

Deer impact on forest understory also may have an effect on water quality. Forests store, filter, clean and slowly release water to replenish groundwater and stream flows. Without a robust understory to break the falling rain, less water in absorbed into the ground and more water becomes run-off that adds sediment to our waterways. Several of our neighboring water shed managers have implemented deer reduction programs to protect their water quality.

Forests with deer densities exceeding 20 d/mi^2 will have little, if any, natural regeneration (Behrend et al., 1970; Tilghman, 1989; deCalesta 1994, Healy, 1997; McShea & Rappole, 2000). At high densities deer populations can greatly alter the appearance and ecology of forest vegetation (Stout, 2004). At very high densities, browse lines may develop where all palatable plant parts within six feet of the ground are eaten.

Biodiversity and structural and functional complexity of forests have relatively recently been recognized as critical concerns for public and private land management. The health and stability of ecosystems are closely related to their biodiversity (United States Department of Agriculture Forest Service, 2010).

B. Deer Exclosures

Deer exclosures have been used to demonstrate the effect of deer on vegetation, by excluding them from a fenced-in area.

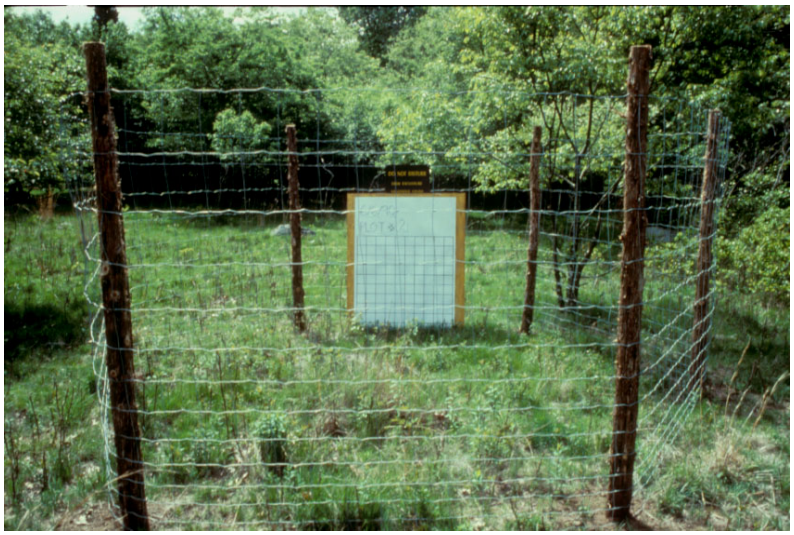

Figure 5.1. Deer Exclosure at installation (Bluff Point).
Source: Kilpatrick & LaBonte, 2007, p. 5

Bluff Point Coastal Reserve (1.3 mi^2) in Groton, Connecticut, serves as a good example of how overabundant deer herds can impact plant communities. In 1975, the Connecticut General Assembly designated Bluff Point as a Coastal Reserve to protect its unique plant and animal communities for the benefit of present and future generations. Deer hunting was not permitted at Bluff Point. In the late 1980s,

the DEP documented severe deer over-browsing of vegetation, and in the mid-1990s, surveys estimated the deer population exceeded 200 d/mi^2.

Figure 5.1 shows a deer exclosure (8-foot-high fenced area) constructed at Bluff Point Coastal Reserve in 1990 to visually document the impact of the deer population (220 d/mi^2) on the plant ecosystem. "After 5 years of no deer management (1995), vegetation outside the exclosure remained unchanged, while vegetation structure and diversity within the deer exclosure increased dramatically" (Figure 5.2). "In January 1996, a deer reduction program was initiated at Bluff Point. During the following 5-year period (1996-2001), the deer population was reduced from about 222 to 20 deer per square mile. The reduced deer population resulted in a significant increase in vegetation structure and diversity outside the deer exclosure." (Figure 5.3) (Kilpatrick & LaBonte, Managing Urban Deer in Connecticut, 2007, p 5).

Figure 5.2. Deer Exclosure 5 years after installation (Bluff Point).
Source: Kilpatrick & LaBonte, 2007, p. 5

Figure 5.3. Deer Exclosure 5 years after deer management outside exclosure (Bluff Point).
Source: Kilpatrick & LaBonte, 2007, p. 5

In a 12-year-old deer exclosure at Highstead Arboretum (150 acres) in Redding CT, it was discovered that the density of tree seedlings (defined by height, minimum 1 foot, maximum 3 feet 3 inches) were 1700 seedlings/ha.; outside the exclosure there were 25 seedlings/ha. (Figure 5.4; left side is inside the exclosure). Densities of trees ~3 feet high and 1 inch in diameter were 25/ha. inside the exclosure and 0/ha. outside the exclosure (Figure 5.4, right side). This demonstrates a huge difference from deer browsing, but the results also show that the vast majority of tree seedlings have grown less than 1 meter in 12 years, even when protected from deer browsing. “Shade from a thick shrub layer likely was an important factor in the slow growth" (personal communication, Ed Faison, Forest Ecologist, Highstead Arboretum).

Figure 5.4. Deer exclosure (left side) in Highstead Arboretum, Redding CT
Source: Russ Kinne, reprinted with permission

C. Historical Factors Affecting Changes in the Composition of Forests

Like much of Connecticut, Newtown's recent forests were generated by the natural succession from land that had been cleared for agriculture and fuel for charcoal production. From about 1850, agricultural activity declined and pioneer species such as eastern red cedar, black birch and black cherry emerged in untended fields. As time passed, oaks and hickories overtopped the pioneer species and became dominant. Finally, shade-tolerant sugar maples and eastern hemlocks developed in the understory and are now part of the forest canopy as well.

Today Connecticut's forests are dominated by: 33% red maple, 25% oak, 15% birch, 6% eastern hemlock, 5% eastern white pine and 5% hickory. Beneath the canopy of the trees are thousands of other species (both plant and animal) that comprise the complex forest ecosystem, all interdependent.

In addition to natural succession and human influence, deer browsing has affected regeneration, abundance, and distribution of species of trees, particularly in regenerating stands or those in early stages of succession, where the forest floor is open to sunlight. Selective browsing of certain species by deer gives a competitive advantage to other species and can result in the complete elimination of some desirable species from the mix in a regenerating stand.

However, the impact of deer varies across the region and the state. Deer population size cannot be the sole concern, because the actual impact of herd size depends on many other factors, such as alternative food sources and the duration and intensity of winters. All things being equal, deer in areas with alternative

food sources (such as agricultural or suburban landscapes) will have less impact on forest regeneration and more impact on town and private landscapes, than in areas of contiguous forest (Williams et al., 2006). Also, in years in which there is a large acorn mast, deer preferentially eat acorns and thus do less damage to herbaceous and woody species.

Excellent publications designed for landowners and forest managers who are interested in good stewardship of their land are available. These include: *Northeastern Forest Regeneration Handbook: A Guide for Forest Owners, Harvesting Practitioners, and Public Officials* (USDA Forest Service, 2006), *Eastern Hemlock Forests: Guideline to Minimize the Impacts of Hemlock Woolly Adelgid* (U.S. Department of Agriculture, 2004); *Strategies to reduce browse damage on eastern white pine in southern New England, USA* (Ward & Mervosh, 2008).

D. Forest Fragmentation Effect on Deer, Birds and Ticks

Forest fragmentation occurs when large, continuous forests are divided into smaller blocks, either by roads, clearing for agriculture, urbanization, or other human development. The list of negative impacts includes decreased forest interior, loss of wildlife and plant habitat, decreased biodiversity and loss of recreational opportunity. Fragmentation also diminishes the forest's ability to provide clean air and clean water (Sustainable Forests Partnership, 2008).

It is very important to understand that forest fragmentation results in "edge" habitats that provide optimum conditions for deer herds, mice and other small rodent populations, and invasive plants, to thrive and grow. Thus, land use decisions are a major driver of not only how the landscape develops immediately but also how it develops over the next decades.

When queried regarding the impact of forest fragmentation on the succession of forest species, Dr. Scott Williams, Assistant Agricultural Scientist II, Connecticut Agricultural Experiment Station (CAES), responded that "… increased fragmentation is synonymous with increased residential areas, which would likely increase the rodent population. And increased fragmentation would lead to a corresponding decrease in the bird and bat populations, which would then increase the number of undesirable insects [e.g., mosquitoes]. Black legged ticks [deer ticks] would also increase due to the increase of the deer population" (Williams, personal communication, Appendix D).

1. Fragmentation Effect on Birds

Ornithologists suspect that forest fragmentation harms many woodland birds by increasing their susceptibility to predation and nest parasitism. Also, loss of habitat area affects migrating birds when they return in the spring as it becomes increasingly difficult for them to find appropriate nesting sites. According to the Cornell Lab of Ornithology, large areas of continuous forest are needed to maintain "forest-interior bird species" in the Eastern US (Cornell Lab of Ornithology website, 2011). As discussed in following sections of this Chapter, further losses and fragmentation should be avoided in Newtown.

2. Fragmentation Effect on Risk of Tick-Borne Diseases

Many authors agree that widespread trends in low-density development in fragmented woodlands increase the potential for increased human exposure to ticks and resulting infection in areas endemic for Lyme disease (Jackson et al., 2006; Allen et al., 2003). "In north-eastern US, the massive dual forces of reforestation and suburbanization have increased human exposure to forested habitat. The occurrence of Lyme disease results in part from these land-cover changes that bring humans into proximity with the vector and its native hosts. Although the *I. scapularis* tick has a broad host range, its principal host in the larval and nymphal stages is the white-footed mouse (*Peromyscus leucopus*); its preferred host as an adult is the white-tailed deer (*Odocoileus virginianus*) on which it reproduces. Movements of deer determine the vector's presence in the landscape, given a cool, moist microhabitat and the availability of hosts for immature stages" (Jackson et al., 2006, pp. 315-316).

"Both the white-tailed deer and the white-footed mouse thrive in heterogeneous landscapes created by land-cover modification. Deer require a mix of forest cover and open areas with tender vegetation; the white-footed mouse is highly opportunistic and will inhabit forest edges as well as islands of woodland too small or inaccessible to sustain populations of other forest species. All of these habitats can be coincident with or adjacent to low-density residential areas" (Jackson et al., 2006, p. 316). The authors cite fragmentation as a reason for elevated populations of white-footed mice, an important vector for transmitting the Lyme spirochete. Not only were white-footed mice found to be more numerous in smaller forest fragments (<5 acres), but also infected nymphal ticks were more prevalent. "There was a dramatic increase in the density of infected nymphs, and therefore in Lyme disease risk, with decreasing forest patch size." (Allen et al., 2003, p. 267)

There is general agreement that residents living at the edge of open wooded spaces are at higher risk of contracting Lyme and other tick-borne diseases (TBD). Since it is estimated that up to 75% of Lyme disease is contracted in one's own back yard (Stafford, 2007), often adjacent to wooded areas, educating residents about this phenomenon is crucial. Many houses in Newtown have back yards adjacent to or near small forest edges.

High deer density is one of the main drivers of loss of biodiversity in fragmented forest patches (McShea & Rappole, 1992; Rooney, 2001; Rooney & Waller, 2003). Studies have also confirmed an increase in Lyme cases in residents living near highly deer-infested open space (Lastavica,1989). Jackson, et al. (2006) describe finding the highest Lyme rates in 50% forested landscapes with a large forest-herbaceous edge. These landscapes offer more sheltered foraging opportunities for white-tailed deer and white-footed mice, which transport the black-legged tick. Notably, their model applies to landscapes that range over several orders of spatial magnitude. Such stability is somewhat unusual in geographic research and may reflect their use of environmentally meaningful analysis units to capture host habitat and human contact with it.

E. Invasive Plants' Effect on Newtown's Forests

Invasive plants are creating a significant negative impact on Connecticut forest land. Most open space parcels in Newtown reveal encroachment by autumn olive, Japanese barberry, Oriental bittersweet, mile-

a-minute and garlic mustard. In many cases these plants are replacing native species, as native species are preferentially browsed by deer in the forest.

In a talk sponsored by the Newtown Conservation Commission on May 15, 2010 Logan Senack, Invasive Plant Coordinator for the CT DEP and University of Connecticut, explained that invasive species are second only to loss of habitat as a threat to biodiversity. Invasive species are well equipped biologically for survival and dominance, using various mechanisms to aggressively spread and out-compete other species, leading to loss of native species and loss of biodiversity.

Invasives can probably be traced to European settlers who imported some of the plant species from their homelands for their desirable characteristics and were unaware of their invasive potential. The introduction of alien plants has not only caused the displacement of native plants, but also indirectly caused additional problems in some cases by bringing in alien pathogens and insects.

Invasive plant introductions continue today. Many well-intentioned landowners purchase plants from local or not-so-local vendors that, once established, can become aggressively invasive. They are often advertised as "deer resistant" (e.g., Japanese barberry and winged euonymus), which further helps their sale. Some portions of the region have areas ranging in size from acres to whole towns where invasive plants have almost totally displaced native vegetation. "Inaction is ecologically expensive and restoration is financially expensive." (Ward et al., 2006, p. 9) Everyone from landowners to tree planters, the nursery industry, and public officials should be made aware of problem species and creative solutions (Ward et al., 2006).

Al's Trail, the Orchard Hill Nature Center, Dickenson Park, and the Pole Bridge property are all important recreational areas in Newtown where invasives are changing the character of the landscape. Autumn olive is a prolific fruit bearer with berries widely dispersed by birds. It can be seen in many open areas, (the fields at Orchard Hill Nature Center are a good example) crowding out existing trees and shrubs. Oriental bittersweet is ubiquitous; older vines become so heavy that they eventually topple large trees (the Newtown Forest Association Blackman Road property on Route 6 has suffered the loss of a number of large trees from bittersweet dominance). Winged euonymus, seen along Al's Trail and other places, forms dense thickets that shade out many other plant species. Garlic mustard, which secretes a chemical in its roots to discourage growth of other nearby plants, has become so invasive in the last decade that is difficult to find places where it is not present. Japanese barberry is also widely dispersed on town lands. It is particularly detrimental to forested areas as it succeeds in reproducing in heavily shaded habitats as well as in sunny and partially shaded areas, displacing native plant species and reducing habitat and forage for some wildlife. It also provides a habitat conducive for mice and ticks, as discussed in a following section of this Chapter.

F. Relationship between Deer and Invasive Plants

Although deer will eat almost anything during harsh winter conditions, in general they do not find invasive plants palatable. Thus deer, at high densities, give a competitive advantage to the invasives. Forest understories have become dominated by browse resistant species such as hophornbeam, blue beech and striped maple along with exotic invasives such as Japanese barberry, Ailanthus, Oriental bittersweet

and winged euonymus. “Unfortunately, these browse resistant species often have lower economic, aesthetic, and wildlife values than the species they displace” (Ward, 2000, p. 4).

While many invasive plants are not palatable to deer, some studies have shown that in fact deer facilitate the spread of invasives by browsing and then depositing the seeds elsewhere in a pile of droppings (Ward, 2007). If given proper conditions, some of these seeds will germinate to become seedlings. A southern Connecticut study showed that 86 species of plants germinated from seeds found in deer pellets, of which 50% were not native to the United States (Williams et al, 2008).

Researchers studied the relationship between deer and invasives in 10 forests in northeastern Pennsylvania and western New Jersey from 2003 to 2006. They fenced off 40 1-square-meter patches of forest so that deer could not feed there. In these exclosures, the invasive plants grew about as well as the native plants did. But where deer were present, invasives fared better than the natives. This might be expected since in general, deer prefer native over non-native species (Eschtruth & Battles, 2009).

G. Japanese Barberry and Its Connection to Lyme Disease

Connecticut’s native species are quickly being displaced by Japanese barberry. Seeds are dispersed largely by birds, which are very fond of its tiny, red fruits. Although birds can digest the fruit’s flesh, the seeds pass unharmed through their digestive tract. In this way, entirely new colonies of barberry sprout up wherever there are bird droppings, claiming areas once occupied by indigenous shrubs and wildflowers, in some locations that have been preferentially browsed by deer.

Japanese barberry is not only an undesirable invasive shrub in Newtown, but it also presents an increased risk associated with TBDs, because it provides a prime habitat for both white-footed mice and black-legged ticks. Barberry may be particularly attractive to ticks as it leafs out earlier in the spring compared to most other shrubs, creating the shelter and humidity favorable for tick survival. In addition, the height of barberry (upwards of 7 feet) is ideal for adult ticks to await the opportunity to attach to white-tailed deer. As discussed in the following paragraphs, research recently published by scientists at CAES confirms that Japanese barberry, a dominant understory shrub in some parts of Connecticut, confirms the barberry-blacklegged tick association (Williams et al., 2009).

Due to anecdotal reports that black-legged ticks were twice as numerous in barberry-infested forests compared to forests without barberry, the authors tested the hypothesis that the densities of white-footed mice (primary reservoir for *B. burgdorferi,* causal agent of Lyme disease in humans and domestic animals), black-legged ticks (primary vector for *B. burgdorferi*), and *B. burgdorferi*-infected tick prevalence, were higher in forests with dense barberry than in adjacent areas with no barberry.

To this end three study areas in Connecticut were chosen, in Redding (Aquarion Water Company land), in Storrs (University of Connecticut forest land), and in North Branford (Regional Water Authority land). Three plots were established at each site, one being heavily infested with barberry, one where barberry was managed by a series of control measures, and the third where no barberry existed.

Over a 2-year period, measurements were made of percentages of: barberry; number of white-footed mice; larval ticks; adult ticks; and ticks infected with *B. burgdorferi*. The results showed a higher

abundance of both larval and adult ticks in high-density barberry areas. Areas where barberry was managed showed a marked reduction in ticks. Also, infection prevalence of ticks with *B. burgdorferi* was shown to be greater in high-density barberry areas compared to areas with no barberry.

Considering the higher concentration of ticks in barberry and the fact that these ticks have a higher infection rate, the presence of barberry poses a considerable threat to public health. The study concludes that "[r]emoval of Japanese barberry will significantly decrease the abundance of ticks, their infection prevalence with *B. burgdorferi*, and the environmental risk of Lyme disease" (Williams et al., 2009, p. 982).

1. Relevance for Newtown

Since barberry exists in manicured lawns in Newtown as well as roadsides, open fields and forested areas, it appears to be an important factor relevant to TBD in our town. Education about this phenomenon is needed as well as measures to reduce its presence. An Invasive Species Working Group (working under the direction of the Newtown Conservation Commission) has been created. Barberry reduction, as an ongoing effort, should continue to be a prime focus of that group. Higher deer densities simply make the job of containing barberry more difficult.

It is not known exactly how prevalent barberry is in Newtown but it spreads rapidly and can be found in many sites, along road sides, wooded areas, trails, and also on private property. Barberry can easily be cut down but further treatment is usually needed to prevent it from re-occurring. If the bush cannot be dug up with the roots, new shoots may form the following year that will need to be cut. As an alternative, after initial trimming the cut areas can be sprayed or painted with an herbicide used according to label directions. Propane torches were used to eradicate barberry in the above-referenced study in the areas where barberry was managed (Ward et al., 2009). This technique is currently being used in Redding as part of a program to reduce the effects of invasive plants.

A note of interest regarding the role of deer in the spread of barberry: barberry is generally classified as being browse-resistant. However, deer are known at times to eat barberry fruits and barberry seeds have been found in deer pellets. However, Japanese barberry did not germinate from deer fecal samples gathered in Connecticut (Williams et al., 2008). Thus it is not likely that white-tailed deer are playing a major role in dispersing barberry seeds.

Extensive dissemination of barberry and other invasives throughout Newtown has occurred through successful seed dispersal and factors that favor invasives over native plants. Seeds are dispersed by birds and small mammals after consumption. Preferential deer browsing on native species rather than invasive plants is a major factor in facilitating barberry spread. Other factors, including human plantings of invasives, overhead canopy in Newtown's mature forests that decrease light to the forest floor that would encourage native species to regenerate, and the hardier nature of invasives, also play a role. However, deer will preferentially feed on native species, giving barberry an advantage by providing the ideal vacant woodland floor for its spread.

H. Deer Impact on Bird Populations

Changes in forest structure caused by deer browse can have a negative impact on bird species that nest in the understory (McShea and Rappole, 1997). As reported in the 2006 Connecticut State of the Birds, the Connecticut Breeding Bird Survey indicates that since 1966, shrub land species such as brown thrasher, house wren, song sparrow, field sparrow, prairie warbler, blue-winged warbler and eastern towhee have declined (Metzler, 2007).

McGuinness (1996) noted that "[d]ensities of [w]hite-tailed [d]eer greater than 20 deer per square mile significantly reduced ICN [intermediate canopy nesting] species richness and abundance as a result of decreased height of nesting habitat. We noted a 30 percent decrease in species richness and a 37 percent decrease in abundance of ICN songbirds between 10 and 64 deer per square mile…. Eastern Wood-Pewee, Indigo Bunting, Least Flycatcher, Yellow-billed Cuckoo, and Cerulean Warbler were absent at densities greater than 20 deer per square mile. Eastern Phoebe and American Robin were absent at densities greater than 38 deer per square mile."

However, not all birds are negatively impacted by deer browsing; for example the northern cardinal and yellow warbler numbers are increasing. It does appear, however, that birds that nest in cavities and canopy-nesting birds have increased at the expense of shrub-nesting birds.

I. Bird Habitat Restoration

What would it take to restore the habitat to have a positive effect on songbirds within a managed habitat? Studies on conservation land in East Haddam indicate that within a six-year period, a shrub layer and an increase in herbaceous diversity developed in fenced plots that excluded deer, whereas unfenced plots exposed to browsing remained the same. However, other plots on the same land showed no change during the same time period, an indication that site conditions and seed bank may be contributing factors to vegetation recovery.

A Pennsylvania study demonstrated that a prolonged reduction in deer density (between 20 and 30 d/mi^2) is required to have a positive effect on habitat and songbirds within managed forests (Metzler, 2006).

J. Importance of Active Forest Management

1. Role of Sunlight

The effect of light was dramatically demonstrated during a day-long survey of 4 open space parcels by Dr. Scott Williams and Joseph Barsky of CAES on March 19, 2010. Results of that survey as well as follow-up communications from Dr. Williams appear in Appendix D.

A number of members of the TBDAC and the Newtown Conservation Commission accompanied Dr. Williams and Mr. Barsky on the forest inspection. The second site visited was the Grady open space parcel in Sandy Hook, off Stonebridge Road. The 30-acre parcel abuts the larger Paugussett State Forest. Paugussett is managed by the State; trees are cut and harvested to improve forest health and age/class diversity. It was obvious from standing in one place and looking at both sites that they have developed differently.

The Grady parcel (Figure 5.5a) offered a few saplings and sparse understory while the State forest land (Figure 5.5b) was much denser with understory and offered more diversity of species. The pictures in Figure 5.5a and b illustrate the difference between the two parcels. The photographs were taken while standing on the same spot, moving only the camera.

Figure 5.5a. Grady open space (no forestry management), 04/30/10

Figure 5.5b Paugussett State Forest (with forestry management), 04/30/10

Dr.Williams commented that the dense canopy on the Grady property was preventing light from reaching the forest floor, limiting growth of understory and seedlings. Evidence of deer browse was seen on Grady as well as on the State forest land. However, the difference in the appearance of the two sites is evident (sunlight effect).

It should also be noted that the estimated number of deer in Paugussett State Forest is likely half the number in the Grady parcel (according to Dr. Scott Williams), due to recreational hunting which has taken place there for many years. Therefore, deer browse on the Paugussett site is less than on many other sites in Newtown.

Thus when observing a stand of trees that "you can see right through" due to lack of understory, a dense canopy should be considered as a possible cause, as well as deer browse, or likely a combination of the two.

Once invasives are established they crowd out the growth of other species. This can be seen on many open space parcels. Shown here are barberry bushes at the Raynolds open space parcel in April of 2010 (Figure 5.6). Barberry leaves appear early in the spring and compete with other species for water and nutrients.

Figure 5.6. Barberry at Raynolds Open Space (04/30/10)

During the forest inspection Dr.Williams clarified the term "edge habitat". While the group was standing well within an open space parcel, Dr. Williams indicated that we were still in edge habitat as evidenced by invasive plants and other indicators. Edge habitat is a function of forest fragmentation which promotes invasive species which can kill established trees (Oriental bittersweet), increases deer, rodent, undesirable insect and tick populations, and decreases bird and bat populations. Dr. Williams' comment leads us to believe that the largest parcels of land are the healthiest parcels, once again indicating the negative impact of forest fragmentation.

K. Agricultural Damage

Anecdotal reports of extensive deer damage to agricultural crops in Connecticut are common, but not well documented. In 2003-2004, surveys were distributed to members of the Connecticut Farm Bureau, Connecticut Nursery and Landscape Association, and the Connecticut Pomological Society. The surveys indicated wildlife damage on nearly 40% of the acreage. A wide variety of crops was reported to be damaged by deer including Christmas and fruit trees, pumpkins, berries, nursery plants, vegetables, grapes, and hay fields (Williams et al, 2006).

We were unable to find specific information pertaining to deer damage of agricultural land in Newtown.

L. Landscaping Damage

As mentioned earlier, deer browse an average of 5-15 pounds of vegetation per day (Alexander, 1980). Suburban deer preferentially browse on ornamental species rather than native plants (Swihart et al., 1995).

Over a 2-year period in the late 1990's, 269 Connecticut gardeners in 63 towns have participated in a survey of deer browse damage. An analysis of the surveys shows that gardens and landscape plants of most respondents were impacted by deer. The average gardener reported growing 66 species of landscape plants (range 1-247). Most gardeners (97%) who completed the survey have had some browse damage to

their landscape plantings. Eighty-eight percent of gardeners noted browse damage to both their shrubs and herbaceous plants (Ward, 2000).

An Economic Survey was recently completed by the Department of Health Policy and Management of New York Medical College, sponsored by the Fairfield County Municipal Deer Management Alliance (FCMDMA) in cooperation with the Connecticut Coalition to End Lyme Disease (CCELD) and Connecticut Audubon Society (Attachment 4). The total losses from environmental damage and landscape losses due to deer overpopulation in Newtown were estimated at $6,212,245, the cost per household being $804. These estimates were derived from a survey done in Bernards Township, New Jersey in 2003. However, it is not clear whether or not it is appropriate to assume that perceived costs would be similar if a survey were to be done in Newtown.

Many excellent bulletins and articles are available to gardeners and homeowners that provide information about the use and placement of appropriate plantings to minimize deer damage. One of those is "Limiting Deer Browse Damage to Landscape Plants", Jeffrey Ward, CAES, 2000 (*http://www.ct.gov/caes/lib/caes/documents/publications/bulletins/b968.pdf*). Articles pertaining to the use of deer repellents are also available, one being "Effectiveness of Deer Repellents in Connecticut" by Jeffrey Ward and Scott Williams, CAES (*http://www.berrymaninstitute.org/journal/spring2010/ward_williams_sp10.pdf*).

M. Deer Effects on the Landscape

Most of the literature cites a strong correlation between high abundance of deer and negative impacts to the environment (deCalestra, 1994; McShea & Rappole, 2000; Russell et al., 2001; Cote et al., 2004; Levy, 2006). There is some disagreement on issues of scale and the effect contributed by land use practices (Bashore et al., 1985; Hubbard et al., 2000; Allan et al., 2003; Brownstein et al., 2005).

However, there is general agreement that forests with deer densities exceeding 20 d/mi^2 will have little, if any, natural regeneration (Behrend et al., 1970; Tilghman, 1989; deCalesta, 1994; Healy, 1997; McShea & Rappole, 2000). At the time of this report, Newtown deer population is estimated to be between 70 and 105 d/mi^2 (DEP aerial surveys, 2009, 2011, Attachment 3).

Horsley et al. (2003) examined the impact of controlled deer densities at 10, 20, 40 and 65 d/mi^2 in northern Pennsylvania forests. They concluded that deer densities determine whether the forest moves toward a monoculture of browse-resistant species or toward a diverse species composition. Most trends between deer density and species density, height, and diversity were linear. Over time, the net effect of increasing deer density resulted in a reduction in species diversity and altered species composition. The study pointed out that the effect of deer browse accumulates over time. Once the browse-resistant species become established and then dominate the landscape, they prevent the re-establishment of the preferred species. Thus, areas with high deer densities over long periods of time create conditions that are difficult to reverse. This study also found the threshold for deer density for negative impacts on forest vegetation to be approximately 20 d/mi^2.

A forest assessment of four Newtown open space parcels was done in March, 2010 by Dr. Scott Williams, but there is little specific information pertaining to Newtown's other forested areas. Deer numbers for specific sites are not known. Damage to the forests from deer browse at specific sites except as noted in

Dr. Williams' March 2010 report (Appendix D) has not been identified or quantified. There are no standard metrics or criteria for evaluating deer browse damage that have been applied to Newtown's forests. We recommend that such metrics be developed.

N. Tick-Borne Disease Risk and Proximity to Forests

Case studies document that living and/or working in or near areas with overabundant deer greatly increases one's chances of contracting TBDs.

Lastavica et al. (1989) described a local epidemic of Lyme disease, which spread from a nature preserve and affected an adjacent community of permanent residents in coastal Massachusetts. The attack rate from 1980 through 1987 was 35% among 190 residents living within 5 km. of the nature preserve and was greatest (66%) among those living closest to the preserve. "In the nature preserve, the density of the vector tick, *Ixodes dammini*, exceeded that in other New England sites. The zoonosis rapidly became endemic, and the severity of its impact correlated with the abundance of deer. This epidemic of Lyme disease demonstrated that outbreaks can be focal and can spread rapidly within a community of permanent residents." (Labonte et al., 2009, p. 133)

Smith et al. (1988) showed that the risk of contracting Lyme disease is 2.5 times higher in outdoor occupations, such as forestry, landscaping and farming.

Clearly, the problems discussed in this chapter are significant and need to be addressed. Efforts must be made to preserve nature itself and to foster education of our children, who are the future stewards of the landscape.

O. Recommendations Passed by the TBDAC

1. Contract a forester for professional services to make assessments and recommendations of all major Town-owned open space areas and develop a forest management plan for selected open space parcels. Develop metrics for evaluation of forest health to be used to assess any changes over time. (11 yes, 0 no)

2. Re-evaluate the parcels evaluated by CAES in March 2010 in five years to determine any changes. (11 yes, 0 no)

3. Discourage further subdivisions which create more edge habitat and implement cluster zoning regulations for future developments. (9 yes, 2 no)

4. Support efforts of a newly formed Invasive Species Work Group to eliminate/reduce barberry from Town open space, parks, schools and private property. Investigate possible state funding of such efforts. (11 yes, 0 no)

5. Encourage landscaping practices that reduce the presence of ticks and white-footed mice on private property (removal of barberry, use of wood chips, etc.). (11 yes, 0 no)

6. Build one or two deer exclosures (perhaps in Al's Trail and Orchard Hill Nature Center) for demonstration/education purposes. (7 yes, 4 no)

7. Continue to monitor biological controls of ticks, such as fungi, nematodes, etc. Of particular interest is the fungus *M. anisopliae* Strain 52, marketed as Tick-EX-EC, which is expected to be commercially available in 2011. (10 yes, 1 no)

8. Reduce deer herd to average density of 18 to 20 deer per square mile. (7 yes, 4 no)

9. Lobby the State of Connecticut to ban the use of lead in hunting ammunition. (10 yes, 1 no)

P. Recommendations rejected by the TBDAC

1. Encourage predators of mice by developing a program for building and distributing owl boxes—a possible Scout project. (2 yes, 9 no)

CHAPTER 6. DEER-VEHICLE CRASHES

A. Newtown Crash Data

According to the Fatal Analysis Reporting Systems of the National Highway Traffic Safety Administration (NHTSA), nationwide in 2008 210 deaths (including one in Connecticut) were associated with motor vehicle-animal (mostly deer) crashes. Most deer-vehicle crashes (DVCs) result only in property damage. NHTSA estimates that nearly half of property-damage-only crashes are unreported (Blincoe et al., 2002). Newtown DVC data was obtained from the Newtown Police Department (NPD) and other sources, and unless otherwise noted are not from published reports[9].

According to these data, during the period 2000 to 2009 there were 987 DVCs in Newtown reported to the NPD. Given that most DVCs are property-damage-only (and these are unreported about half the time), the actual total number of reported and unreported DVCs is likely to be closer to 2,000. This estimate excludes crashes that occurred on I-84 (state police DVC data could not be obtained by the TBDAC).

Figure 6.1 shows the number of monthly DVCs from January 2000 through December 2009. A three-month "moving average" is included in the figure to "smooth" the graph and remove the effects of early versus late rut in describing a pattern. From 2000 through 2009 there was a 39% reduction in DVCs annually, as demonstrated by the clear downward slope in Figure 6.1. Several factors may play a role in this decline including but not limited to economic factors, weather conditions, change in deer population, and speed enforcement by police.

If the decline in DVCs was due to deer population reduction (with or without a combinations of other factors) then DVCs should decline more rapidly than other types of crashes in Newtown (as they would be unaffected by deer population). In order to evaluate whether deer population (or something else specific to DVCs) is a likely factor in the reduction in DVCs we also looked at the trend in crashes that are similar to DVCs in terms of crash dynamics but which are not necessarily deer related. Specifically we analyzed minor injury crashes[10] in Newtown (data were obtained from the Connecticut Department of Transportation (CONNDOT)—Highway Safety Office). We then compared the slope of the linear trend line of the DVCs to the slope of these other motor vehicle crashes (MVCs) (Figure 6.2).

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[9] Data were compiled/analyzed by Dr. Chaudhary, a member of the TBDAC, who is a traffic safety researcher.

[10] Minor injury crashes are crashes where the most severe injury was listed as *complaint of injury* with no visible sign of injury (compared to *evident injury* and *severe injury*) as designated by the investigating officer. Property-damage-only crashes were available for all years required.

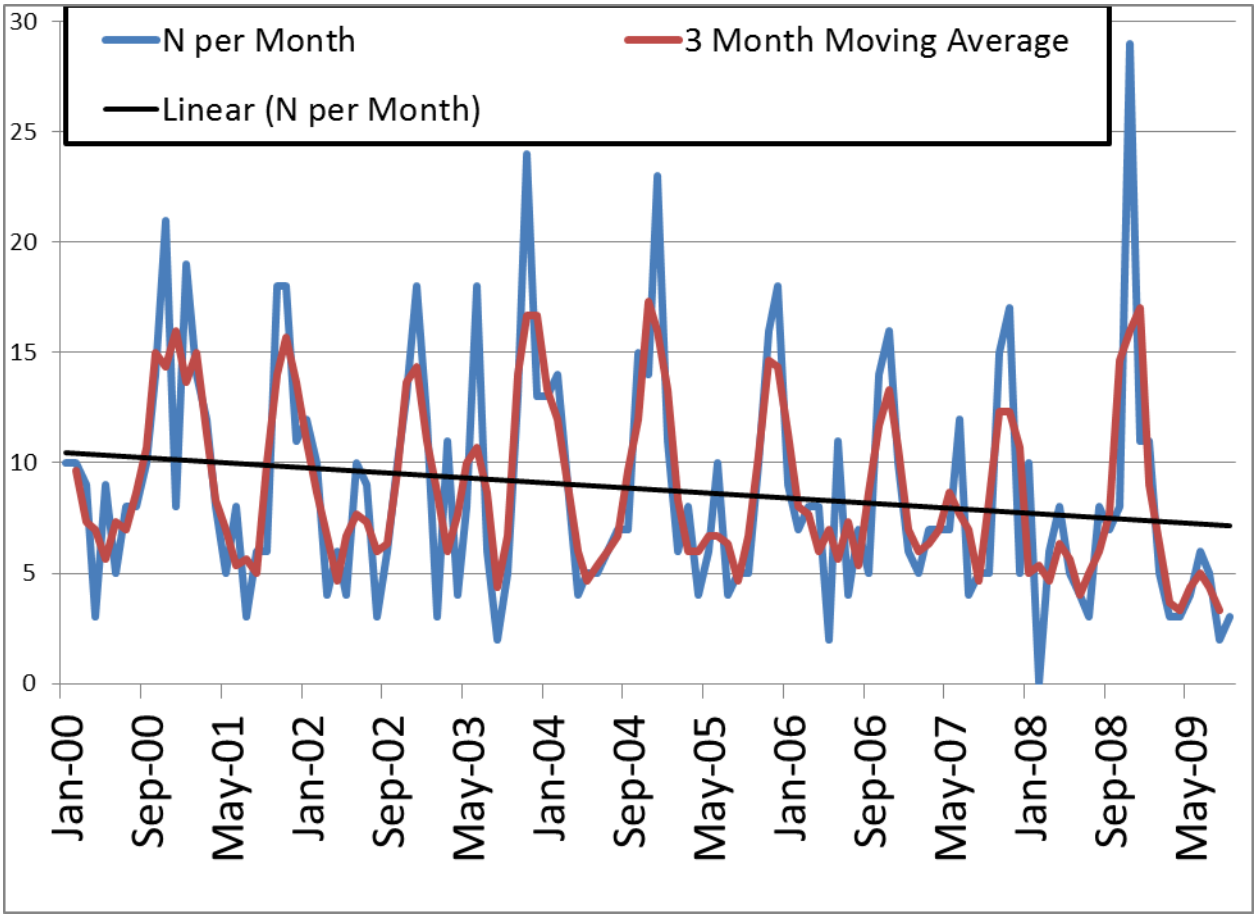

Figure 6.1. Monthly Deer Vehicle Crashes (2000 to 2009)

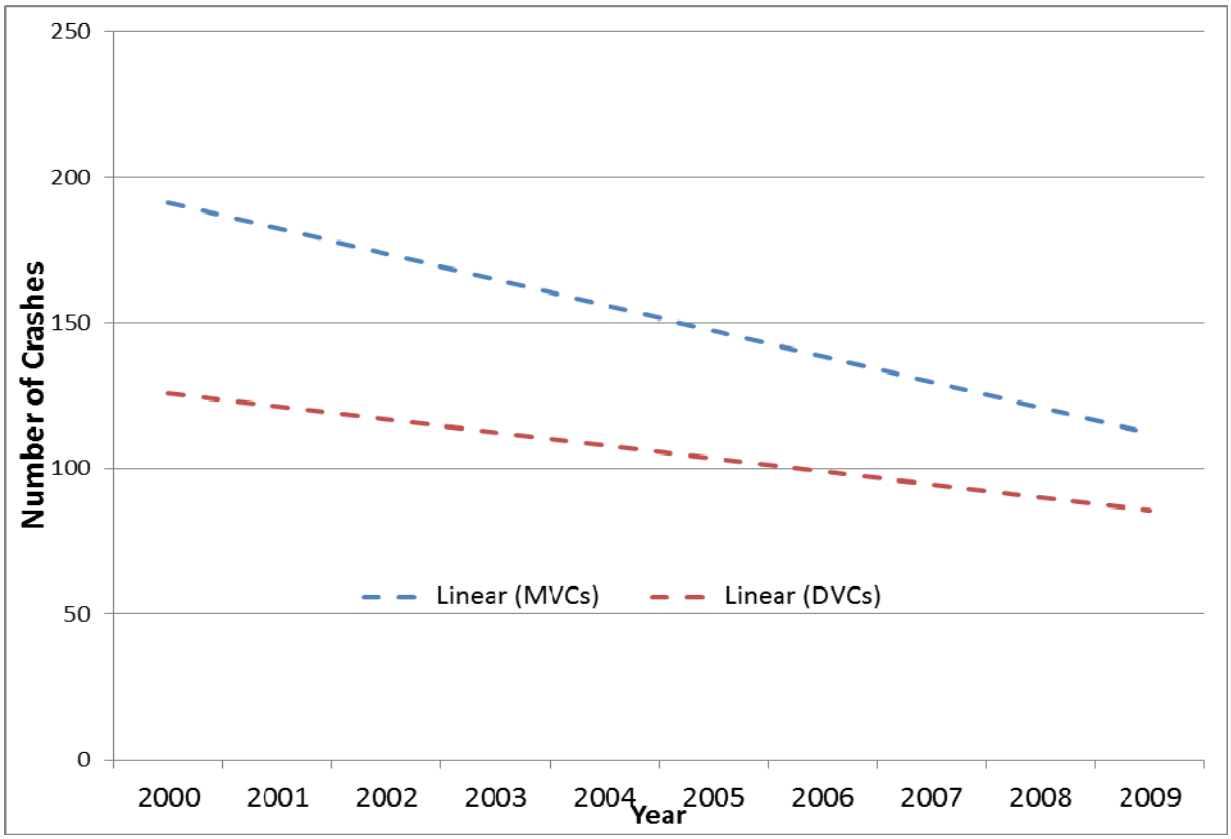

Figure 6.2. Annual Deer Vehicle Crashes and Non-Deer-Related Motor Vehicle Crash Trend in Newtown (2000-2009)
Sources: Newtown PD; CONNDOT

This graph indicates a relatively parallel downward rate of change in both types of crashes (suggesting no difference in the rates of decrease). There was a 46% reduction in MVCs (vs. 39 % in DVCs) from 2000 (N = 158) to 2009 (N=85)—the difference between these reductions was not big enough to be considered "significant" by scientific standards. Specifically, a statistical analysis (Chi Square) determined that the difference between these two values (39% and 46%) was likely due to chance (χ^2 = .54, p > .05). *Statewide* reductions in minor injury crashes were similar to those in Newtown (33% reduction from 2000 to 2009). The statewide decrease did not statistically differ from either Newtown MVCs or Newtown DVCs (ps > .05). Thus, the downward trend in DVCs in Newtown was likely a result of an overall decrease in crashes rather than something related to DVCs specifically (e.g., deer population changes). The downward trends in Newtown crashes were comparable to the downward trends in the state.

Crashes with deer increase drastically while deer are more active during rut season. As shown in Figure 6.3, DVCs clearly spike in the mean number of DVCs in Newtown during the months of November and December (NPD data). There is also a slight increase in DVCs in June.

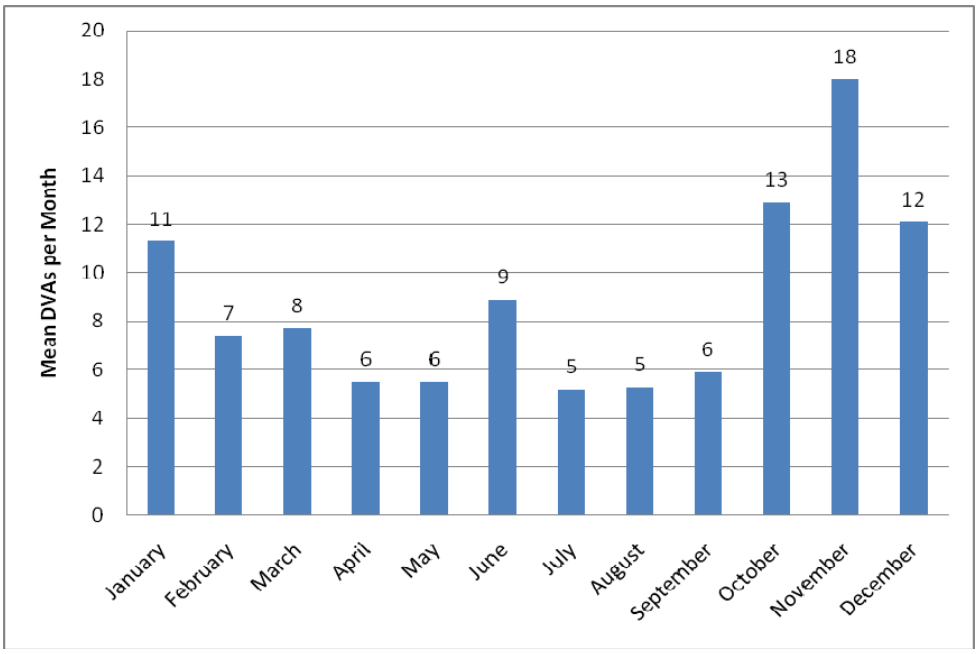

Figure 6.3. Monthly Mean of Deer Vehicle Accidents (2000 to 2009)
Source: Newtown PD data

In addition to plotting the trends of deer crashes over time, the committee also plotted the location of crashes on a map. The hope was to identify "hot spots" of high deer population. The results, however, indicate that the DVCs are associated with high traffic volume. The majority of crashes occurred on the most heavily traveled roadways (e.g., Routes 302, and 25) (see Figure 6.4). Aside from this finding, the deer crashes appear to be scattered through the town. The figure below shows the crashes from 2002 to 2008. The white "pins" indicate crash sites[11]. It should be noted that some percentage of the crashes were not pinned because the intersections could not be located by the mapping software and others were placed on top of each other. That said, there are plenty of data points to provide an adequate overview of the problem.

[11] Many crashes on route 34 did not map.

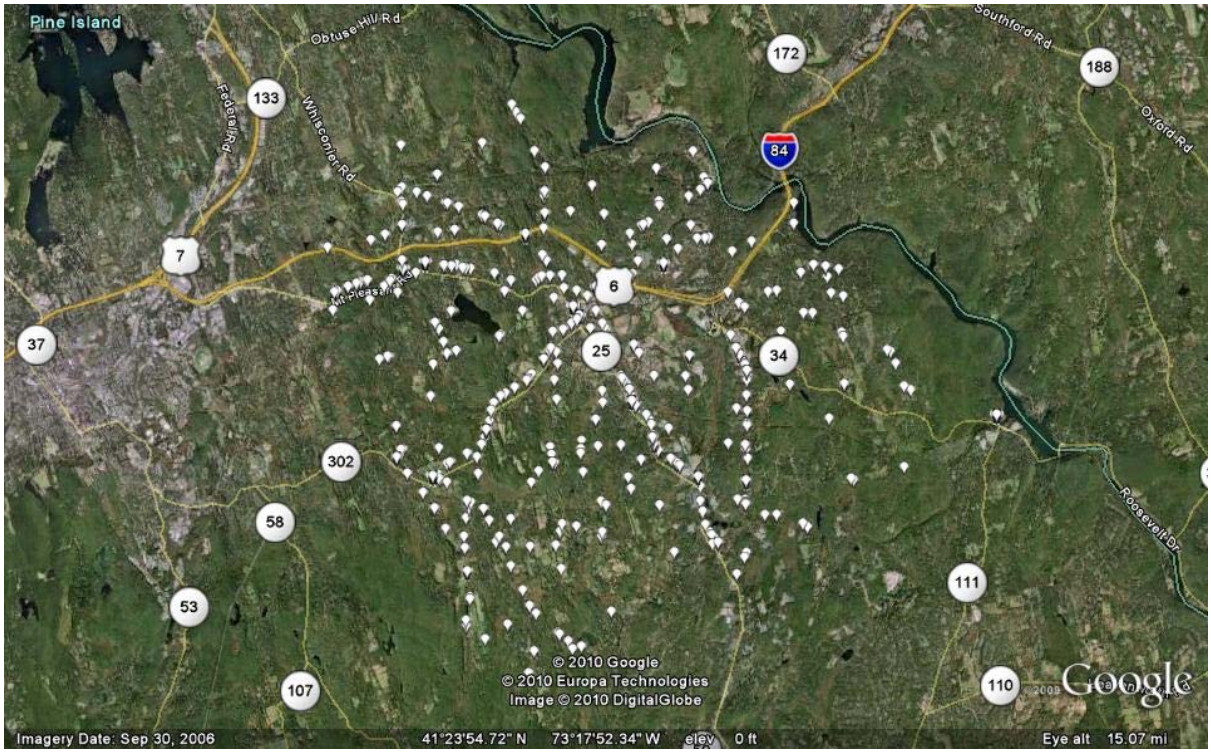

Figure 6.4. Pin Map of DVCs in Newtown (2002 to 2008).

Newtown Deer Crash Costs and Injuries

In 2007 and 2008[12] there were about 194 reported collisions with deer in Newtown (as per NPD data). The majority of these resulted in property damage only. Using the CONNDOT data, it was determined that 69 of these crashes resulted in at least $2,000 in damages to the vehicle or an injury (and were therefore included in the database). In total there were 10 injuries to occupants of motor vehicles from these crashes within Newtown. One of these injuries one was minor, 7 were moderately severe and 2 were very severe as determined by the officer investigating the crash.

The CONNDOT data on Newtown DVCs were entered into NHTSA's MVS (software to estimate motor vehicle crash costs). The system estimated that the average annual cost (i.e. average cost for the 2 years) for these crashes was $507,471. The MVS system estimates the distribution of injuries reported by police using the maximum abbreviated injury scale (MAIS). The system also estimates the number of unreported incidents, and costs specific to the State of Connecticut. These costs are in 2004 dollars and as such are expected to be higher in 2011 dollars (especially considering that some of the costs are medical which have outpaced standard inflation).

[12] 2009 data were unavailable at the time this analysis was conducted

The accuracy of these cost estimates vary depending on the distribution of injuries from DVCs versus all crashes. These costs do not include pain and suffering but do include crash related *lifetime* medical costs, property damage (e.g. roadway and vehicle), loss of productivity (e.g. missing work, lost income), traffic delay and time for police and emergency vehicles. Some of these costs are borne by the town (e.g. officer time, damage to road signs and other infrastructure).

Note that the costs discussed in this section are only those related to motor vehicle crashes with deer and do not include other costs of deer (e.g. landscape damage and damage prevention). Nor do these costs make any attempt to put a value on quality of life lost, temporarily or otherwise, as a result of injuries.

B. DVC Countermeasures

There have been numerous studies looking at countermeasures to reduce deer vehicle crashes. Researchers have looked at deer whistles, reflective mirrors, deer fencing, deer herd reduction, and signage to name a few. According to a review study conducted by the Insurance Institute for Highway Safety (Hedlund et al., 2004) some of the countermeasures have been proven unreliable, some are weakly effective and some hold promise. Deer whistles and permanent signs (that do not vary by location and time of year) are considered ineffective.

Reflective mirrors which use car headlights to keep deer away from roadways have been well studied. The results are somewhat mixed. The lights work by scaring deer from the roadside when vehicles are present. The Strieter company conducted research evaluating the effectiveness of their product but but the methodology was problematic. However, a more recent study provides support for the long-term effectiveness of the lights. In contrast a study by University of Georgia (D'Angelo et al., 2006) finds no effect. However the University of Georgia study violated some of the assumptions regarding how the lights are supposed to be used. Specifically, they counted the number of deer around the lights. Presumably the lights do not prevent browsing/grazing by the deer but would drive them away when vehicles are present. All in all, the the findings are mixed but there is support for the concept that lights may reduce DVCs.

Feeding deer to keep them away from roadways has been shown to be somewhat effective but deer may become dependent on the food and over time more deer maybe attracted to the roadside. There are also continual costs associated with this method. Depending on the feed, there is also the possibility of increasing herd size via providing additional nutrition to the deer (Hedlund et al., 2004).

Research on contact repellents (such as those used to dissuade deer from eating desirable vegetation) have shown mixed results. The repellents can change deer eating patterns but are unlikely to keep deer away from the roadways (Hedlund et al., 2004).

Deer fencing is clearly the most effective way to prevent deer and vehicles from colliding. Tall fencing placed along the roadways prevent deer from coming in contact with passing vehicles (Hedlund et al., 2004). But such effects can be expensive, impractical and unsightly. There is also anecdotal evidence that they can sometimes trap deer within the traffic stream.

Reduction of deer herds has been proven to reduce deer vehicle crashes. In Princeton, NJ in 1972 when hunting was effectively reduced (via firearm discharge prohibition) DVCs increased 436% over 10 years. In two adjoining townships where hunting continued there was no significant change in the DVC rate (Kuser, 1995).

Deer reduction via sharpshooting has been successful at reducing deer vehicle crashes in Iowa City, Princeton, NY and Solon, OH (DeNicola & Williams, 2008). In Iowa City, DVCs decreased by 78 percent in three years; in Princeton, by 75 percent in six years; and in Solon, by 49 percent in two years. Other sharpshooting programs under way that have also demonstrated substantial DVC reduction include Mt. Lebanon, Upper Saint Clair and Solebury Township, PA, conducted by the Wildlife Services division of the USDA; Fox Chapel, PA, by the local police; and Sea Pines, SC by the resident wildlife biologist.

There are no formal studies looking at the impact of moderate deer reduction (e.g., controlled hunts) on deer vehicle crashes. However, deer reduction via controlled hunting has been shown to be successful based on unpublished data from Bernards Township, NJ. Results indicate a reduction of "deer road kills" by 65 percent in nine years. The minimum reduction needed to measurably reduce DVCs is also unknown. However, it is generally agreed that fewer deer will result in fewer deer vehicle crashes (Hedlund et al, 2004; Sullivan & Messmer, 2003).

Cutting foliage back away from roadways has also been shown to reduce deer collisions. Presumably this allows vehicle operators extra time to see approaching deer and engage in evasive maneuvers to avoid collision (Hedlund et al., 2004). Deer may also stay farther away from the roadways if no cover is available.

Temporary signs posted during deer migration have been shown to be effective but it is unclear whether this method would work for the relatively less migratory white tailed deer found in Newtown. However, placing signs out during rut (usually October through December) in frequent crash locations may be effective (Hedlund et al., 2004). There is also evidence that signs that display their message only after detecting deer movement (active signs) may be effective.

Lastly, there is some evidence that educating the public regarding deer vehicle crashes may help drivers avoid some crashes. Specifically, drivers need to be aware of times of day and when rut occurs.

C. Recommendations Passed by the TBDAC

1. The TBDAC concludes that the Town consider the use of temporary signage during rut season (mid-October through mid-January)—based on crash data present in Figure 4.3 to warn drivers of potential deer crashes. Sign placement should be based on high frequency crash sites. (11 yes)

2. The TBDAC concludes that the Town consider engaging in some highly visible public information and education program to educate the public on the risk of DVCs during rut. This effort should be "rolled out" annually starting in October. (11 yes)

2A. As part of this conclusion, we ask the Town to consider enhancing the awareness program by supporting a school-based contest to create the message to be rolled out. (11 yes)

3. The TBDAC recommends that at high DVC locations, to the extent possible, the Town clear foliage from roadsides in an effort to increase available reaction time for drivers to avoid deer crashes. (11 yes)

4. The TBDAC concludes that the Town consider engaging in some form of deer population control to reduce DVCs. Such control could be focused on high DVC sites. (8 yes, 3 no)

5. The TBDAC recommends that the Town considers the use of reflective lights (e.g., those produced by the Strieter Company) to deter deer from roadways. (10 yes, 1 no)

D. Recommendations Rejected by the TBDAC

1. The TBDAC recommends that the town considers installing fencing along some roadways with particularly high rate of DVCs. (2 yes, 9 no)

CHAPTER 7. TICK-BORNE DISEASE PUBLIC INFORMATION AND EDUCATION PLAN

The goal of this section is to provide the Selectmen with a four-step strategic plan for public education on tick-borne disease (TBD) prevention through tick avoidance, tick identification, and awareness of potential infection. The first step proposes a strategy for *effective* dissemination to the public of health messages. The second and third steps consist of *determining topics* to be disseminated to the public, and *when, where and how* to disseminate that information. The next section offers suggestions (some of which are mentioned in other sections of this Report) on how *management of Town-owned property* could reduce risk of TBD by users of those spaces. A final section will suggest additional public forums to educate the public on the Town's proposed plans to combat TBD.

A. Background: Newtown's Current Education Prevention Efforts

The efforts to education the public in Newtown about TBD up to this time have included efforts through the private and public sector. These include the BLAST message (further elucidated below), which has been adopted by the Housatonic Valley Council of Elected Officials (HVCEO) to promote one major prevention message consistently throughout the area through a collaborative effort of health districts. (HVCEO is a ten-town regional coordinating body composed of Bethel, Bridgewater, Brookfield, Danbury, New Fairfield, New Milford, Newtown, Redding, Ridgefield and Sherman.)

Information has been disseminated to the public in various formats and locales. At the level of town governance, Newtown has posted signs warning of tick infestation in high-risk areas. The School District Health Coordinator has supervised the addition to grammar and high school curricula of age-appropriate TBD avoidance information, and has broadcast TBD prevention through various media outlets, including The Bee and local channels 17 and 21. Public and private sector entities jointly have distributed information through health fair presentations, talks to the public and targeted presentations to groups that are at higher risk of TBD.

B. Attitude/Behavior Change and the Health Belief Model

Several members of the TBDAC have been active for years in the efforts to educate the public about TBD prevention. They, and the other TBDAC members, feel that the prevention message, in its current form, has reached it useful conclusion. That is, in its current form the education and public information dissemination is not reaching new audiences and/or failing to impact their behavior regarding TBDs. There are some potential flaws in the current campaign. Behavior and attitude change comprise a complex issue.

For example, one would imagine that individuals who understand the consequences of smoking would never start. However, knowing the risk apparently is not sufficient. Compounding the situation is the problem that unlike smoking, for which the negative effects on health are well known by the population, the population is less well informed of the risks of TBDs. People are excellent at thinking up excuses and/or rationalizing unhealthy behavior. The Health Belief Model outlines a strategy to change behavior.

The Health Belief Model (Hochbaum, 1958, Rosenstock, 1974) states that a positive change in behavior will occur when individuals believe that they can effectively engage in behaviors that will prevent a negative health consequence to which they are susceptible. Thus, one must: believe that she or he is likely to fall victim to the disease; believe that the disease has adverse consequences for her or his well-being; believe that preventive behavior is effective; and believe that she or he has the ability to engage in the behaviors. All this must happen, and the person must remember to do the behavior, in order to engage in the preventive behavior.

Why have current education efforts to decrease tick-borne disease been ineffective? First, many of the citizens of Newtown may not be aware of their susceptibility to the disease. Local and statewide news media seem to report less on Lyme disease (and rarely other TBDs) than in the past. A search of Google News (key words: Lyme Disease Connecticut) shows 19% fewer articles in the 4-year period of 2007 to 2010 compared to the 4-year period 1998 to 2001. This difference is likely an underestimate as newer articles are more likely to be available to electronic searches than older ones. This lack of newsworthiness of the diseases may lead to an illusion of low risk. Indeed the likely cause of less media coverage is that it is "old news." Nothing has changed and so reporting on the topic is not likely to attract an audience. The problem is, however that *nothing has changed*--the diseases are still present and maybe even becoming more prevalent.

Second, many citizens may not be aware of the potential severity of TBD. Some may know that Lyme infection is easily treated by a few doses of an antibiotic but they may not be aware of the consequences of untreated Lyme. There also appears to be a lack of awareness by the public regarding other diseases carried by ticks including the devastating effects of anaplasmosis.

Third, there has been poor follow through on the part of individuals to follow basic recommendations for self-protection. There are clear and easily recognized benefits of preventive behaviors. Simply put, they reduce chances of contracting disease and/or assist in early detection of disease. Indeed the "barriers" to these behaviors are generally not extreme. Some suggestions like avoiding high-risk areas may be problematic for some (e.g., hikers, outdoorsmen and those who work in risky environments) but these can be overcome by engaging in some of the other behaviors (e.g., clothing, tick checks, personal sprays). The proactive and preventive behaviors themselves are usually quite simple, thus inability to take recommended precautions should not hinder behavior change regarding TBD. Finally, visible reminders in the form of signs and regular messages with varied content in multiple formats, content and dissemination resources, will remind the public of the dangers and preventive behaviors.

C. Message Content

Research also suggests that although simple messages are easily understood when disseminated through audio and/or visual media, complex messages must be read to be best understood (Chaiken et al., 1978). Thus, public health information being disseminated on a mass scale will most effectively reach its target audience via a simple message that directs individuals to a website or readily available pamphlet for further details. There is an abundance of information to disseminate on the topic of TBD, some of which can easily be displayed on a banner or billboard, while more complex aspects may need to be "teased" as a simple message, and then explained in writing. Additionally, active learning may be more effective than passive learning in terms of retention and maybe even understanding. Therefore messages may also be

spread in the form of an online or pamphlet-based quiz (for an example quiz, see CDC online quiz: http://www.cdc.gov/ lyme/quiz/).

There are several important messages that need to spread to the public. Below is a list of suggested topics.

1. Tick Avoidance, Tick Reduction

The town should point residents toward the Connecticut Agricultural Experiment Station (CAES) *Tick Management Handbook, Revised Edition* (Stafford et al, 2007) which is available online and contains details of many of the points highlighted below.

- Limit activity in high tick density areas: Residents need to be informed about where ticks thrive (e.g. tall grasses, pachysandra fields etc). Walking "off the beaten trail" may increase one's likelihood of contacting ticks for instance. This suggestion may impact daily activity and may not be feasible to all (e.g. those working in such environments).

- Residents should be informed that areas with high deer densities may be more prone to also have high tick densities.

- Personal protection: Residents should be advised to wear light colored clothing to make it easier to see ticks on them. Also, it is advisable to tuck pants into socks so that ticks do not crawl up pant legs and gain access to skin that way.

- Spraying one's body or clothes (including footwear) may prevent ticks from attaching. Different sprays have different costs and benefits. Families should be made aware of what sprays are designed for clothing (versus direct skin contact) and which are recommended for safe application to children. There even exists clothing already infused with permethrin.

- Landscape design (also see forestry section): Property modification (lawn mowing, mulch borders, swing sets/jungle gym placement) can also reduce the number of ticks on property or contacts with ticks that are in the property. Stafford recommends that areas intended for children should not be in shaded border areas of property. Residents should be informed that up to 75% of Lyme disease cases are believed to stem from ticks picked up in people's own backyard.

- Monitor, treat and check pets: Not only will checking and treating pets decrease the pet's chances of getting TBDs but may prevent a tick from reaching family members after being brought inside by a pet. However, some methods of preventing ticks from attaching to pets may make them more likely to release from a pet and become available to attach to a family member. It is also advisable to prevent pets from entering high-risk areas if possible, and to bathe pets after such excursions.

- Limit deer access to property: To the extent that deer carry ticks onto the property, deer fencing limits their access and decreases their likelihood of coming into contact with a tick. To the extent that hunting on personal property is part of a Town-wide strategy for deer herd reduction, the Town may opt to include such a message.

- The Town may choose to qualify the message to include those homeowners with *very* large properties, or those within a group (or "alliance") of homeowners willing to act together, may benefit by personal property hunting even in the absence of a town-wide strategy. Residents should be made aware that the State's Department of Environmental Protection (DEP) had expressed a willingness to provide help regarding deer issues.

- Residents should be discouraged from feeding deer and perhaps encouraged to plant non-invasive deer-resistant plants.

- Property spraying: Judicious and "season-appropriate" spraying of areas of personal property where ticks are likely to be abundant can significantly decrease risk of TBD. Spraying during early spring should target all ticks in the area. Thus, one spraying (maybe two), depending on the spray, should seriously reduce the number of ticks in one's yard. Some companies recommend more frequent spraying. Given that ticks travel only a very short distance, the initial 1 or 2 sprays should be adequate but there is a chance that an occasional tick will travel in on an animal. Spraying should be done annually because a small number of adult females that enter the property can produce very large numbers of offspring. There are wide range of sprays that can be used on one's property, each with its own pros and cons. It is recommended that the message delivered by the town leave the choice of product to the property owner and maybe provide examples of the most popular effective sprays.

- Rodent reduction. Rodents such as mice and chipmunks transmit diseases to ticks. Residents should discourage and reduce rodent infestation by decreasing or eliminating habitats that encourage their propagation and food sources.

- Tick checks and identification**:** It is a commonly held belief that dog ticks are big and that deer ticks are tiny. This is a myth that may lead individuals to ignore a tick bite by a relatively large tick even if it is a deer tick (i.e. they misidentify a deer tick as a dog tick). As described in the Epidemiology section, ticks pass through three different life cycles, including the large adult stage (often mistaken for dog ticks). Rather than attempting to assess risk by size or appearance of tick, individuals should be encouraged to follow precautions uniformly.

- The deer tick larva is about the size of the period at the end of this sentence (see Figure 2.3). The nymph is about the size of a poppy seed, and the adult is about the size of a sesame seed. Nymphs, when questing for hosts in late spring and early summer, are often found at ankle height. Adult ticks, when questing for hosts in the fall, are often found at waist height. Again, the main point to disseminate here is that size is not a good judge of what type of tick one finds.

- Bathing/Showering**:** Bathing/showering after doing outdoors activities has been shown to reduce risk of TBD, but the mechanism is unknown. It can be by removing clothes that may have ticks on them, or by "washing away" unattached ticks, or both.

2. Disease

Health messages should encourage anyone who believes they may have been bitten by a tick (even in absence of symptoms), who develops an unusual rash or who is feeling unwell, should be evaluated promptly by their physician. In addition, health messages should emphasize that a single dose of a prophylactic antibiotic can reduce by 90% the chances of acquiring Lyme disease when someone is treated within 3 days of finding an engorged tick. Symptoms of possible TBD are reviewed below in the BLAST message. At the very least such a message should include that the bulls-eye rash is *not* a requirement for Lyme disease and is not at all associated with other TBD. The Town may opt to include other common symptoms of TBD in its messaging (assuming that there would be no liability issues associated with such action) to encourage prompt medical treatment of any infection.

In addition, messages should stress that unlike some diseases such as chickenpox and measles, Lyme disease can be reacquired.

Residents may also be made aware of the current research related to Lyme vaccines. Given the difficulties with Lymerex and bad press associated with vaccines in general, residents may be wary of any future vaccines. A vaccine against Lyme has the potential to effectively eliminate the disease.

3. Comprehensive Message (BLAST)

The BLAST message constitutes an easy-to-remember list of behaviors that can reduce likelihood of becoming infected with a TBD. Although the BLAST strategy is already disseminated in many towns, including Newtown, most TBDAC members had not heard of this message prior to joining the Committee, so more widespread and/or effective dissemination of the message may be warranted. Many of the components listed above are described in the BLAST message. Mrs. Donna Culbert, the Newtown Health District Director, has modified and expanded the original BLAST message (See Appendix A—Jennifer Reid—for a description of the original BLAST message). Because the BLAST message is simple and easily identifiable, because it promotes **ease** of behavior, and **remembering** the behavior (two key components to changing behaviors towards positive health), this is an effective tool to reduce TBD. More effective dissemination of this message will reduce incidence of TBD. The BLAST message, as expanded by Mrs. Culbert:

After BE AWARE, **B** stands for **bathing** soon after spending time outdoors. A recent study showed that people who bathed or showered within 2 hours of coming indoors did not contract Lyme disease as frequently as those who did not bathe or shower promptly.

L reminds everyone to **look** their bodies over for ticks daily and remove them properly. Speedy removal helps avoid disease transmission. Remove ticks carefully by their mouth parts with a tweezers and save them in a plastic bag for identification. Contact your local health department for tick-testing policies and notify your physician if you have any concerns. “L” also reminds us to look for expanding rashes and reported them to your physician in a timely manner. The painless erythema migrans (EM) rash sometimes seen with Lyme disease can often go unnoticed and will eventually disappear while the infection remains. Other early symptoms include fatigue, headache, fever and achy muscles and joints.

A encourages you to **avoid** ticks when possible, and to become educated about repellants and **apply** them appropriately. Know where ticks live and **avoid** those areas: Ticks don't like sunny, dry areas; they like shade, shelter and moisture. Ticks can be found in leaf litter, shaded gardens, weeds, tall grass, shrubs, low trees, and ground cover like pachysandra. Dress properly when entering potentially tick-infested areas: Wear long pants that are light-colored to allow easy identification of ticks. Tuck your pant legs into socks and shirt into pants. Tape pant legs and wear long sleeves when working near the ground. Cover hair with a hat. Tie long hair back. **Apply** repellent. Studies have shown that applying 30-40% DEET-based repellent to skin is effective at repelling blacklegged (deer) ticks. Application of 0.5% permethrin-based insecticide to clothing is highly effective at repelling and even killing ticks. Clothing treated with permethrin can be washed several times and still retains its repellant properties. The use of repellants, while proven effective is a personal decision. For more information on tick repellants, visit the National Pesticide Information Center's website.

S stands for **safeguarding** your yard to reduce your possible tick exposure. **Spraying** the yard can reduce tick abundance. Homeowners should consider the benefits of applying pesticide to the perimeter of their yards. Studies have shown that even one application of pesticide at the right time of year and in the best location can reduce blacklegged tick populations by 85 – 90%. Complete information on tick management is available at the CAES website. Additional **safeguards** include creating a "Tick Safe Zone" (see Attachment 9), in which the homeowner manages their yard to make it less hospitable to ticks, by doing the following: remove leaf litter and clear tall grasses and brush around homes and at the edges of lawns; place wood chips or gravel between lawns and wooded areas to restrict tick migration to recreational areas; mow the lawn and clear brush and leaf litter frequently; keep the ground under bird feeders clean; stack wood neatly and in dry areas; and keep playground equipment, decks and patios away from yard edges and trees. Deer play an important role in the tick's life cycle, often serving as the third and final blood meal. Deer should be discouraged from migrating into your yard by using noninvasive deer-resistant plantings and residents should not feed deer. The Health District has an excellent brochure that can guide homeowners with making changes in their yards.

T reminds everyone about **treatment.** In general people who begin medical treatment soon after becoming infected, have a quicker and more complete recovery from Lyme and other TBD. Learning to recognize the symptoms and receiving early medical **treatment** will help to prevent more serious illness. Erythema migrans (EM) is a rash and can be the first symptom of Lyme disease. The telltale rash starts as a small red spot at the site of the bite and gets larger over a period of days or weeks and forms a red rash shaped like a circle or oval. Not everyone gets or sees the rash. Other symptoms can include fever, headache, stiff neck, body aches and tiredness. Although these symptoms may be like those of common viral infections such as the flu, Lyme disease symptoms tend to continue longer or may come and go. Lyme disease can also affect your nervous system, causing symptoms such as stiff neck, severe headache (meningitis), temporary paralysis of the facial muscles (Bell's palsy), numbness, pain or weakness in the limbs and poor muscle movement. Other more serious long term affects may include memory loss, difficulty with concentration and change in mood or sleep habits. Less commonly, people who have not taken antibiotics may develop heart or other problems weeks, months, or even years after they were infected with Lyme bacteria. Receiving early medical **treatment** is the key to preventing long term health effects.

It is also important to **treat your pets**. Local veterinarians offer a variety of methods for protecting animals from tick-borne diseases. Dogs and cats increase one's chances of exposure to TBD. Pets can carry ticks in to the home on their fur. Pet owners should be cautious about sleeping with their pets.

D. Public Information and Education Campaign

The information described above needs to be disseminated in a manner that lets the maximum number of town residents not only see the message but notice and comprehend the message. The message should result in behavior/attitude change. Thus the messages need to be highly visible, easily understood and conform to the ideas in the Health Belief Model. The town has engaged in community education aimed at residents from all sectors of the community should continue to be addressed with education efforts. Families with children, adults, senior citizens, athletes, outdoor workers, outdoor enthusiasts (gardeners, golfers, hikers, campers, etc.) are the goal target group for the messaging. Ideally, the message would reach folks in the many areas of their everyday life.

1. Highly visible teasers

The first step is for the public to see messages that address their risk and the consequences. These should include information on where they can go to find out what to do. These teasers should be catchy slogans and easily understood facts. Things like "Got ticks?" or "Got Lyme (yet)?" with reference to the Newtown Health District website citing Lyme disease statistics and briefly explaining potential consequences of untreated tick-borne disease.

These public service announcements (PSAs) should be spread with extra publicity at least once per year. This general message should utilize paid billboards and free media, including banners (for example above Queen Street), radio station segments, and news media spots following press releases or press events. One-time designed PSAs can be made or student contests can be used to create them. To date, Newtown has used print messages (flyers, magazines, newspapers, newsletters, mail), television (local news, local cable stations), and radio. Radio spots could be utilized, possibly as a regional effort to help bear the financial commitment. Billboards can also be used as part of an effective media campaign. Posters with the messages should be widespread and conspicuously displayed, at locations and venues such as:

High School Health Fair (Spring)
Community Wide annual Health Fair (Fall)
Warning signs at schools and recreation areas
Display information at community events
Town Hall
Grocery stores
Doctors' waiting rooms
Hospitals
Visiting Nurse Association
Veterinary offices
Pharmacies/grocery stores/health stores/pet stores
Schools
Churches

Nurseries and gardening supply stores
Hardware stores
Stores that cater to outdoor activities (i.e., EMS)
Civic groups and clubs
The Newtown Patch

Second, Newtowners should be made aware of the potential for adverse consequences and ways to ameliorate their risk. This would include not only the information advertised above, but additionally, specific time-sensitive messages to be shared periodically through posters and email blasts (sent to residents who have registered to receive Newtown advisories and to anyone else who registers to receive them). Messages could also be included in tax bills (those that go to residents, not to mortgage holders) and could potentially also be included as an insert in The Bee Extra, The Pennysaver, and other mass circulations, by agreement with other entities. These bulletins should attempt to carry a brief message relevant to the season.

Message of the Month re TBD to enhance efforts to increase public awareness of TBD, and to engage Newtowners as active partners in the efforts to decrease TBD. Each *Message of the Month* (perhaps designated as from the Selectmen) could be circulated broadly via print, on line (Newtown Health District website, emails to Newtowners), posters at appropriate locations (see above), brief presentations in schools and at other gatherings, and potentially circulation with the assistance of The Bee and would consist of succinct messages of varied content to capture attention. In order to give people time to act, messaging suggesting action should *precede* the month in which action should take place. Ideas generated by during TBDAC meetings include:

- January: TBD is preventable and treatable! If you have been bitten by a tick, see your physician!
- February: Ticks emerging! Topical repellents protect you and your animals!
- March: BLAST message.
- April: Ticks hate mowed lawns! Wood chips around perimeter inhibit tick infestation on your property!
- May: If you intend to spray against ticks, this is the month to do it!
- June: Are your children playing where ticks hang out? Move swing sets from shaded edges of lawn where ticks live!
- August: TBD management plans: Hunting, Four Posters.
- October: Protect yourself during leaf litter (fall cleaning) removal
- During Rut Season: Poster depicting teenagers in a car driving down a road, his arm over her shoulders. Further down the road, attractive doe on one side of road, with buck eyeing her from other side. Caption: Love is in the air. Rutting season. Drive with caution!

Messages are more effective when message recipients become involved (i.e., active learning). In this spirit, if one or more artistic high school students could be enlisted, they could illustrate the pictorial *Message of the Month* and gain recognition for their effort. Perhaps there could be a high school contest for "illustration of the month." These posters could be widely disseminated with help of current and potential media partners to get message out (see suggested circulation sites suggested above).

2. Other Public Awareness Methods

a. Board of Education:

- The Board of Health has an age-appropriate program approved for children. An effort to augment that curriculum without increasing the town budget could include participation by children themselves in the message. These could include:
    - High school illustration of *Message of the Month*;
    - High school enactment of *Message of the Month* delivered in grade schools;
    - High school play (with humor) depicting TBD (could feature a mouse, tick, deer and human), with additional participants presenting the various ways that one can reduce risk of TBD, to be presented in grade and middle schools (and possibly to parents);
    - Walk-a-Thon to increase awareness of TBD prevention.
- Newtown schools can provide in-services for all staff on TBD.

b. Non-school related activities:

- The focus here would be all the various sports teams, groups, clubs, gatherings, etc. of children that are supervised by adults. Coaches and other team leaders, scout masters, etc. should be fully versed in and communicate to parents the message of TBD prevention. Each such individual should be fully versed in the ***BLAST*** message and have a written handout for parents that impresses upon them not only the risk that is present that could affect their child but also their ability to attenuate that risk (see Health Model Theory above).

3. Education of New Residents

- A succinct handout included in a welcome package (perhaps along the guidelines of BLAST) would reach individuals potentially unfamiliar with TBD.
- Publicity events and fund raisers may also be beneficial. For example, one of the Newtown 5k races can be used as an event to promote TBD awareness. It can be renamed, for instance, the 5k Run for Lyme (or something encompassing TBD in general). The race could be followed by a health-type fair dedicated to TBD.

4. Health District

- People should be informed regarding the testing of ticks removed from a person (whether or not they are engorged).

- Newtowners should advised to communicate with their physician whenever they discover a tick bite.

E. Recommendations Passed by the TBDAC

1. The TBDAC recommends that the Town engage in a public information and education campaign (PI&E) to run at least annually (with some periodic continuation of seasonally relevant messages). Ideas for such a strategy are contained in this report. (11 yes, 0 no)

2. The TBDAC recommends that the PI&E campaign be designed to maximize its effectives by considering relevant theory related to health behavior modification (e.g., Health Belief Model). (11 yes, 0 no)

3. The TBDAC recommends that the messages included in the campaign include the topics described in the "Education" section of this report. (11 yes, 0 no)

4. The Town should stress the relationship between deer and tick. (6 yes, 5 no)

5. The Town should stress judicious property spraying as described in the report. (10 yes, 1 no)

6. The TBDAC recommends that the messages be disseminated in such a way to reach the maximum number of residents and that there should therefore be a wide variety of paid (e.g., billboards, radio) and free/minimum cost (e.g., banners, flyers, signs) media used. (11 yes, 0 no)

7. The TBDAC recommends that coordinator(s) be appointed to help implement the recommendations from the committee adopted by the Town. (11 yes, 0 no)

CHAPTER 8. MUNICIPAL MANAGEMENT STRATEGIES

Effective municipal-level strategies will markedly reduce risk of acquiring TBD in the public domain. Dr. Kirby Stafford and other experts recommend an integrated multi-faceted pest-management program and creation of "tick-free" zones (Stafford, 2007, p 44; Par-tick-ular Park Booklet for Municipalities, Weston/Wilton Health District, Attachment 10).

A. Decrease Risk of Tick-Human Encounter

Certain environments are tick friendly, and simultaneously attract animals that infect ticks (e.g., rodents) as well as animals that transport and feed ticks (e.g. some avian species; small, medium and large mammals). Human tick bites occur when individuals brush against vegetation containing ticks. The greatest density of ticks occurs in shaded damp environments, in areas of shrubs and overgrown vegetation, and in edge habitats (e.g., along trails and perimeters of property where vegetation abuts cleared space). Forests with overgrown invasive plants, particularly barberry, tend to have higher tick densities than forests without invasives.

Integrated landscape management markedly reduces the risk of TBD. A combined approach using landscape modification, acaricide sprays and posted warnings in tick-friendly public surroundings would decrease the exposure to ticks and TBD.

- Sports Fields. Assess fields and perimeters, apply appropriate measures. E.g.: Grounds/playing fields: well-mowed grass. Perimeters of fields (edge habitats): mow/brush-hog/weed-wack overgrown shrubs and vegetation; remove vegetative litter and brush; spread wood chips; spray acaricides at appropriate intervals; consider fences to prevent balls (and children) from leaving playing field.

- Town Trails. Maintain trail width (reducing tick encounters) by trimming vegetation, particularly invasives, along paths. Public recognition by Selectmen for volunteer efforts by community groups (to date, Lions Club, Conservation Commission, Boy Scouts) to increase community awareness and participation in trails maintenance.

- Roadsides. Brush-hog overgrown vegetation regularly from late Spring through September to remove tick- and rodent-friendly habitat. Additional gains: improved visibility with fewer DVCs; fewer non-deer related car accidents (wider roads, better visibility); reduce overgrown invasives.

- Edge Habitats. Human creation of edge habitats in Newtown by cutting large parcels of property into smaller parcels has significantly contributed to the risk of acquiring TBD in Newtown. Wherever and whenever feasible, minimize further land and forest parcel fragmentation.

- Acaricide Sprays. Properly timed and strategically applied sprays kill up to 95% of ticks. Recommend application of sprays along perimeters of schools and parks and along high-volume trails and pathways. Toxicity profile and community acceptance of sprays varies. Currently available tick-cidal sprays include chemicals and botanicals (herb and flower-based, e.g. garlic and Eco-EXEMPT IC2). Tick-selective biologic sprays (e.g., Tick-EX-EC, tick-parasite

nematodes) are in research and development; Tick-EX-EC should be available in the near future. If the Town implements 4-Poster devices, spraying in deployed areas may become redundant.

B. Educate community members who are at increased risk for contracting TBD and/or who supervise children who are at increased risk because of outdoor activities

- Training sessions for team coaches, camp counselors, Scout leaders and other adults supervising children outdoors.

- Educate parents whose children are involved in outdoor activities and adults who are involved in recreational outdoor activities (e.g., gardeners, hikers).

- In-service sessions for town employees at risk of exposure (e.g., Parks and Recreational Health), provide permethrin for clothing.

- Educational information should include preventative information (appropriate clothing, personal protection, BLAST message), proper tick removal methods, and recommendation to contact health care provider immediately if tick bite is discovered. BLAST cards or handouts for easy reference could be included with registration confirmations and provided at informational sessions.

CHAPTER 9: THE VACCINE SOLUTION

Vaccines represent one of the most effective mechanisms to combat infectious disease. Dr. Kirby Stafford repeatedly has stated that a safe, effective vaccine is the best hope for controlling or even eradicating Lyme disease (Stafford, 2007).

Exposure to a bacterium stimulates the human immune system to create antibodies that recognize and attack that specific organism upon re-exposure to that bacterium. Most vaccines mimic this immune response without exposure to the organism itself, sparing the effects of disease while creating antibody resistance should exposure occur. However, natural antibodies against the Lyme spirochete bacterium (*Borrelia burgdorferi)* do not afford lasting immunity, that is, people with measurable antibodies can contract Lyme disease repeatedly. An effective Lyme vaccine would have to stimulate an effective immune response. This is an obtainable goal—three injections of Lymerix, a Lyme vaccine approved in 1998 and discontinued shortly thereafter (see explanation below), demonstrated 75% efficacy in preventing symptomatic Lyme disease and 100% of asymptomatic infection.

Impediments to development of a safe, effective vaccine include the limited number of States (12) where Lyme is endemic, limiting pharmaceutical companies' potential sales and profit, as well as potential litigation issues surrounding any vaccine. Despite this, several vaccines are currently in development; the most promising creates antibodies to tick saliva (a very significant infection-facilitating factor) (HHMI, 2009).

It is the hope of the TBDAC that politicians from endemic states will work together to encourage the development and monitoring of a safe and effective vaccine. A multi-state collaborative effort to eradicate Lyme disease, enlisting the support of organizations such as the Gates Foundation, offers the best opportunity to combat the disease in a timely and cost-effective fashion.

A. Lymerix Vaccine

The original Lyme disease vaccine stimulated production of antibodies against a surface protein of the Lyme spirochete (Piesman & Hayes, 2009). Lymerix was clearly effective. As reported by a study by Tufts University School of Medicine, after the first two injections, vaccine efficacy was 49% (i.e., ~50% decreased risk of contracting symptomatic Lyme); after the third injection, efficacy was 76%. Asymptomatic Lyme vaccine efficacy rates were 83% and 100%, respectively. The paper concluded that three injections of vaccine prevented most definite cases of Lyme or asymptomatic *B. burgdorferi* infection.

Shortly after Lymerix was commercially available, it was pulled from the market. The manufacturer cited poor sales, but it is probable that litigation concerns over purported side effects reported by the public after receiving the vaccine also were involved in this decision. The Vaccine Adverse Event Reporting System (VAERS), a CDC- and FDA-sponsored program, monitors post-licensure vaccine safety and requires medical providers to report clinically significant medical events that occur after vaccination, even if the provider cannot be certain that the vaccine caused the event. Careful analysis of the data suggests that the vaccine was safe and that reported side effects were coincidental rather than caused by the vaccine. However, there was significant public opposition to these findings, based on methodology, Lyme

disease definitions, and concerns about possible stimulation of autoimmune responses that could create reactivate Lyme and create new autoimmune diseases.

The TBDAC includes this history not to debate the Lymerix vaccine but to provide the background for the first Lyme vaccine and to suggest that development of a safe and effective Lyme vaccine is a realistic goal.

B. Analysis of Reported Lymerix Vaccine Adverse Events

Below is the abstract of a report from Lathrop et al. (2002) describing the evidence related to adverse effects of the Lymerix vaccine.

OBJECTIVE: To evaluate adverse events following Lyme disease vaccination reported to VAERS during the first 19 months of the vaccine's licensure. Design, setting, and participants: Analysis of all VAERS reports of adverse events following vaccination for Lyme disease in the US from 28 December 1998 to 31 July 2000. MAIN OUTCOME MEASURE: We evaluated reported adverse events for unexpected patterns in age, gender, time to onset, dose number, and clinical characteristics and compared them to adverse events observed in clinical trials of this vaccine. RESULTS: Over 1,400,000 doses were distributed and 905 adverse events were reported to VAERS, 440 in men and 404 in women, with ages ranging from 10 to 82 years. The majority (56%) of adverse events occurred after administration of the first dose. The most frequently reported adverse events were arthralgia [joint pain] (250), myalgia [muscle aches] (195), and pain (157). There were 59 reports coded as arthritis [joint pain with inflammation], 34 as arthrosis, [joint pain without inflammation], 9 as rheumatoid arthritis, and 12 as facial paralysis. Sixty-six (7.4%) events were classified as serious, involving life-threatening illness, hospitalization, prolongation of hospitalization, persistent or significant disability/incapacity, or death. Twenty-two hypersensitivity reactions were reported. CONCLUSION: Based on reporting to VAERS, we did not detect unexpected or unusual patterns of reported adverse events following Lyme disease vaccine administration, other than hypersensitivity [allergic] reactions, compared with adverse events observed in clinical trials.

C. Recommendations Passed by the TBDAC

1. It is the consensus of this Committee that a safe and effective Lyme vaccine offers the best hope to combat Lyme disease. (6 yes, 5 no)

2. The Committee recommends that the Board of Selectmen pursue state and regional cooperation to facilitate the development and deployment of said vaccine. This could include financial assistance, some form of legal protection and community education. (6 yes, 5 no)

CHAPTER 10. SUMMARY OF MUNICIPAL COMMITTEE REPORTS

What follows is a brief review of Appendix B, "Summary of Municipal Reports". From the many municipal deer management committees reviewed by the TBDAC, there were many similarities in their findings and conclusions, including:

- High density of deer is correlated with high rates of Lyme and other tick-borne diseases (TBDs).
- Ecological impacts to the forest and landscapes are significant.
- Deer-vehicle crashes (DVCs) are significant and underreported.

Deer reduction was a major recommendation of all communities studied, with the exception of Weston. Although there is limited available evidence of deer reduction to date in these communities, the towns acknowledge that reducing the deer population will take many years and may become increasingly more challenging as hunters have to spend more time to achieve their goals. Yet, they all feel that they are on the correct path and that reducing the deer population is the key to reducing TBD, and have rejected letting nature take its course.

Many towns studied targeted particular deer density levels (typically 10 d/mi^2) that have been demonstrated to result in significantly reduced deer impacts. By contrast, Lower Makefield County, PA, is worth noting in that their goal was not to achieve a particular deer number, but rather a quantifiable reduction in deer impacts. They opted to monitoring deer presence and reproduction with low-cost yet effective cameras. In addition, Lower Makefield will monitor the trends Lyme disease cases within the community with an annual survey.

Professional surveys conducted in four Fairfield County towns all support the conclusion that TBDs are a major concern to communities and that the vast majority of residents have been negatively affected by rising TBD rates. In addition, a large majority (averaging 75%) support some form of deer reduction program.

Another important finding is that prevention efforts over the last decade have shown limited effectiveness. Vázquez et al. (2003), reported that, "checking one's body for ticks and spraying the property with acaricides were not effective... Using protective clothing was 40% effective and routine use of tick repellents on skin or clothing was 20% effective."

This finding of limited tick check effectiveness is further supported by two different professional surveys in New Canaan in 2000 and Wilton in 2002. Both surveys reported that 87% of residents do tick checks after being outside. By contrast, Connally (2009) found that tick checks and bathing were effective to reduce TBD risk.

Various other recommendations were considered by the other municipal committees reviewed. 4-Posters were not considered by any CT deer management committee, while outside Connecticut, 4-Posters were recommended in Nantucket and not recommended at present in Lower Makefield Township.

Municipal committees recommended a variety of education efforts that included:

- Improved educational efforts for both communities and schools.
- Placing an emphasis on improved personal protection and landscape modification techniques.
- Building community exclosures to demonstrate the role that overabundant deer have on our environment.

CHAPTER 11. PERFORMANCE METRICS

The Committee believes that it is important that the Town should monitor and periodically assess the relative success of the various recommendations that are adopted in addressing tick-borne disease (TBD) and the other concerns discussed in this Report. TBD is a long-term problem for Newtown, and measuring whether the steps taken to address TBD are yielding positive results may help future Town leaders in determining whether adjustments to Newtown's Tick-Borne Disease Management Plan may be appropriate.

The success or failure of the Tick-Borne Disease Management Plan (and related recommendations) can be measured through a variety of approaches, each with their own strengths and weaknesses. A combination of multiple performance metrics is likely to be superior to reliance on any single approach. Because reducing the incidence of TBD is ultimately the goal of the Tick-Borne Disease Management Plan, accurate measurement of disease *trends* would be the "gold standard" in assessing the effectiveness of the overall plan. Accurate reporting of Lyme disease is notoriously difficult and often contentious, however, so alternative metrics may be necessary as a supplement or alternative to disease statistics. Periodic measurements of tick density and/or deer density are potential tools in this regard, although these metrics are obviously less direct measurements than data on changes in disease incidence itself. Finally, because most monitoring systems will require some degree of cost, it may be necessary to make trade-offs in arriving at an optimal surveillance plan. The most important element for tracking purposes is that a set of metrics are selected that can be applied in a reliable and consistent manner over the indefinite but lengthy period of time during which Newtown will continue to grapple with endemic TBD.

Any potential measure of performance risks can generate misleading or useless information if not properly designed and implemented. It will therefore be important to consult with appropriate epidemiological and other relevant experts in advance of launching a monitoring program. Experts from the Connecticut DPH (Dr. Randall Nelson) and Western Connecticut State University (Dr. Neeta Connally) have expressed willingness to work with the town in designing a surveillance program. DEP officials are another potential resource in this regard.

Whatever measures are to be used should be implemented at the earliest possible time because it is important to have a baseline measure taken prior to the implementation (or at least prior the start of the effects of implementation) of the Management Plan so as to be able to measure changes stemming from the Plan. Many of the proposed countermeasures will not have an effect for several years following implementation (e.g., deer reduction). Others, however, may have an immediate or rapid impact. For example, direct reduction of the deer tick population (e.g., through sprays applied to environment or chemicals applied to deer), behavior-driven reductions in human tick bites (e.g., through landscape modification, appropriate clothing, avoidance of infested areas) and behavior responses to tick bites that reduce the risk of disease (e.g., through prophylactic antibiotics, immediate removal of ticks) should have immediate or at least relatively rapid effects on rates of TBD if successful.

Financially, tracking the effectiveness of the various countermeasures would be a good investment. It is possible that some of the implementation strategies would need to be adjusted to create an optimal deployment of the countermeasures. Measuring the outcome of the countermeasures is needed to know if

current deployment is having an effect. The lack of an evaluation may result in funds being expended on an ineffective program. For example, an education program may have all the right elements, but if it is not reaching the public (or changing the behavior of those it reaches), then there is a potential for wasted resources. Similarly if the Town expends funds to reduce the number of ticks, it would be beneficial to know if those funds are having the desired effect or if another strategy needs to be deployed.

Below we describe some proposed methods of tracking our success (and failures). The committee highly recommends that the town use trained professionals (when necessary) to ensure accuracy of tracking.

A. Tick-Borne Disease Monitoring

As mentioned, this is a direct measure of success, whereas most other metrics would instead measure some value that is related to TBD. That said, it is virtually impossible to accurately measure all incidence of TBD accurately. For example, patients are often treated for Lyme disease as a prophylactic following a tick bite before the manifestation of symptoms. Some portion of these patients would never have gotten the disease. Conversely, the preeminent indication of Lyme disease is the EM rash, but it does not present in all cases (or may go unnoticed). Other patients may be misdiagnosed with another disease or fail to seek medical attention at all.

That said, as long as the measurements are consistent over time, we should be able to gauge whether TBDs are increasing or decreasing. For instance, EM rashes may not present on all cases but it is believed that 1) whatever the rate of presentation is, it is stable, and 2) none of the proposed TBD countermeasures are likely to impact that rate. Therefore, even if tracking EM rashes can only count a portion of Lyme cases, it could accurately track changes in Lyme disease incidence trends. Ideally, we would be able to at least estimate the number of actual Lyme disease cases based on whatever tracking method is used, although it is not clear that there is a widely accepted figure available for the percentage of Lyme disease cases in which an EM rash is presented.

1. Active Surveillance

Active surveillance involves recruiting physicians to participate in the reporting of TBD cases. The doctors will be asked to report specific details of cases that were treated for a TBD. A key element of active surveillance is the frequent contact by data collectors with participating offices to encourage maintenance of reporting levels over time. It should be noted that active surveillance is likely to result in an increase in reported TBD cases. In some instances, cases that may not have been reported to the state may now be reported as physicians engaged in the program are more aware, and maybe more meticulous, about the reporting. Again, starting early on the evaluation will help prevent attributing any changes "caused" by this method from being associated with the countermeasures themselves.

One risk of reliance on an active monitoring program is that the significant labor required to implement such a program correctly may be hard to sustain over time. Depending on methods used, active surveillance can potentially yield biased results, especially when TBD countermeasures are deployed with a lot of publicity. In theory, countermeasures should generally work against multiple TBDs, so progress measured by active surveillance of a single disease (e.g., Lyme) may be an adequate proxy for other

TBDs. Alternatively, active surveillance of multiple TBDs would yield more specific tracking data, but would also entail greater compliance efforts.

- Pros:
    - Measure changes in "the problem" directly
- Cons:
    - Need physician buy-in
    - Labor intensive
    - Will provide only an estimate of total cases
    - Consistent methodology must be maintained

2. Use of DPH Monitoring

The Connecticut Department of Public Health (DPH) already collects and reports data regarding Lyme disease at the Town level. Unlike active tracking described above, the submission of this data to the State depends largely on diagnostic and reporting practices of individual physicians. For example, the DPH statistics rely in part on diagnostic blood work that shows evidence of a TBD, but blood work may not be requested in many probable cases of Lyme disease. The precise level of reporting to the State is unknown, and may vary with exposure to media regarding TBD. It is clear, however, that DPH statistics substantially underreport the incidence of Lyme disease. This is in part by design – in order to maintain reasonably rigorous epidemiological standards, the requirements to qualify as an official Lyme disease case are set at a level that would exclude many likely cases. Another problem with this data is that there is no guarantee of consistent reporting elements being requested from the DPH. Indeed several reporting changes over the previous years have undermined the ability to know what the true change in Lyme disease has been. If the State stops requiring labs to report for instance, it will result in the appearance in a drop of Lyme disease cases; if the State eases the definitional requirements for an official Lyme disease case, it will result in the appearance of an increase in Lyme disease cases. Thus, while DPH data offer a readily available measure of comparison of Lyme disease cases from year to year, the many flaws of such data militate against their use as the primary measure of effectiveness of a Tick-Borne Disease Management Plan.

- Pros:
    - Free, data already exists
- Cons:
    - Substantial underinclusion; periodic changes in methodology complicate year-to-year comparisons

3. Annual Household Surveys regarding TBD Incidence

Another possible method to monitor TBD trends would be to conduct an annual or biennial telephone or web-based survey that asks residents directly about their experiences with TBD over the previous year (or possibly some other period). A somewhat similar type of survey has been done in Newtown in the past on a pro bono basis by a professional survey firm.

A properly designed and conducted survey could be useful in tracking the effectiveness of various countermeasures in several respects. Notably, survey questions can be geared towards specific countermeasures. That is, questions can assess the extent to which the sample has been exposed to any education messages; has changed their behaviors associated with disease risk; and has actually experience the diseases. Unlike alternative measures, a survey can measure exposure risk as a function of behavior – for example, the extent to which residents have modified their behavior (e.g., tick checks, clothing modification, time spent in high infestation areas) and environment (e.g., landscape modification, spraying, fencing) to reduce the likelihood of contracting TBDs. A survey could also potentially help identify locations at which to focus town efforts – for example, if survey responses regarding public recreational sites show that Al's Trail is in particularly heavy recreational use among town properties, that data might inform a decision to deploy a higher-cost countermeasure such as 4-Posters or sharpshooters in that area.

Among the potential drawbacks of surveys is their cost, to the extent that survey services are not available on a pro bono basis. While it is possible to conduct a survey without the benefit of professional input, any survey that is not professionally designed and implemented is likely to provide relatively little value. Even a well-designed survey will also have some limits. Because patients are often treated prophylactically with antibiotics after a tick bite before the onset of symptoms, those surveyed after such treatment would be likely to response affirmatively to a question about contracting TBD even in the absence of symptoms or a formal diagnosis. Survey participants are also likely to have imperfect recall as to whether a TBD was contracted during a survey period or at some earlier time, and may tend to overstate their compliance with personal behavior modifications. Mere implementation of a countermeasure, with public awareness, could change survey responses on various elements even if underlying behavior or facts have not changed. Thus, results over a longer period of time will best gauge the effectiveness of the programs.

To the extent that the questions stay the same between administrations of the survey, and any response biases do not change, a survey can provide a measure of trends in many facets of the town's TBD problem.

- Pros:
    - Can measure many elements of the management plan.
    - Measure proximal and distal measures of TBDs.
- Cons:
    - Possible cost
    - Expert input for survey development to ensure proper survey (one-time cost)

- Possible expert implementation of survey (recurring cost)
- Self-reporting issues including shifting response biases as a function of program implementation (e.g. public awareness regarding ticks may make a respondent more aware of exposure to a tick; individuals may now report a tick bites whereas prior to education the incidents may have been forgotten).
- Consistency in methodology must be maintained

B. Monitoring of Tick-Borne Disease Indicators

1. Tick Drags

Periodically counting the number of ticks in a variety of plots around the Town will provide information regarding the effectiveness of countermeasures designed to reduce ticks density, which is an important element of TBD risk. Tick drags involve dragging a material through an area using scientifically accepted methodology and then counting the number of ticks attached to the material. The drags must be conducted at the same time of year, and in the same places to be able to measure change in tick population. Tick drags are regarded as the most effective proxy for monitoring the effectiveness of TBD countermeasures by some.

In some cases the acquired ticks are checked to see whether they are hosting a disease. This final step may be important in that the risk of disease is associated with exposure to *infected* ticks as opposed to ticks in general, but as none of the proposed countermeasure are designed to impact tick infection rates, the trend in the overall number of ticks can serve as a measure of whether the countermeasures are working as expected to reduce tick population and tick risk with or without the additional step of infection testing. Testing ticks would provide additional data, but would also entail additional costs.

Ideally, tick drags would be conducted by trained scientists in connection with a formal study, but it might be possible to develop adequate local expertise on appropriate methods as an alternative. Dr. Neeta Connally of Western Connecticut State University (WCSU) has indicated a willingness to assist in the design and implementation of the drags (where, when how to drag; training of employees or volunteers; data analysis, etc.). Drs. Connally and Boily believe that tick drags can be done at very little cost and that WCSU students can be trained to do most of the work

- Pros:
  - Allows testing on highly localized basis
  - Low cost (with WCSU support)
- Cons:
  - Tick density and TBD risk may not be perfectly correlated
  - Cost (if WCSU support cannot be obtained)

- Consistency in methodology must be maintained

2. Deer Counts

Periodic measurements of deer density within Newtown would provide relevant information with respect to the effectiveness of countermeasure with respect to multiple issues. As is discussed above, deer density levels are often used as a reference for tracking TBD risk. Density levels of 10 d/mi^2 or lower have been shown to be associated with substantial reductions of TBD risk, so tracking deer density levels will enable Newtown to measure its progress toward attaining that goal. Deer density levels may also be suggestive of whether incremental reductions in TBD risk are achieved. Deer density levels above 20 d/mi^2 have been associated with forest damage, so that deer density monitoring would be valuable for monitoring the deer-related aspects of forest health as well. Finally, there is a roughly linear relationship between deer populations and deer-vehicle collisions (DVCs) in any particular locality, so that reductions in deer density would yield relevant information concerning whether DVC risk has been reduced.

There are several options for measuring deer density that vary in cost and accuracy. No measure is perfect, but all would yield useful information. None of the methods can give an absolutely accurate instantaneous count of a deer population, but can indicate trends of increasing, stable or declining deer populations over a period of years. The methods include:

- Aerial Survey – Night (Thermal Imaging). An aircraft (either helicopter or fixed-wing) is fitted with thermal imaging equipment, often known as FLIR (forward-looking infra-red), which detects warm animals against cooler terrain. Flight surveys are usually conducted on winter nights, when the thermal contrast is most pronounced. Depending on the assignment, the aircraft may overfly the entire study area with slightly overlapping swaths, or may fly individual transects (lines) over a sampling of the total area. The imaging data is recorded, along with GPS and timestamp data. The recordings are then analyzed to yield counts of deer. An accuracy of up to 90 percent is claimed, although confidence varies according to tree cover, etc. (conifers tend to shield deer from view year-round, for instance). Due to the specialized equipment and the need to modify an aircraft for it, plus the need for skilled personnel, thermal imaging has been considered the most expensive method of censusing deer. However, costs for portable FLIR equipment have been declining.

- Aerial Survey – Daylight. An observer and a pilot fly an aircraft (usually a light helicopter) counting deer along a transect or series of transects, repeating each pass four times and averaging the results. The flights are conducted in daylight on winter days when the ground is snow-covered, enhancing the visibility of the deer. The raw data is adjusted using a correction factor to yield an estimate of deer density.

- Distance Sampling / Spotlight Counts. A series of transects, or a single route that wends its way through the survey area, is laid out with the aim of including all different types of terrain within the forest or community. A team of two or three people drives the route at night at slow speed (10 mph), using spotlights to sight deer on either side of the vehicle. The procedure may be repeated on several successive nights in order to obtain a good sampling of deer. In a simple spotlight count, the team records the numbers of deer sighted. In distance sampling, range-finding

equipment is used to estimate the distance of each deer from the vehicle. Then a computer program (available for free) uses the deer/distance data to calculate estimated deer density.

- Pellet Counts / Trail Counts. Nearly any animal sign (e.g., scat, trails, tracks) can be used to estimate populations; for deer, the most common of these techniques is the pellet count. A series of transects is laid out in the survey area. The transects are walked by observers, who require only minimal training and often are students or volunteers. The observers stop at regular intervals (e.g., 100 paces) and count the number of pellet groups within a certain radius (e.g., six feet) of their position. The survey is adjusted to account for the number of days the pellets may have been on the ground (e.g., since the last leaf drop in the fall) and the number of times that deer defecate per day. The survey is also adjusted for coverage area, to yield a deer density estimate. Pellet counts are only considered accurate within about 15 to 20 percent, but consistently repeated counts create confidence in the method as an index of population trends.

- Plant Browse Surveys ("Stem Counts"). Random plots are marked in the survey area and then are inventoried at intervals of one or more years to determine what plants are present. For comparison, deer exclosures are often built and inventoried at the same intervals. Inventory categories can include herbaceous versus woody stems, breakdowns by plant species, and stem size. The stem counts also can keep track of native versus invasive plant species.

- Camera Surveys. It is now common for hunters to employ automatic trail cameras, often in conjunction with baiting stations, to assess places where deer congregate. The cameras can take photos in daylight and/or nighttime with infrared sensors. In recent years, researchers have been developing analysis techniques to derive deer density estimates from the camera data.

- Mark / Recapture / Resight. Often used in conjunction with studies of deer biology, a mark/recapture or mark/resight program involves trapping or tranquilizing deer and marking them with tags or collars. When the deer are either recaptured or resighted, the ratio of marked deer in proportion to total deer can be used to infer population size and density.

- Hunter Harvest. Nearly all states make estimates of deer and other game populations using hunter harvest data. In some states, the harvest data is only general, but in other states, the age, sex, weight and condition of the deer are noted. This can yield population trend data as well as estimates of density.

- Deer-Vehicle Accidents / Road-kill. Careful and consistent records of deer-vehicle collisions, as well as road-killed deer, can indicate trends in deer population. Data should be adjusted for any changes in traffic volume, road use, etc.

As with other metrics, the most important elements of a deer count program are to implement a count relatively soon in order to establish a baseline for measuring the impact of countermeasures, and to utilize a counting method whose use can be continued periodically over the life of the program. Any of these methods needs to be applied on a regular and consistent basis in order to provide useful results.

- Pros:
    - Provides a metric relevant to multiple objectives (TBD, DVCs, etc.)
- Cons:
    - Precise deer density/TBD relationship unknown
    - Cost

3. Hunting Statistics

Hunters are required by law to report each deer successfully hunted to the State, and the State publishes annual hunting statistics on a town-by-town basis. These official statistics are understood to substantially understate actual hunting activity because not all hunters comply with reporting regulations, but may provide a rough basis on which to compare hunting activity from one town to another or from one time period to another because the level of underreporting may not vary materially from place to place or over time. Hunting statistics alone, however, provide only limited insight into the effectiveness of interventions designed to reduce deer density because such density is also heavily affected by other factors (e.g., annual recruitment of new fawns into the deer population, non-hunting mortality), and provide even less insight into the effectiveness of reducing the underlying problems of TBD and related issues that the town seeks to address. That said, because hunting statistics are a pre-existing, regularly collected data point on which to draw, it is appropriate to consider them in connection with the evaluation of the Town's overall program.

- Pros:
    - Free, data already exist
- Cons:
    - Hunter success does not measure deer density per se, and is a very crude measure of success in reducing deer-related problems.

4. Town-Collected Questionnaire Data

Newtown may be able to easily collect additional data concerning TBD by taking advantage of Town-resident interactions that already take place. For example, Newtown students can be asked if they have been treated for Lyme and or other TBD for the purposes of obtaining a consistent collection of TBD data. Some non-exhaustive suggestions of means to accomplish this are to include TBD questions with information intake conducted with incoming kindergarten students and/or new students, or including such questions on the required physical examination form that is given to students entering specific grades. It would have to be determined how many year(s) to include in the questionnaire ("has your child been treated for Lyme and/or other TBD in the past year?" versus "has your child been treated for Lyme and/or other TBD in the past [number to be determined and inserted] years?").

Similarly, Newtown could provide a simple questionnaire to residents obtaining annual dog licenses inquiring as to whether household pets have been treated for TBD in the last year (or other period). This would provide a method of monitoring TBD among Newtown pets.

The committee also recommends that there be a responsible party to ensure the accuracy and monitoring of this information to ensure that the data collection is consistent and will be followed up on.

C. Evaluation of Issues beyond TBD

1. DVC Tracking

Tracking the number of DVCs will indicate whether countermeasure design to reduce such crashes have been effective. As described in Chapter 6 of this Report, there may be some fluctuation in the rate of these crashes to factors unrelated to actions taken by the Town. Therefore it is recommended that the tracking be done relative to some other crash rate (e.g., property-damage-only crashes). The data to provide such tracking is already collected by the Newtown Police Department (excluding crashes on I-84 where the State Police would have handled the crash reporting). Many DVCs go unreported and therefore "deer kills" may also be counted. That is, we can measure deer collected off the roadways (presumably after being killed by impact with a motor vehicle). Such data would need to be collected separately from the State and the Town depending on which entity maintains the roadway in question. It should be noted that DVC and "deer kills" would likely need to be examined separately as there would likely be some duplicate counting if they numbers were combined (some road kills would have resulted in a crash report).

- Pros:
    - Data already exist, though not necessarily all in one place
- Cons:
    - Some data entry costs, or one-time modification of the original data entry process may be required if map based tracking is to occur.

2. Forest Metrics

As is described in Chapter 5 concerning deer impacts on local landscapes, the Committee recommends certain steps to monitor forest health, including: (a) to contract a forester for professional services to make assessments and recommendations of all major town-owned open space areas and develop a forest management plan for selected open space parcels; (b) to develop metrics for the evaluation of forest health to be used to assess any changes over time; and (c) to re-evaluate the parcels evaluated by CAES in March 2010 in five years to determine any changes.

D. Recommendations Passed by the TBDAC

1. Newtown should implement an active surveillance program among local physicians to monitor TBD in a more systematic manner. (11 yes, 0 no)

2. Newtown should conduct periodic scientifically reliable annual surveys of Newtown residents to track relevant TBD issues. The survey should ideally be administered annually. (11 yes, 0 no)

3. Newtown should conduct periodic (at least annual) tick drags using accepted scientific protocols that are sufficient to monitor changes in tick density in response to Newtown's Tick-Borne Disease Management Plan. (11 yes, 0 no)

4. Newtown should conduct periodic (at least biennial) deer counts using accepted scientific protocols that are sufficient to monitor changes in deer density in response to Newtown's Tick-Borne Disease Management Plan. Multiple methods for the first few counts may allow future measures to use the cheapest method assuming the methods produce comparable results. (11 yes, 0 no)

5. Newtown should monitor DVCs in a systematic manner that pulls together relevant data maintained by the Police Department, Highway Department and State. (11 yes, 0 no)

6. Available performance metrics should be publicly reported on an annual basis. (11 yes, 0 no)

GLOSSARY

CAES -- Connecticut Agricultural Experiment Station

CDC – Centers for Disease Control

CONNDOT – Connecticut Department of Transportation

CWD – Chronic Wasting Disease

d/mi^2 -- deer per square mile

DEP – Connecticut Department of Environmental Protection (as of 2011, Connecticut Department of Energy and Environmental Protection)

CONNDOT – Connecticut Department of Transportation

DPH – Connecticut Department of Public Health

DVC – deer-vehicle crash

EM – erythema migrans

FCMDMA -- Fairfield County Municipal Deer Management Alliance

HVCEO -- Housatonic Valley Council of Elected Officials

HSUS -- Humane Society of the United States

MAIS – maximum abbreviated injury scale

MVC – motor vehicle crash (non-deer related)

MVS – NHTSA's motor vehicle software that estimates vehicle crash costs

NHTSA – National Highway Traffic Safety Administration

NPD – Newtown Police Department

PI&E -- Public Information and Education Campaign

PSA -- Public Service Announcement

TBD – tick-borne disease

TBDAC -- Newtown Ad Hoc Tick-Borne Disease Action Committee

WCSU -- Western Connecticut State University

LIST OF ATTACHMENTS

Attachment 1. *Tick Management Handbook. An Integrated Guide for Homeowners, Pest Control Operators, and Public Health Officials for the Prevention of Tick-Associated Disease, Revised Edition*

Attachment 2. *Managing Urban Deer in Connecticut*

Attachment 3. DEP aerial surveys, Dr. Kilpatrick interpretation

Attachment 4. FCMDMA Economic Report

Attachment 5. DeNicola presentation handout

Attachment 6a. Rutberg presentation handout 1

Attachment 6b. Rutberg presentation handout 2

Attachment 7. Pound presentation

Attachment 8. BLAST presentation

Attachment 9. Tick Safe Zone Brochure

Attachment 10. Par-tick-ular Park Brochure

Attachment 11. Dr. Nelson slide presentation

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http://www.bernards.org/Deer%20Management%20Advisory%20Committee/Minutes/2011/11-07-07m.pdf.
http://www.bernards.org/Deer%20Management%20Advisory%20Committee/Minutes/2011/11-05-09m.pdf

APPENDIX A. SPEAKER SUMMARIES

Kirby C. Stafford III, MS, PhD,

Medical-Veterinary Entomologist, Vice Director and Chief Entomologist, Connecticut Agricultural Experiment Station

Dr. Stafford addressed a range of topics from the life cycle of the deer tick (i.e., *Ixodes scapularis*) to various intervention options to reduce TBD risks, particularly in homeowners' backyards. The interventions reviewed included spraying, landscape modifications, rodent bait boxes, deer management, and the use of the 4-Posters for deer. Dr. Stafford also handed out copies of his 2007 Tick Management Handbook.

- Lyme disease is the leading arthropod disease in the U.S.
- The incidence of Lyme disease continues to increase.
- Lyme disease is underreported, state and national statistics probably represent only 10-20% of diagnosed cases.
- Other problems associated with the overabundance of white-tailed deer include ecological degradation, vehicle collisions, agricultural damage, landscape and garden damage.
- The three approaches for managing deer as a tick control option are exclusion, reduction, or treatment with acaricides.
- What happens when you reduce the deer numbers? There is initially an apparent increase in tick abundance as they are no longer being picked up by the deer. There also may be an initial increase in infection rates as a larger portion of ticks feed on reservoir hosts. Then the tick numbers will decline. If nothing is done to manage a deer population, it is unclear where things will go as far as the Lyme disease problem is concerned…. However, the overabundance of deer clearly affects the Lyme disease issue. If you reduce the deer you will reduce ticks.
- Deer are important hosts for the ticks. The adult tick feeds primarily on white tailed deer; an estimated 95% of adult female ticks that are laying eggs are coming off white tailed deer. There are other hosts the adult ticks feed on, but they do not play a major ecological role. When you reduce the deer population, and numerous studies have shown this, you will reduce the tick population and therefore your risk of encountering a tick. If the tick population drops below a certain threshold, you won't have a sufficient number of ticks feeding on the mice carrying the Lyme disease spirochete to maintain transmission between the ticks and the mice and you can actually break the disease cycle. The overabundance of deer clearly affects the Lyme disease issue. If you reduce the deer, you will reduce ticks.

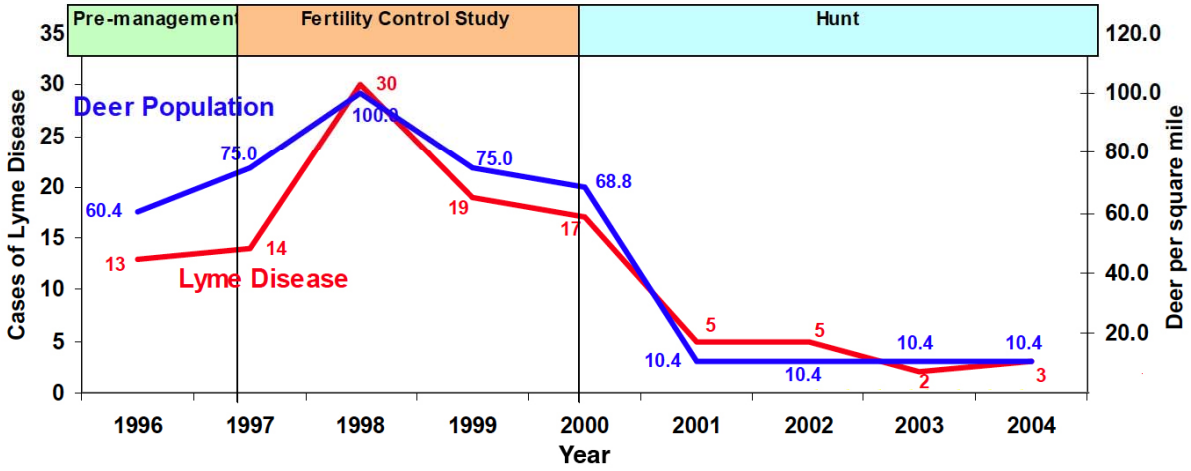
Howard Kilpatrick, MS, PhD,

Deer Program Biologist, Connecticut Department of Environmental Protection

Dr. Kilpatrick addressed the committee on October 21, 2009. Dr. Kilpatrick discussed the various problems associated with deer overpopulation and options for dealing with some of those problems, including deer reduction options such as hunting and sharpshooting as well as 4-Posters.

- The key to reducing deer overabundance is access to land throughout the Town, a combined effort of both public and private landowners.
- Dr. Kilpatrick discussed the successes of Mumford Cove, Connecticut in dramatically reducing Lyme disease by reducing deer overabundance.

Figure 2. Changes in deer density and cases of Lyme disease in Mumford Cove, Connecticut, 1996-2004 (CT DEP data).



- Much of Dr. Kilpatrick's discussion was referenced from the CT DEP booklet, *Managing Urban Deer in Connecticut for Communities and Residents* (Attachment B).

Anthony DeNicola, MES, PhD,

President, White Buffalo, Inc. (501(c)(3) nonprofit wildlife management and research organization)

Other appointments: Adjunct Faculty Member, Rutgers University,
Certified Wildlife Biologist, The Wildlife Society,
Research Associate, University of Illinois,
Research Associate, Denver Zoological Foundation,
Visiting Faculty Member, Trinity College

For purposes of clarification through this summary, any reference to sharpshooting or to professional sharpshooting refers to professional organizations such as White Buffalo, Inc. Recreational, controlled and amateur hunting refers to town or private hunting efforts.

1. Dr. DeNicola advised the Committee that he has worked with deer for 20 years and that without being arrogant, he feels that he knows just about everything there is to know about deer. His Ph.D subject was deer contraception, and he is the founder and President of White Buffalo, Inc., a 501(c)(3) nonprofit wildlife management and research organization. Dr. DeNicola advised the Committee that he has captured more deer, contracepted more deer, and organized more sharpshooting programs than anyone else in the United States. He has worked on deer sterilization programs and was involved in the original 4-Poster study in CT. He is actively involved in research, including research on design and development of darts, and research on non-lethal methods of killing ticks on deer, such as deer collars that kill essentially 100% of ticks on deer that are applied while deer come to a feeding or bait station.

2. In 1986 Dr. DeNicola worked in Newtown putting radio collars on deer. At that time deer density was 40 to 50 d/mi^2.

3. Professional sharpshooting as performed by Dr. DeNicola's organization is well organized, highly effective and humane. As outlined by Dr. DeNicola, any program to attract deer initially involves *effective* baiting at for at least one week (preferably three weeks) to create a consistent pattern of deer attraction to the site. The area is surveyed for human activity as well. Next, highly trained professional sharpshooters work at night from elevated stations or against an earthen backdrop. The sharpshooters use precise firearms effective up to a range of 100 yards, and they target a deer's brain (not head) for instantaneous death. Miss rate: 1/50 shots fired (typically because deer moves its head). Employees are tightly scrutinized with background checks and receive intensive training. Standards for White Buffalo sharpshooters are much higher than those of the State system, with an apprenticeship and certification process. White Buffalo has extensive insurance that covers homeowners on whose property they hunt.

4. Dr. DeNicola stressed that professional sharpshooters practice *effective* hunting. Each herd has a mature female that leads the group. If the lead female is euthanized, the other deer stay within 20 yards and are also eliminated. If the lead deer is not killed, she will run when the first deer is killed, and the herd will follow her.

5. Baiting is effective if it draws deer to a site. In general, amateur hunters (recreational or controlled hunt) scatter grain randomly (both in area and temporally) and therefore their method of baiting is not as effective as that of professional sharpshooters. Dr. DeNicola states that deer should associate bait and humans scattering grain as a positive, and therefore grain should be put out consistently for a period of time before hunting is attempted.

6. Deer learn very quickly. Dr. DeNicola advised that deer learn when a dog is on a leash or has an invisible fence; they learn to avoid bait boxes; they learn to look up in trees for hunter stands; they have evolved to live in a small area because they know the activity in their area. Professional sharpshooting, contraception efforts, etc. are organized to avoid "deer learning." If professional sharpshooters follow a season of amateur recreational or controlled hunting, they have a much more difficult task because of "smart" deer who have become educated by amateur hunters.

7. An effective deer reduction program requires equipment, tremendous training to understand the equipment and deer behavior, and ability to manipulate deer. This is a cumulative process. The cost escalates, with a very steep cost curve long term. It is easy for professional sharpshooters to go from 300 d/mi^2 to 50 d/mi^2. Below 50 d/mi^2, manpower and expense significantly increase, and continue to increase on a nonlinear curve as deer density decreases. For professional sharpshooters to get from 20 d/mi^2 to 10 d/mi^2 may cost $200,000, and be double the cost of going from 300 d/mi^2 to 50 d/mi^2.

Illustration: At a professional sharpshooter bait site

50% of total deer killed the first day;

25% of the original total killed the second day;

10% of total deer killed the third day.

Cost of professional sharpshooting program in Newtown would depend on housing density, access, deer density goal, and would not include "by-product" management.

8. Deer home range in Newtown for rural areas may be 200-300 acres; for the areas with 2- to 3-acre zoning, home range may be 50 to 150 acres. Because of size of home range, ingress of deer from other towns is almost irrelevant.

9. In Dr. DeNicola's opinion, in general amateur recreational and controlled hunting is not an effective deer reduction mechanism because of

- lack of coordinated team effort (such as used in professional sharpshooting, see above);
- too much disturbance by amateurs in a given area; and
- ineffective baiting that creates "smart deer".

Newtown in particular would create issues because of fragmented land ownership and lack of free access for amateur hunters throughout the community. True deer reduction will work *only* if the process is highly structured, with deer attracted to specific individual properties and dedicated professional trained

hunters working as a coordinated team, with access to private properties. With high deer densities, recreational hunters can kill one deer per hour. With lower deer densities (less than 25 d/mi^2) a hunter may kill one deer every 15 hours. Amateur hunters (recreational and controlled hunting) will not achieve a deer density lower than 40 to 50 d/mi^2 because the effort becomes too great and they lose interest. It is for this reason that amateur hunters prefer higher deer densities.

Unless hunting is highly structured, organized and managed, and hunters held accountable for does, Newtown will not achieve deer density reduction.

Town efforts matching an amateur hunter with a landowner will not eliminate enough deer to decrease deer density; this simply creates recreational opportunities.

Free model of recreational hunting does not work in suburbia. Need a strategic approach.

Cannot expect to significantly reduce deer density for free or cheaply.

There are hidden costs of high deer density (motor vehicles, landscaping) that people pay, that could be put instead into a professional sharpshooting program.

Illustrations cited by Dr. DeNicola:

Princeton: Before White Buffalo was hired, in 1999 and 2000 approximately 342 roadkills in 14 square miles (with a 4-1/2 month recreational hunting season, 200 deer per year killed without impact on deer population). Four years after White Buffalo hired, road kills were in low hundreds; last year 60 to 80 road kills per year. Professional sharpshooters employed after the recreational hunting season kill twice as many deer in 2-1/2 weeks as amateur shotgun, muzzle loaders and archers kill in 5-1/2 months.

Duke Farms, NJ: on 2,000 contiguous acres, 180 d/mi^2. Sharpshooters saturated area and eliminated tremendous numbers of deer in approximately one week. Bow hunting alone cannot maintain lower deer density, but bow hunting every year followed by shot gun hunting by organized, committed and coordinated sportsmen on non-fragmented space can maintain lower deer density.

10. Recreational hunters are upset when the deer density decreases to 50 d/mi^2 or less because of difficulty finding deer. Amateur hunters have very little impact as a whole when one gets to critical densities of < or = 50 d/mi^2. Fragmented landscapes and "smart" deer increase difficulty.

11. State objective: create recreational opportunities. Municipal objective: manage deer.

12. Landscapers and individuals concerned about motor vehicle accidents typically want deer reduction. Dr. DeNicola personally would not feel comfortable telling landowners that amateur recreational or

controlled hunting will eliminate tick-borne disease on their property because these forms of hunting will not reduce deer density to a level that would affect tick-borne disease.

13. Dr. DeNicola believes that there will be no change in incidence of Lyme disease until deer density is less than 20 d/mi^2. If decreasing tick-borne disease through decreasing deer density is the most pressing issue, Newtown will need a drastic and expensive lethal effort. There is no data on decreased risk of disease relative to tick abundance.

14. Re forest ecology: the more deer present, the more vegetation they eat.

15. Regarding tick-borne disease reduction, Dr. DeNicola discussed tick-cidal technologies, including the Four-Poster device, and technologies that are now being researched by his and other organizations, including deer collars that kill essentially 100% of ticks on a deer host.

16. Very hard to reduce deer population with just contraception vaccinations because:

Contraception is only 80-90% effective

Without reproductive stresses deer live longer and are healthier

Must repeat the contraception vaccines

Deer sterilization is a slightly more costly but more effective means of non-lethal deer density reduction.

17. State-wide trend of deer density: stable. Deer density is not uniform across Connecticut. The only way to know true deer density is to make an assessment. Dr. DeNicola suggested *distance sampling protocol*, which town employees (i.e. a police officer) and trained volunteers could readily perform. For effective management strategies, it is important to know where the deer are. Good data is needed in an effective management program.

18. Effective deer density reduction can only be created by an intensive management program and can only be maintained by a program that continues to function year after year.

Randall S. Nelson, DVM, MPH,

Epidemiologist and Public Health Veterinarian, Epidemiology and Emerging Infections Program, Connecticut Department of Public Health

- Dr. Nelson addressed the committee on November 18, 2009. Dr. Nelson's presentation focused on Lyme disease surveillance and statistics.
- "Lyme disease case reporting is problematic."
- He discussed the lack of funding available from the CDC to educate the public.
- The CT DPH does have information on their website providing information on TBD's and on the role of deer densities and increases in TBD's.
- He mentioned Lyme disease is a "hyperepidemic" and that the prevalence of Lyme disease cases in Newtown is higher than the Fairfield County average.
- "If you reduce the deer, you will reduce Lyme disease."
- He referred to the CT DPH website, http://www.ct.gov/dph/cwp/view.asp?a=3136&pm=1&Q=395590&dphNav_GID=1601&dphPNavCtr=|#47046

Mr. David Streit,

BeSafeRedding Program

- Mr. Streit discussed the program BeSafeRedding which is an organization created in consultation with the CT DEP/DPH, CDC and the Redding Health Department. The program supports the reduction of tick related diseases, deer-vehicle accidents and destruction of the woodlands that result from deer overpopulation.
- BeSafe uses voluntary efforts from landowners and licensed hunters and facilitates the process of putting responsible landowners in touch with licensed hunters.
- To date, BeSafeRedding has enlisted 100 property owners in Redding.
- 75% of the calls to BeSafeRedding are from concerned mothers for the health and safety of their children.
- Many of the residents that are on board were historically against hunting, but now understand the connection between high deer densities and increases in TBD.
- BeSafeRedding uses phrases, “If it’s not hunted, don’t hike it” and “No child left inside”.
- The towns of Wilton, Bethel and Easton are considering adopting “BeSafe” programs in their perspective towns.

Allen T. Rutberg, PhD,

Research Assistant Professor, Center for Animals and Public Policy, Cummings School of Veterinary Medicine, Tufts University

Dr. Allen Rutberg, a Research Assistant Professor at the Tufts University School of Veterinary Medicine who is also affiliated with the Humane Society of the United States, spoke to the committee at a special meeting on January 21, 2010. Dr. Rutberg holds an A.B. degree from Harvard University and a Ph.D. from the University of Washington. His research focus has been on the contraception of deer and wild horses for most of his career.

Dr. Rutberg's presentation focused on the current state of his research with PZP, a contraceptive agent that has been the subject of experiments with both deer and wild horses since the 1970s. Dr. Rutberg explained that PZP provides 80-90% fertility control for treated does and is effective for a two-year period for treatment. PZP costs on average about $100/dose, exclusive of labor. Labor is at present the primary cost element in the contraception of deer because deer must be tagged in some manner that identifies them as having been treated. While another fertility control agent, Gonacon, has already received federal approval for deer management, Dr. Rutberg expressed his view that PZP had certain advantages over Gonacon, particularly a longer testing history.

Dr. Rutberg anticipates that he expects to finish PZP field testing and receive federal authorization for its use as a deer management tool within the next 3-5 years. Dr. Rutberg explained that he is evaluating potential sites for a deer contraception field trial of PZP that he will be conducting and said that he might be interested in a site within Newtown for this purpose. Dr. Rutberg's research is primarily funded by the Humane Society of the United States, but he explained that he would expect the town in which he conducts his field trial to contribute a portion of the funding (roughly $10,000 annually) as a measure of its commitment to the research.

Dr. Rutberg reviewed and answered questions concerning his PZP field tests at Fire Island, NY, the National Institute of Standards and Measurement (NISM) in Maryland and Fripp Island, South Carolina. Deer density has declined from 80/sq km (207 d/mi^2) to approximately 40/sq km (104 d/mi^2) over 11 years at Fire Island, from roughly 333 d/mi^2 to 222 d/mi^2 over 10 years at NISM, and from approximately 180 d/mi^2 to 130 d/mi^2 in four years at Fripp Island. Dr. Rutberg estimated that it might be possible to reduce deer density to around 40 d/mi^2 on a test site in Newtown within several years.

Dr. Rutberg answered various questions from those in attendance concerning his research and proposed field trial. He confirmed that PZP causes does to experience extended estrus seasons, which some have posited might result in greater deer-vehicle collision risk, but reported that a study on this hypothesis that he published in the journal Human-Wildlife Conflicts found no such increased risk.

Jennifer Reid,

Community Coordinatory--BLAST Program, Ridgefield Health Department

The BLAST Program was developed in 2008 by the Town of Ridgefield to raise awareness of the most effective Lyme disease prevention practices, as well as to educate the community about the early signs and symptoms of Lyme and other tick-borne diseases to promote timely diagnosis and treatment. Community Coordinator Jennifer Reid from the Ridgefield Health Department presented the BLAST program power point and discussed some of the many ways Ridgefield is implementing the program. The program's creation was funded by a competitive grant awarded by the CT DPH. Since its introduction, it has been endorsed by the CDC and selected as a poster presentation and model marketing program by the Connecticut Public Health Assoc. Ridgefield also has an official Lyme Disease Task Force and a Lyme Disease Support Group sponsored by the Ridgefield Visiting Nurse Association.

The BLAST program focuses on the five most effective behaviors based on the latest research from the Connecticut Emerging Infections Program at Yale University and the Connecticut Agricultural Experiment Station. The program teaches the public how to: 1) avoid tick bites; 2) find and remove ticks safely and effectively if they do get bit; and 3) recognize symptoms of Lyme disease and seek timely treatment. Additional information on the full range of local tick-borne diseases has been added since the program's creation.

The BLAST program uses a catchy acronym that residents can use to remember ways to prevent tick bites, reduce tick abundance, and reduce their families' risk of acquiring Lyme disease. The BLAST message is:

B athe soon after spending time outdoors. Data from a recent study conducted by the Connecticut Emerging Infections Program at Yale University has shown that people who did not contract Lyme disease were nearly twice as likely to shower or bathe within 2 hours after spending time in their yards as people who did get Lyme disease (Connally et al., 2009).

L ook over your body every day. According to the Center for Disease Control and Prevention (CDC), approximately 60-80 percent of people who get Lyme disease get an expanding red-rash known as erythema migrans (EM). The EM rash may occur at or near the site of the tick bite, but not always. Unfortunately, this rash is painless and can often go unnoticed, and will eventually disappear. EM rash is typically the first sign that one has contracted Lyme disease. One should also LOOK for other signs and symptoms of Lyme disease, such as fever and aching joints (Steere, 2001).

In addition, one should inspect his or her body daily for ticks. It takes a blacklegged tick a minimum of 24 hours to transmit the bacteria that causes Lyme disease to humans (Piesman et al., 1991; Piesman et al., 1987). Therefore, performing tick checks on one's self or one's children every day can prevent disease transmission. Two research studies have show that tick checks were performed more frequently amongst people who did not get Lyme disease than people who did get the disease. (Connally et al., 2009; Orloski et al., 1998; Smith et al., 2001).

A pply repellent. Studies have shown that applying DEET-based repellent (30% DEET or higher) to your

skin or clothing is effective at repelling blacklegged ticks (Bug Off, 1993; Buzz Off, 2000). Clothing treated with permethrin can be washed several times and still retain its repellent properties. Safety information about these products are provided to the public (Schreck et al., 1986).

S pray your yard to reduce ticks. Homeowners should consider the benefits of applying pesticide to the perimeter of their yards. Studies have shown that even one application of pesticide in the appropriate locations of the yard and at the appropriate time of year can reduce blacklegged tick populations by 85-90 percent. (Curran et al., 1993; Stafford, 1991; Stafford, 1997). Although one can hire a professional to apply such chemicals to their properties, there are many effective pesticides that homeowners can buy at their local garden centers. These pesticides are approved for safety and efficacy if applied according to package directions. Safety information about these products is provided to the public.

T reat your pets for ticks. According to the American Pet Products Manufacturers Association (APPMA), 63 percent of all U.S. households own a pet. Some studies have shown that owning a dog or cat can increase one's tick for getting Lyme disease (Wormser et al., 2006). In addition, cats and dogs can also get sick with Lyme disease. We emphasize the importance of treating pets to reduce human exposure to blacklegged ticks.

J. Mathews Pound, PhD,

Research Entomologist, Agriculture Research Service, U.S. Department of Agriculture

Dr. J. Mathews Pound, a research entomologist at the United States Department of Agriculture's Research Laboratory in Kerrville, Texas, spoke to the committee via teleconference on February 17, 2010. Dr. Pound holds B.Sc. and M.Sc. degrees in biology from Georgia Southern University and a Ph.D. in Entomology, 1981 from the University of Georgia. His research has focused on ticks throughout his career.

Dr. Pound's presentation focused on the "4-Poster," a bait station device invented by Dr. Pound that is designed to control tick populations by applying acaricide to deer feeding at the device.

Dr. Pound first explained the history of the 4-Poster. In the early 20th century, cattle in much of the South Central and Southeastern United States were at risk of contracting cattle fever (bovine babesiosis), a tick-borne disease that is often fatal to cattle and which thus represents a significant economic threat. This threat was controlled by the systematic application of acaricide to cattle in cattle dipping stations, a practice which continues to the present. Beginning roughly 20 years ago, however, cattle fever outbreaks began to increase as deer populations grew along the border of Texas and Mexico. Dr. Pound and the USDA developed the 4-Poster as a means of controlling this new threat to the U.S. cattle industry.

The 4-Poster's effect on tick populations have been evaluated in several published studies, some of which were discussed by Dr. Pound. A study from 1995 to 1998 at the Kerr Wildlife Management Area in Hunt, Texas, found that the 4-Poster achieved greater than 85 percent tick control after two years over all stages of the tick life cycle. Another study at the Goddard Space Flight Center in Greenbelt, Maryland found 91 percent control over nymphal and near-100 percent control over adult blacklegged ticks after three years. A major USDA study conducted in several locations in Connecticut, Maryland, New Jersey, New York and Rhode Island found 60-82 percent control over nymphal blacklegged ticks.

Dr. Pound explained that variations in results at different sites were party a result of trial and error. For example, several of the early tests used amitraz as the acaricidal agent, although Dr. Pound has now concluded that a permethrin formulation is more effective. Permethrin is a widely used pesticide found in various over-the-counter pest control products. While lethal to ticks, it is minimally toxic to most mammals (cats are an exception). Permethrin also binds to soil, which prevents it from leaching into ground water.

Dr. Pound also discussed the operation and maintenance of 4-Poster feeding stations. Among other requirements, high-quality "re-cleaned" corn must be used in order to minimize debris and fragments that can clog the unit. It is also important to place the 4-poster on a level site (or to modify a site to allow level placement). The rollers containing the Permethrin formulation must be carefully handled. 4-Posters must be maintained every week while in service and regularly filled with corn. Dr. Pound recommends taking 4-Posters out of service and into storage from mid-December to the end of February when tick-questing activity is low.

Placement of 4-Posters is a function of both geography and deer density. Where treatment is desired, a feeder should be placed every 50-100 acres (i.e., 6-13 unit/mi^2) or for every 15-18 deer (for Newtown's estimated deer density 4-5 units/mi^2).

Dr. Pound addressed various questions from the Committee. He does not believe that feeding corn to deer with 4-Posters will increase their survival or breeding rates because corn is low in protein, and said that there are no studies to the contrary as far as he is aware. He also does not believe that 4-Posters are likely to increase the spread of Chronic Wasting Disease (CWD) in areas where it exists (there have been no reported CWD cases in Connecticut) because deer tend to spread saliva through grooming patterns in any case. 4-Poster usage and deer hunting are compatible with one another, though Dr. Pound said that he would not favor hunting at 4-Poster sites themselves because hunting activity (particularly using firearms) would deter the surviving deer from using the 4-Poster stations.

Donna Culbert, MPH, PE, RS,

Newtown Health District Director

Ms. Culbert discussed the initiatives that the Health Department has done.

- Tick testing (engorged ticks only)
- Brochures and information on personal protection available at the Health Department, health fairs, Health Monitor in the Bee.

Ms. Culbert discussed statistics and mentioned that more Newtown residents are getting TBD. It is not only Lyme, but anaplasmosis and babesiosis are on the rise and people are getting more than one disease from the tick bite.

There are inconsistencies in reporting that made it appear that Lyme disease cases have dropped, but they have not. Even though the State and CDC reporting system typically shows only about 20-40 cases, Ms. Culbert had received 236 reports of Lyme cases in Newtown from the two major testing labs in 2009.

Not everyone gets the rash or they miss it, then the disease progresses.

Everyone must be 100% compliant every single day, which entails taking all the precautions such as doing a tick check, tucking pants into socks, wearing long pants and shirts, etc.

This is virtually impossible for everyone to do 100% of the time, especially children whom are at greatest risk in contracting a TBD.

Message is getting out to residents, but is it effective? Ms. Culbert was agreeable to working on an improved campaign to get people's attention. Open to ideas from the committee regarding additional approaches. (ie. billboards, Public Service Announcements, education for coaches, updated school curriculum, utilizing the BLAST program, Lyme awareness, etc)

Ms. Culbert noted in her opinion, that TBDs are one of the top three health threats along with heart disease and substance abuse.

Regarding the deer issue, Ms. Culbert said, "The numbers show a lot of deer and a lot of problems."

She mentioned the findings from the committee are a huge opportunity to educate the public.

Mr. Rob Sibley,

Deputy Director of Land Use, Newtown

Rob Sibley, Associate Director of Land Use, Newtown, answered questions from the committee on January 6, 2010.

Q: Can stipulations or conditions placed on open space parcels be changed or overlooked?
A: Open space in Newtown comes through various mechanisms: donations, easements, purchases, and sub-division requirements (15% of sub-division acreage). There are hundreds of unique parcels, each of which has a legal description delineating any land use restrictions. Any stipulations in the deed are carried over in perpetuity and cannot be changed. Any particular parcel would have to be researched to determine specific restrictions. Also, when state grant money is used for the purchase of a parcel, there is no hunting allowed on that parcel. The Conservation Commission has a list of basic restrictions on open space parcels and the police have powers of enforcement.

Q: What is the population of deer on Newtown open space?
A: There are no town counts, only the DEP surveys.

Q: What is the assessment of the health of Newtown forests?
A: Most Town-owned land historically was farmed, thus we currently have second- and third- generation growth of trees. Invasives within the last 200 years have been encouraged by land use practices. In recent years the increase of non-native species is pressuring the loss of native species. Also, new invasives have been introduced. Browsing or over-population by specific species has been encouraged by development of the land. The decline in native species has resulted in the loss of habitats for birds, animals and native plants. Any animal that has any possibility of pressure (on native species) can have a major impact on the eco-system.

Q: Does that include humans?
A: Yes. We should blame ourselves in that land use practices have driven this change.

Q: Does Newtown have tick population figures?
A: No town-sponsored data. He receives information from the DEP and the Department of Health.

Q: Has Newtown considered a deer exclosure?
A: No one has sponsored one here. Mr. Sibley was involved with the Greenwich Audubon exclosure. Exclosures in general are difficult to maintain but one could be done here with sponsorship and volunteers.

Q: Does acid rain have an effect on our forests?
A: Connecticut soils have a good capacity to buffer acids. Within the last 3 ½ years he has not seen any degradation in pH readings in his water quality analyses.

Q: A committee member quoted a Highstead speaker as saying that deer, through the compaction of soils under their corridors, cause run-off. Do you agree?

A: Compaction from any use will change the way rain is either infiltrated or runs off.

Q: Mr Sibley was asked to comment on the deer population numbers, i.e. present population of 70 d/mi^2, 10-12 d/mi^2 to reduce TBD, and 15-20 d/mi^2 to have healthy forests.
A: Deer populations are at a high level because of human interference which has created much edge habitat.

Q: Do deer spread exotic and invasive seeds?
A: There are several vectors for seed spreading including wind, water and scarification or through a gullet. Many mammals and birds are involved in this process, although he did not know to what extent deer are involved, since the plants they eat are poor in nutrition and move through the gullet quickly.

Q: Is it realistic to try to get the deer population down to 10-12 d/mi^2 by hunting on open space?
A: It would be difficult because the deer are not spread uniformly around Town. And not all open space parcels can be hunted. He estimated that a 10% reduction, at most, could be attained.

Q: Have you talked with neighboring towns that have done deer management?
A: He stated that he attended a Redding Conservation Commission meeting and heard a report specific to parcels that had been hunted. He said that careful consideration is needed before Newtown implements a management program. He said he would look at any reports from other towns as they are available.

Q: Are there restrictions on sprays being used in open space?
A: At least two commissions, Conservation and Park and Recreation, would have to be consulted before any spraying could be done.

Q: Are there are any remediation efforts in open space.
A: No, but signs have been posted along park edges about ticks.

Q: What is your assessment of the forests in Newtown?
A: He said that it is a mixture of healthy and impaired woodlands. Although the large tracts of undeveloped lands in Newtown (state forests, etc.) act as a buffer, the large amount of fragmented land due to development has had a huge impact on Newtown's natural resources.

Q: Are there visual corridors in the forests due to deer browse?
A: There are some but there are also many which are very dense and difficult to walk through.

Q: What would need to be done to accommodate hunting on a specific piece of open space land?
A: You would need a petition which would be reviewed by the responsible commissions, then research the parcel to make sure there are no deed restrictions, confirm state statutes and check DEP hunting regulations.

Q: How many Town-owned open space parcels are there over 50 acres?
A: Approximately 25, which includes parks, schools, etc.

Q: Should there be a study of Newtown forests that are less than healthy?
A: You could look at all the parcels greater than 30 acres, study those and determine which ones would have the biggest impact. Some studies done by interns/students/subdivisions do exist. Use that information as baseline. He mentioned that most environmental impact studies come from subdivisions parcels which are usually a previously healthy habitat.

Mr. Tom Belote,

Co-Chair, Ridgefield Deer Management Committee

History:

- Ridgefield is different than Wilton due to town ordinances that previously restricted hunting on town open spaces.
- The Board of Selectmen appointed a 19 member Deer Committee to study whether there was an overpopulation of deer in Ridgefield and, if so, what was the impact on the community.
- The Deer Committee conducted a six month study after which it issued a report to the selectmen in June 2005 finding there was a severe overpopulation of white tail deer in Ridgefield that impacted on: (1) the prevalence of deer/vehicle accidents;(2) the rate of Lyme disease and other tick born diseases; (3) the overpopulation and its over browsing was having a severe impact on the town's conservation open space parcels and (4) the overpopulation was having an overall adverse effect on the quality of life in Ridgefield. The report concluded that there were no effective methodologies, including contraception techniques that could resolve the adverse effect of the overpopulation and recommended culling the herds and the only ecologically sound method to remedy the problem. The report was adopted by the committee by an 18-1 favorable vote.
- Board of Selectmen voted to accept the recommendations of the Deer Committee and voted in favor of amending the existing town ordinance that banned hunting on town open space by 4 to 1 vote. The matter was referred to a town meeting for a vote.
- The residents voted to amend the town ordinances to permit hunting on town open spaces by a nearly 3 to 1 margin.
- The Board of Selectmen appointed a Deer Management Committee to supervise the controlled hunt on town property. The committee is comprised of five members one of whom is the Chief of Police and one serves as the Huntmaster who supervises the day to day operation of the hunt.
- The culling/controlled hunt program began in 2007 with 1 test property of 400 acres to demonstrate that a controlled hunt was a safe method to cull the herd. Safety has always been the first priority. With the first year's success, additional town owned parcels were added to the hunt over three years. In 2009 eleven town parcels were included in the controlled hunt.

Facts:

- Ridgefield leads the state with the number of deer taken by both private and public (town) hunters. Redding is second.
- Majority of Ridgefield's controlled hunting is on 20-40 acres or even less using both bow and firearms (over 30 acres).
- The town alone cannot solve the problem and needs to encourage private property owners to open their properties to qualified hunters.
- Ridgefield sets much higher level of expertise for hunters to participate in the controlled hunt than the state does for license certification. The town controlled hunt has numerous restrictions that are not required by the State for private hunting including proficiency

testing. There are also restrictions on the schedule of the controlled hunt such as no hunting on school holidays and M- F only, no weekends.

- Ridgefield controlled hunt requires that hunters be in fixed stands (located in GPS) that are 12'-14' high and shoot down up to 20 yards away most within 15'. Arrows and firearms are used. No hunting is allowed other than from elevated tree stands so that the hunters are shooting into the ground no more than 15-20 yards away with firearms and approximately 15 yards with bow. Hunters work in pairs and communicate via radio and cell phone with themselves and with the huntermaster who is appointed by the Deer Committee.
- Ridgefield continues to have a perfect safety record, never lost a deer or had any accidents. Hunters have specified arrows, so if any deer is found without the arrows, it will most likely be from poachers.
- Poachers have been chased off town properties by the town's controlled hunt personnel and homeowners are thankful for the added safety precautions taken.

Shadow Lake Area in Ridgefield:

- In 2008, the first year that Shadow Lake open space was hunted, 48 total deer were taken of which 44 were does and 4 were bucks. White tail deer typically stay within a radius of 1 square model even when food is scare. If deer are removed from that range new deer do not immediately enter the same zone and it could take years for some migration into the area. White tail deer have a life expectancy of 18 years and become sexually reproductive at 1 ½ to 2 years. Each year a doe will typically produce at least two offspring. According to the CT DEP computer model calculations, (each doe produces 2 fawns, reproductive years, etc.) after only five years the culling of those 48 deer equates to a reduction of the future herd by 209 offspring. No computer model extends the prediction beyond the five year period.

Current Status: 1/27/2010

- The current level of methodology alone will not bring the levels down to reduce TBD's, thus Ridgefield is seeking more private land owner participation and will be seeking approval from the state DEP to extend the hours and dates of the current hunting regulations to more effectively cull the existing herd to levels under 18 deer per square mile. This application for participation under the CT DEP's "sharp shooting" regulations might include:
- Extending hunting hour an additional hour to hour and a half.
- Extend the hunting season to February when food sources become less scarce.
- Mr. Belote feels confident that if these are modifications in the operation of the town's controlled hunt are will be effective in assisting Ridgefield to attain its goals.

Expenses/Hunter Applicants:

- No costs to town of Ridgefield- hunters provide the food, stands, etc.
- Currently there are more hunters applying for the Ridgefield hunt program than Ridgefield is willing to accept.

DVA's-

- There was no accurate reporting to begin with, so at this point to determine the impact of a DVA ratio is too early.

- Vast improvement with Police in reporting DVA's since the committee began.

Ms. Pat Sesto

Director of Environmental Affairs, Wilton; past co-chair, Fairfield County Municipal Deer Management Alliance

- Ms. Sesto discussed how Wilton came to the decision to implement a deer reduction program. The committee met for 18 months and published a report in January 2003.

- The committee included public involvement such as a town survey and educational forums that were a large component to the initiation and success of the program. The aspect of the Town Code that prohibited hunting on town land had to be changed. Following an uneventful public hearing, the change was made.

- Over the years, the committee did achieve the goal in reducing the deer population. This season (2009), the deer harvest was not as high as previous years noting that the committee will continue to work with the DEP and deer biologists to understand the drop and revisit/revise the program as needed.

- From a conservation perspective, Ms. Sesto stated that within the last 5 years there has been an excellent recovery of the forest. She stated that some deer reduction is better than none and the incremental factor of time will help.

Community Education:

- Exclosure erected in 2005 on a public trail and with signage explaining purpose.
- Shows dramatic difference in effects of deer over-browsing with the diversity within the exclosure being the greatest educational result.

Fairfield County Municipal Deer Municipal Alliance (FCMDMA):

- Ms. Sesto explained the FCMDMA mission statement which now includes 17 Fairfield County towns including Newtown. The FCMDMA relies on state and national experts to guide them.

FCMDMA Legislative Initiatives:

- Cost of butchering ($75 per deer) NY is free
- Sunday Hunting
- Get DEP and DPH to work together
- Extended hunting season and hours

FCMDMA Areas of Study:

- Roadside reflectors
- Economic Impact of the Overabundance of Deer
- Working with University of New Haven scientists in accessing tick infection rates of Lyme and other TBDs via tick drag studies

FCMDMA Educational Efforts/Findings:

- Milan Bull- Audubon Society
- Newspaper, radio

***Summaries of meetings or seminars TBDAC members attended outside of regular meetings**

***Richard S. Ostfeld, PhD,**

Zoologist and Senior Researcher, Cary Institute of Ecosystem Studies, Millbrook, NY (a private, not-for-profit environmental research and educational organization)

1. The effective relationship between deer and ticks is more complicated than most people understand. Ticks are not host specialists. Although nymphal ticks prefer rodents and adult ticks prefer deer in the Northeast, in other parts of the country different hosts are preferred.

2. Analysis of various studies indicates that the relationship between deer and tick abundances is sometimes strong and sometimes weak or nonexistent. "The long-held, entrenched notion that deer are 'indispensable,' 'primary', 'keystone,' and 'definitive' needs to be replaced by a broader view of the factors responsible for regulating numbers of blacklegged ticks." Ostfeld, Lyme Disease. The Ecology of a Complex System 2011, p. 33.

3. Any impact on reducing tick numbers by reducing deer would be counter balanced by increase in hosts for immature ticks. Decreased deer means increased rodents and increased hosts for immature ticks. Eliminating or fencing out deer fosters higher small rodent populations like white-footed mice. Ticks are not host specialists and they feed on many species. The more interventions can be targeted toward multiple hosts, the most effective the tick reduction.

4. Native forest communities benefit from a moderate to low deer density and deer management benefits forests. If you eliminate the deer or vastly reduce the deer herd, native trees and understory plants, including some rare herbs, would thrive. Deer browse more heavily on native plants than on invasive plants. Barberry can persist 15 or more years because barberry is deer-resistant and shade-tolerant. Dr. Ostfeld referenced a Kirby Stafford study indicating nymphal ticks may be more prevalent within barberry patches than outside them.

- Improved conditions in understory create greater vegetation structure and complexity, fostering small rodent populations, which could easily cause an increase in tick hosts rather than a decrease, and rodent hosts are the vectors for diseases whereas deer are not.

5. Island and peninsula studies are irrelevant to non-island communities because of the absence of other hosts for adult ticks on isolated islands.

6. If the goal is tick-borne disease reduction, 4-Posters are more effective than deer reduction because they eliminate the adult ticks themselves. If deer were reduced, adult ticks will find another host. This type of intervention generally reduces tick numbers by ~70% across the board. Bait boxes to treat mice, chipmunks and shrews would target nymphs.

7. A fungus (Metarhizium strain) displays tick-cidal properties and reduces reproductive ability of surviving ticks. A narrow spectrum spray containing this fungus would be extremely effective in reducing ticks. [footnote re Tick EX status and expectation of 2011 production]. Nootkatone (Alaska yellow cedar extract) is also promising. A multifaceted integrated pest management approach that ties in a series of host-targeted acaricides (4-Posters, bait boxes, landscaping sprays) is the most effective strategy at this time, pending marketing of biological controls such as Nootkatone and Tick EX.

8. After reviewing a map of Newtown, Dr. Ostfeld stated that it is highly unlikely that opening up small scattered open space parcels to additional hunting would reduce the tick population substantially.

9. "'I'm not ethically opposed to hunting deer at all…. I would argue that deer are a public-health menace in the sense of car accidents, and I know as an ecologist that they can cause enormous damage to forest health. So there are a number of legitimate reasons for controlling deer populations. But the scientific evidence as I've reviewed it, without any preconceived notion or political agenda or any other agenda, does not support the notion that tick numbers and Lyme disease risk are strongly correlated with deer numbers, and the data do not suggest that if you manage deer by hunting, you'll reduce the number of Lyme cases. Most scientists agree that if the number of deer is driven to zero –and other mammal hosts are lacking – it will disrupt the tick population's life cycle enough that their numbers will be 'substantially reduced'…. But there is less accord on just how low a number of deer will make a meaningful difference. 'At Crane Beach [Ipswich, Massachusetts] … they reduced the deer quite dramatically, and, lo and behold, the ticks crowded onto the remaining deer.'" Boston Globe, The Deer-Lyme Disconnect, Elizabeth Gehrman, May 8, 2011.

10. Dr. Ostfeld stated that advising homeowners that deer are the only relevant hosts for adult ticks and that managing deer will manage ticks would be "false advertising".

***Sam R. Telford III, PhD,**

Associate Professor, Department of Biomedical Sciences-Infectious Diseases

Tufts Cummings School of Veterinary Medicine

Epidemiologist and expert on TBD transmission

- Dr. Telford discussed the importance of community approach with full understanding of the 2-year life cycle of the tick. He stressed the importance of education and prevention.
- 4-Posters in CT at this time require special permits. They are useful, but costly. Limitations are the 4-Posters feed the mice (one of the intermediate tick hosts) as well as other animals including the deer further enhancing their nourishment and reproduction rates.
- A long-term community plan with well-defined objectives is essential and deer reduction will diminish TBD risks for our children.
- There are no viable solutions to targeting the mice, chipmunks, etc. One must go to the source of the ticks which are the deer.
- "Deer population management must serve as the main tool in any long term strategy to reduce human incidences of Lyme disease."

Connecticut Forest Ecology Mini Symposium November 12, 2009

This lecture was held at the Highstead Arboretum in Redding, CT. The three speakers spoke about alien species and the effects deer are having on forest ecology. It was attended by four of the TBDAC committee members.

Stephen Patton, PhD

Ornithologist, Director of Landscapes, The Nature Conservancy (TNC) (a private non-profit national entity devoted to land and water conservation)
Devil's Den Preserve Director
Past Chairman, Weston Deer Management Committee

Devil's Den is home to a wide variety of flora and fauna, including more than 500 types of trees and wildflowers. This preserve is the Connecticut chapter's largest contiguous preserve. At over 1700 acres it is the largest tract of protected land in Fairfield County. The Den provides a valuable oasis for species that require interior woodland for successful reproduction. Research has shown that, for a variety of reasons, such large unfragmented forest areas are vital to the health of a variety of species. Devil's Den also represents a significant portion of the watershed of the west branch of the Saugatuck River. It is located in nearby Redding and Weston.

Dr. Patton discussed measures taken to help protect the forest ecosystem, including deer herd reduction, monitoring and control of alien insects, diseases and alien invasive plants.

Land trusts and TNC had restrictions on deer hunting, however with deer populations rising to 120 in parts of Fairfield county in the late 1990's, TNC had to refine their policy for deer management. They now encourage land trusts and private land owners to lower their deer populations to 8-12 d/mi.

Deer cause: Impaired forest regeneration.
Loss of native herbs and forest regeneration.
Reduced structural diversity of the forest plants.
Reduced avian diversity.

As a result of the new policy and increasing deer harvests in Devil's Den, they are now seeing native plants return to the area. Plants like: red trillium, blood root, pink azalea, maple leaf viburnum, pink lady's slipper, cardinal flower and the Indian pipe.

Monitoring for success: Monitor annual deer harvests.
"The real measure of success is to check the ground for plant regeneration."

Forest measures of success: Tree diameter
Antler sample
Soils chemistry and moisture holding capacity profile, description/structure
Shrub and tree composition, density and cover.

Misc. quotes: Coyotes can't control the deer population.
Need to develop a market for venison.

Unlikely birth control for deer will work for keeping deer numbers low.

Edward K. Faison, MA

Forest Ecologist, member of the staff at Highstead Arboretum, Redding

Mr. Faison spoke about the historical ecology of the forest in this area and his work with the two exclosures maintained at Highstead, and the effects deer are having on tree regeneration.

"Deer are having a significant impact on large tree seedling regeneration."
"Deer are ecosystem engineers."
"Ecologically, deer are a keystone species."

In the maple/ash forest at Highstead the effect deer are having on seedling regeneration is very significant. Seedling regeneration is 10x higher inside this twelve year old exclosure.

In the oak forest exclosure, the seedling regeneration is 9x greater inside the exclosure.
700-1100 oak seedlings/hectare needed for oak forest regeneration.

Mice and chipmunks eat the seeds of the trees and deer eat the plants. Therefore you get very poor tree regeneration.

Jeffrey Ward, PhD

Chief scientist and Forester, Department of Forestry and Horticulture, Connecticut Agricultural Experiment Station

Dr. Ward discussed his studies on:

- The dispersal of exotic plant species by deer (with Dr. Scott Williams)
- His studies relative to overabundant deer
- Japanese barberry relative to tick infection rates
- Japanese barberry eradication methods

Dispersal of exotic species by deer. This study was published in 2006. The research area was at Lake Gaillard in North Branford, CT. It was conducted by Drs. Ward and Williams of the CAES. The study's initial goal was to determine whether deer were significant seed dispersers. Then it was to determine which species. Then it was to document dispersal of CT exotic species by deer. And finally it was to determine similar charact4eristics of plants. Below are listed some of the findings.

- Deer can disperse alien plant species long distances (birds really don't).
- Does traveled a median of 0.35-3.69 miles/day.
- Deer spread the seeds of many extremely poisonous plant seeds. Carolina Horsenettle (which was discovered to be 33% of the total exotic species dispersed), American Pokeweed and Black Nightshade.
- One deer can produce 508 viable seeds per day in its scat (20 seeds per poop pellet), of which 79% are not native to CT (approximately 400 germinable exotic seeds/deer/day). 70% of the seeds dispersed by the deer were not native to the U.S.
- This study was conducted at 59 d/mi^2.

- Disturbances to the soil will allow exotics to germinate and develop.
- Exotic seeds then get added to the seed bank.
- Deer lower the reproductive output of browsed species, both native and exotic.
- Deer increase the available growing space for new exotic seeds by heavy browsing pressure.

Deer:
In a 17 year old sugar maple stand where overabundant deer are present (60 per square mile), the maple stand is only 8" high, because of continued browsing.

Dr. Ward discussed his study on tick infection rates in barberry.

- 166 infected ticks/acre in barberry-infested areas.
- 44% ticks infected in the barberry vs. 10% infected in areas without barberry.
- One can reduce infected ticks by 75% by removing the barberry.
- The high density of ticks doesn't have to do with more mice under the barberry. It has to do with higher humidity under the barberry bushes.
- Barberry can be effectively eliminated (without herbicides) using propane torches.

Williams, S.C. and Ward, J.S. (2010). Effects of Japanese barberry (Ranunculales: Berberidaceae) removal and resulting microclimatic changes on *Ixodes scapularis* (Acari: Ixodidae) abundances in Connecticut, USA. Environmental Entomology 39:1911-1921.

APPENDIX B. SUMMARY OF MUNICIPAL REPORTS

Wilton

Wilton Deer Committee

- Committee convened May 2001, public forum May 2002, report published Jan 2003.

Factual Findings

- White-Tailed Deer
    - Wilton deer density between 40-60 d/mi^2 (possibly higher) compared with "ecologically balanced" density of 10-20/sq mi.
    - Healthy doe produces 2 fawns per year & deer can live up to 18 years.
    - Potential doubling of deer population every 2-3 years.
    - In 1900, there were 12 white tailed deer in CT, in 2000 there were 76,000.
    - Each deer eats 5-10 lbs of forage a day.
- Ecological Impacts
    - Today's extraordinary deer population is a function of an increase of habitat coupled with a lower rate of mortality due to the absence of predation, either from humans or animals.
    - Impact to forest is undermining the ability of the forest to regenerate with native plant species and its ability to support desired wildlife species.
- Alarming increase in Lyme Disease
    - High rates of Lyme disease are correlated with high deer populations.
    - Lyme disease is known to impact one or more of the following, the heart, liver, muscles and nervous system.
- Significant number of deer-vehicle accidents
    - CT DEP estimates 6,000-8,000 deer are killed annually on CT roads.
    - 66 deer strikes were reported to Wilton Police Dept. from April 1, 2002- Dec. 13, 2002. Many more accidents go unreported.
- Residential Property Damage

- The destruction of personal property is of major concern to the citizens of Wilton.

- Deer Herd Reduction
    - 78% of town survey respondents agree that deer herd reduction is warranted (method unspecified).
    - Coyotes rarely prey on healthy deer.
    - No FDA approved contraception to manage free range deer herds.
    - 50% of trapped deer for relocation die.
    - Hunting is the principal population reduction technique used by state wildlife agencies in the U.S.
    - Sharpshooting is illegal in CT, but has been effective on a small scale in other states.
    - Need for community education on deer related issues.

Community Survey

- 300 Wilton Residents participated in a telephone survey conducted by Taylor Nelson Sofres Interactive. Topics included:
    - Deer vs. Other Local Issues
        - Respondents asked to indicate their level of concern associated with local issues. Lyme disease topped the list with 56% expressing strong concern. It exceeded other issues such as housing, traffic, business development and hunting accidents.
        - 63% felt the deer population was a problem and required action.
            - Deer cited as a problem requiring action by a greater percentage of residents who had experienced property damage (74%) or who had experienced Lyme disease in their household (66%).
    - Lyme Disease
        - 54% of residents surveyed reported at least 1 case of Lyme disease in their household in the past 5 years.
        - 3 out of 10 who reported diagnosed Lyme cases said symptoms lasted more than 6 months.

- Most residents indicated modifying their dress and using tick repellents, with more than ½ modifying their landscape or staying out of the woods entirely.
- 87% said they check for ticks after being in the woods.

- Property Damage
  - 3 out of 4 residents experienced deer-related property damage within the past 5 years.
  - 75% reported taking some action to exclude deer.
    - over ½ used deer resistant plants or deer repellents.
    - 1/5 installed deer fencing.

- Deer-Vehicle Accidents
  - 28% reported having a deer-related accident in the past 5 years, 70% of which occurred in Wilton.
  - 1 in 10 reported an injury from a deer-related accident.
  - average cost for damage repair was $1,538.00.
  - Just under ½ of the residents were extremely or very concerned about deer-related accidents happening in the future.
  - 4 out of 5 residents report taking extra precautions when driving.

- Environmental Degradation
  - 66% of respondents either strongly or somewhat agreed with a statement that high deer density resulted in environmental degradation in Wilton.
  - When asked about their concern with the current or potential impact of the deer population on flora and fauna the majority said they were either very or somewhat concerned (66%).

- Deer Population Reduction
  - 78% of respondents were in favor of reducing the deer.
  - Birth control was the most favored reduction method (49%), followed by controlled hunting on town land (32%), trapping and relocating (28%), controlled hunting by sharpshooters (27%) and bow hunting (28%). Only 10% felt that no action was needed.

        - Hunting by sharpshooting was considered the most effective population reduction tool by 37% of respondents (whether or not they supported sharpshooting), significantly above other options.

    - State Hunting Regulations

        - 1/3 of respondents indicated being somewhat (24%) or very (8%) familiar with state hunting regulations.

        - 1 in 10 said they allowed people to hunt on their property during the last 5 years.

        - When asked about the likelihood of their supporting hunting on their property if it was the method supported by the town of Wilton, 21% were likely to support it and another 17% were somewhat likely to do so.

Committee Recommendations

- Deer Population Control

    - These recommendations were based on findings listed above, including:

        - "Higher deer densities are directly correlated with a greater risk of contracting Lyme disease, increased deer vehicle collisions, unacceptable levels of property damage, loss of plant and animal and the diversity of our natural landscape."

        - 78% of residents from the survey support deer population reduction.

    - Encourage residents to allow private property hunting.

    - Work with Norwalk Water District (owner of 1,200 acres) to allow hunting.

    - Implement controlled hunts on town land and work with land preservation groups to do the same.

    - Promote and coordinate population reduction with area towns.

    - Compile information package on regulations and hunter availability for residents wishing to pursue hunting.

    - Encourage hunters to take as many does as possible.

- Education

    - Produce brochure and implement other public education mechanisms to distribute info on deer-related topics.

    - Develop and implement mechanisms for consistent and long term distribution of information on deer related topics.

- Support activities and groups that focus on Lyme disease prevention.
- Publicize Police Dept. deer/auto data in local newspapers.
- Encourage management of roadside vegetation for better visibility and, as deemed useful, add “Deer Crossing” signs.
- Promote defensive driving re deer in driver’s education courses.
- Monitor state research and encourage the use of Wilton as a test location when advantageous.
- Monitor the progress and efficacy of recommendations by conducting follow-up survey in five years.
- Install one or more deer exclosures to monitor and promote awareness regarding the effects of deer browsing.

- Legislation
  - Support the advancement of deer contraception technology.
  - Support legal sharpshooting to control deer population growth.
  - Support Sunday hunting
  - Implement regional deer lobbying group.
- Property Management
  - Encourage residents to choose plants less attractive to deer and utilize deer repellents.
  - Encourage residents to erect deer fencing.
  - Encourage residents to strategically place woodchips and apply pesticides at the yard perimeter to reduce deer tick distribution.
- Rejected Interventions
  - Contraception: No FDA-approved contraceptive to manage free-range deer herds.
  - Trap/Relocate: 50% mortality rate of trapped deer.
  - Sharpshooting: Illegal in CT.
- Interventions Not Discussed
  - 4-Posters
  - Acaricidal sprays

- Barberry removal
- Vaccines

Data Sources

- Speakers
    - Katherine Morrissey (Wilton Task Force on Lyme Disease)
    - Howard Kilpatrick (Chief Biologist, CT DEP)
    - Denise Savageau (Greenwich Conservation Director)
    - Laura Simon (Urban Wildlife Director, Fund for Animals)
    - Patrick Comis (CT Audubon Society)
    - Judith Neville (New Canaan Deer Committee & New Canaan First Selectman)
    - Bill Manetti (Animal Rights Front)
    - Dr. Steve Patton (Director of Devils Den/Nature Conservancy)
    - Dr. Kirby Stafford (Chief Scientist, CT AG Station)
    - Eleanor Sasso (Good Neighbors)
    - George Ciaccio (interested citizen)
    - Steve Ralph (Wilton police)

Results

- No formal follow-up reports/surveys available.
- DEP Deer Data
    - Deer Density
        - 2003: 40-60 d/mi^2 (est.)
            - Zone 11 (Fairfield Cty): 80 d/mi^2 1999/2000, 51 d/mi^2 2003
        - 2009: 67.6 d/mi^2 (Easton/Weston/Wilton transect)
    - Deer Harvest
        - 2004-2009 Annual average (all hunting): 176 total, 6.4 d/mi^2
            - Newtown: 306 total, 5.3 d/mi^2

- 2010 (bowhunting through 12/30): 43 total, 3.3 d/mi^2
    - Newtown: 166 total, 2.9 d/mi^2

Ridgefield

Ridgefield Deer Committee

- Committee convened Sept. 2004; report published June 2005 (approved by 17 to 1 vote, with one member absent); adopted by BOS Nov. 2005; vote to allow controlled hunts May 2006.

General Factual Findings

- Ridgefield has a serious problem with deer overpopulation, manifesting itself in elevated rates of Lyme disease, unacceptably large numbers of deer/auto accidents and extensive damage to plant life, ecology and environment.
- Deer density estimated at 40-80 d/mi^2
- Targeted deer density = 20 or fewer d/mi^2
- As of report, hunting is the only effective tool to reduce the deer population
    - no FDA approved contraception available.
    - moving deer impractical or impossible.
- Other techniques, such as effective landscaping and safer driving, can be employed to reduce some of the deleterious effects of deer overpopulation.

Findings re Tick-Borne Disease

- "Our growing deer population has had a clear and direct effect upon the incidence of Lyme disease in Ridgefield, which is now among the highest in the State."
- "Lyme disease has become a serious health problem in Ridgefield. Reported cases grew from 39 in 1991 to 95 in 2002, the last year for which we have comparable data. ... Due to diagnostic challenges and underreporting by physicians, experts believe that the reported numbers understate the true incidence of Lyme by a factor of ten, such that the real incidence would be closer to 900 new cases per year. This higher estimate is supported by a 2002 Wilton survey in which 54% of households reported at least one clinically diagnosed case of Lyme disease, 90% of the cases occurring within the previous five years."
- "Lyme disease can be devastating to people of all ages, but particularly to children who often play outdoors and don't take proper precautions. When diagnosed early, LD can usually be successfully treated. However, because ticks are difficult to spot and symptoms mimic many other diseases, LD often goes undiagnosed and untreated. As the disease progresses, it becomes more difficult to treat and the symptoms become more severe, often leading to disability or incapacitation and sometimes death. "

- Lyme disease and frequently other dangerous infections such as babesiosis, ehrlichiosis and bartonella are transmitted by the deer tick.
- The adult tick's preferred host is the white tailed deer and CAES reports a direct correlation between deer density and tick density. (citing Stafford, 53:2 *Frontiers of Plant Science (*Spring 2001).)
    - "In other words, where there are fewer deer, there are fewer ticks, and vice versa."
- Studies demonstrate relationship between deer, ticks, and Lyme disease (citing Great Island, Bridgeport, Bluff Point, Mumford Cove and Narragansett Bay research).
- Issues not fully understood:
    - Whether relationship between deer, ticks and Lyme disease is proportional.
    - Deer density level below which tick borne illness risk is essentially eliminated (estimated at 8 d/mi^2).
- "While it is unlikely that we will reach and sustain that threshold anytime soon, it is reassuring to know that reducing the deer population is likely to significantly lower the risk of tick-borne infection."
- "The bottom line is that, when there were fewer deer in Ridgefield, there were fewer Lyme disease cases."
- Lowering deer population will result in fewer ticks and Lyme disease cases.
- 20 d/mi^2 targeted.
- Because it will take several years to bring deer population down to 20 d/mi^2, and some tick-borne disease risk will remain thereafter, endorsement of Ridgefield Lyme Disease Task Force initiatives re: education and tick control (incl. landscape techniques, bait boxes and anti-tick spraying)

Findings re Deer-Vehicle Collisions

- Ridgefield has the highest number of deer/vehicle accidents in the state according to CT DOT.
- The number of deer tagged and reported following accidents is merely a fraction of the overall number of accidents.
- The town is only required to submit state reporting cards to the DEP for tagged dead deer. Many towns are not fulfilling this requirement.
- There is no state requirement for reporting accidents that did not result in the deer's death.

- The numerous patches of green space separated by highly traveled tree-lined rural roads with limited visibility contribute to high accident rates.

- Inattention and speed are additional factors for collisions.

Findings re Environmental Damage

- "While Lyme Disease, auto accidents and yard damage are obvious results of deer overpopulation, an often less noticed but no less serious form of damage is taking place in the public and private open spaces of Ridgefield. Over browsing has changed the ecology of our woodlands and fields in the past 20 years ... Repairing the damage already done by deer could take decades."

    - Native plants, insects, birds, amphibians, reptiles and small mammals are disappearing.

- Migratory songbirds lack nesting sites due to understory damage.

- Devil's Den in Weston and the National Audubon Society in Greenwich both decided to encourage hunting/culling on their lands due to environmental damage.

Findings re Deer & the Yard

- "While perhaps the least serious of the 4 problems created by deer overpopulation, yard damage is the most widespread and visible. Hardly a household exits that has not had cultivated plants eaten by deer."

- Because deer forage the forest edge, they find suburban communities like Ridgefield attractive. Pockets of woods provide shelter while yards offer a bounty of food.

- While fencing can solve an individual family's deer problems, it is not a community solution.

Hunting Recommendations

- Ridgefield should allow controlled deer hunting of deer on appropriate town-owned properties.

- Ridgefield should create a deer management committee to oversee controlled hunting, screen and select hunters for skill/safety/knowledge/reliability, establish controlled hunt rules and identify controlled hunt sites, prioritizing high deer density tracts if and when those are known.

- Ridgefield should proactively encourage hunting on private land by providing advice, helping landowners evaluate the need and methods for hunting, and helping them find suitable hunters from a list to be maintained by the committee.

- Ridgefield should modify town ordinances to allow hunting on town-owned land, under the supervision of the town and/or deer management committee.

Other Recommendations

- Work with Yale School of Forestry (or other institution) to collect data on deer impacts, population densities, and trends.
- Conduct aerial survey to estimate deer densities, locate "hot spots," and help assess culling efforts.
- Educate the public about the relation between deer and Lyme disease, how to discourage deer from visiting properties, and how to control ticks and mice on properties.
- To reduce the number of car-deer accidents, the town should steward a driver awareness program on deer movement patterns, areas of high deer concentration, and how to modify driving habits.
- Investigate devices to discourage deer from crossing highways in high-risk areas.
- Develop plan for management of roadside vegetation that attracts deer dangerously close to highways.
- Encourage residents to landscape properties in ways that are less attractive to deer with Conservation Committee, garden clubs.
- Monitor and publicize emerging technologies that may be used to control deer populations, and/or deter deer from yards and from damaging public lands.
- Use websites, press releases, and a "speakers bureau" to educate the public about deer management, deer tick reduction, deer "unfriendly" yards, traffic safety, hunting, and other aspects of the deer problem.
- Rejected Interventions:
    - Contraception: No FDA-approved deer contraceptive available.
    - Trapping/Relocation: Impractical, possibly impossible.
- Not Discussed:
    - 4-Posters
    - Acaricidal sprays
    - Barberry removal
    - Vaccines

Data Sources

- Speakers:
    - Howard Kilpatrick (Senior Biologist, CT DPH)

- Georginia Scholl (FCMDMA)
- Pat Sesto (Wilton Director of Environmental Affairs)
- Steve Patton (Devil's Den/Nature Conservancy)
- Tom Renzulli (DEP Master Senior Firearms & Bow Instructor)
- Laura Simon (Fund for Animals)
- Dr. Kirby Stafford (Vice Director of the CT AG Station)
- Dr. Os Schmitz (Yale School of Forestry)
- Denise Savageau (Greenwich Director of Conservation)

- Various published materials
  - 5 peer-reviewed articles
  - Tick Management Handbook
  - Government data

Results

- No formal follow-up reports/surveys available.
- DEP Deer Data
  - Deer Density
    - 2005:
      - 40-80 d/mi^2 (est)
      - Zone 11 (Fairfield Cty): 80 d/mi^2 1999/2000, 51 d/mi^2 2003
    - 2009: 63.6 d/mi^2 (Ridgefield/Redding transect)
- Deer Harvest
  - 2006-2009 Annual average (all hunting): 270 total, 8.2 d/mi^2
    - Newtown: 306 total, 5.5 d/mi^2
  - 2010 (bowhunting through 12/30): 205 total, 5.9 d/mi^2
    - Newtown: 166 total, 2.9 d/mi^2)

Fairfield

Fairfield Deer Committee

- Sub-committee of Fairfield Conservation Commission formed in winter 2009; report published Oct. 2009.
- Modeled on Ridgefield Report
    - Findings/recommendations substantially identical to Ridgefield report except where otherwise noted.

Scope

- "The Committee voted that Fairfield has three times more deer than its habit [habitat?] in terms of impact."
- The Committee voted that overpopulation of deer has a negative impact on health, ecology and safety.
- The committee considered two options: Do nothing and let nature take its course or take a proactive approach.
- "This approach was chosen based on committee's research, as well as similar findings and actions being taken from nearby towns to reduce the deer herd population that will improve the health and safety of town residents, restore a balanced ecological function to Open Spaces and reduce the town's potential liability for personal damage caused by too many deer."

Findings

- Committee felt that best scientific literature refuted testimony that other hosts would replace deer.
- Committee reviewed studies that suggest that there is little correlation between deer reduction and Lyme disease contraction, but concluded that overwhelming evidence by leading scientists directly contradict these reports.

Data Sources

- Speakers:
    - Tom Belote (Chairman, Ridgefield Deer Management Committee)
    - Edward Faison (Biologist, Highstead)
    - Howard Kilpatrick (Senior Biologist, CT DEP)
    - Denise Savageau (Greenwich Director of Conservation)

    - Dr. Robert Schoen (Rheumatolgist)
    - Pat Sesto (Wilton Dir. of Environmental Affairs)
    - Laura Simon (Field Director, Urban Wildlife Program, HSUS)
    - Scott Williams (Research Scientist, CAES)
- Ridgefield report
- Other published materials

Brookfield

Deer Management Plan adopted 2008 (no published ex ante report available)

Plan Elements

- Lyme disease information placed on town website (**www.brookfield.org/LymeDisease/index.html**)
- The local health department's involvement (tick testing, and tick/Lyme information)
- Application for a one-time Lyme grant through the Health Department
- Spraying municipal properties and schools for ticks
- Sent home the ***ABC's of Lyme*** (LDA brochure) with all K-6 students
- The ***Time for Lyme Curriculum*** was installed in Brookfield schools to teach children about ticks/Lyme and prevention .
- Suggested a school field trip permission slip warning about ticks and the need for a tick check
- Showing Lyme videos on the educational channel
- The annual Rotary Lyme seminar in April/May 2008. The most recent seminar was Oct. 6, 2009.
- Tick Kits were provided for all town grounds workers
- Signs on town-owned property warning about ticks
- Close cooperation with other towns' task forces (Newtown, Ridgefield, Tribury)
- Employed the Ridgefield BLAST program at Health Fairs
- Received a grant for 1000 Tick Kits for town residents. These Tick Kits were distributed to the public free of charge.
- Met with CDC representatives to make recommendations about their efforts to educate physicians, web site information, and other important areas.
- Brookfield joined the Fairfield County Municipal Deer Management Alliance (see: **www.deeralliance.com**).
- A deer reduction plan was put in place with the blessing of the Conservation Commission to manage the deer on town-owned property.
- Brookfield has many private properties where archers are hunting deer. There is no minimum property size requirement for bow hunters.

- Brookfield is looking to expand additional properties each year in the controlled hunt and they feel confident that they are moving in the right direction and reports a perfect safety record to date.

Results

- DEP Deer data
    - Deer Density
        - Brookfield not included in 2009 aerial survey
        - 2009 news article reports 63 d/mi^2 DEP population estimate (source unknown)
- Deer Harvest
    - 2009 harvest (all hunting): 139 total, 7 d/mi^2
        - Brookfield reports that sixty percent of the culled deer are female.
        - Newtown: 298 total, 5.2 d/mi^2
    - 2010 harvest (bowhunting through 12/30): 111 total, 5.6 d/mi^2
        - Newtown: 166 total, 2.6 d/mi^2

Darien

Deer Management Committee

- Committee Formed 1997
- Report following controlled hunt sponsored by Darien Park & Rec and Darien Land Trust submitted 2006

Results

- DEP Deer data
    - Deer Density
        - Not included in 2009 aerial survey
    - Deer Harvest
        - 2005-09 Annual average (all hunting): 44 total, 3.4 d/mi^2
        - Newtown: 306 total, 5.5 d/mi^2
        - Darien town website reports increase in average annual deer harvest from 2 to 60 since Committee instituted
        - 2010 harvest (bowhunt through 12/30): 43 total, 3.3 d/mi^2
            - Newtown: 166 total, 2.9 d/mi^2

Greenwich

Greenwich Conservation Committee

- Conservation Commission requested to examine deer issues mid-2000; report published Oct. 2004.
- Initial Commission Goals: Review deer management information, establish education/outreach program, establish baseline deer data, develop long-term plan based on science and community needs.

Findings

- Without sufficient checks, deer population and associated problems will continue to increase.
- Lyme disease: direct correlation between deer herd and Lyme disease (Mumford Cove and Great Island studies).
- Ecosystems:
    - Destruction of forest ecosystem, plants, songbirds (Healy study: tracts with 26-44 d/mi^2 had 39% tree regeneration vs. tracts with 7.8-15.5 d/mi^2).
    - Greenwich Audubon property (Shono, 2003) reports forests heavily browsed by deer soon lose species such as herbaceous wildflowers, shrubs, songbirds, forest insects and small woodland mammals.
- Deer/vehicle accidents: est. 250 deer killed in Greenwich car accidents 2003 (actual DVAs likely larger; some injured deer may have perished away from roads, some accidents due to near misses).
- Detailed deer survey (aerial surveys, spotlight surveys, radio telemetry, etc.) found different deer densities in different areas: few deer in coastal areas; 68 d/mi^2 North of Merritt Pkwy.

Kilpatrick Mail Survey

- 74% support lethal hunting (bowhunting preferred)
- 79% prefer non-lethal methods (unless substantial cost)
- Respondents expect results within 3-5 years

Recommendations

- Immediate herd reduction by hunting and/or sharpshooting (reduce herd to <26 d/mi^2 in 3-5 years).
- Long-term management through hunting and/or birth control (subject to regulatory approval).

- Periodic census to monitor herd size.
- Encourage private hunting, especially by large landowners.
- Open town-owned parcels to hunting.
- Encourage local hunting associations re membership, standards.
- Limited financial support to hunting groups (carcass preparation).
- Support legislative/regulatory changes re deer management goals.
- Education/outreach.
- Work with other towns (e.g., through FCMDMA).
- Monitor hunting management strategies.
- Monitor effectiveness of program (vegetation damage, DVAs, Lyme disease).
- Work with Kilpatrick/DEP.
- Budget for long-term deer management.
- Rejected interventions:
    - Limiting deer access (does not address deer overpopulation, only valid re individual properties).
    - Natural Predators (inappropriate to reintroduce).
    - Trapping/Relocating (expensive, ineffective).
    - Birth Control (experimental, costly, not commercially available.

Results

- Deer Management Plan adopted 2005
    - One-time sharpshooting cull (80 deer)
- DEP Deer data
    - Deer Density
        - 2004 survey: Few deer in coastal areas; 68 d/mi^2 North of Merritt Pkwy.
        - 2009 aerial survey: 59.6 d/mi^2 (Greenwich/Stamford/New Canaan transect

- Deer Harvest
    - 2005-09 Annual average (all hunting): 97 total, 2.0 d/mi^2
        - Newtown: 306 total, 5.5 d/mi^2
    - 2010 (bowhunting through 12/30): 95 total, 2.0 d/mi^2
        - Newtown: 166 total, 2.9 d/mi^2

New Canaan

New Canaan Deer Management Committee

- Committee formed in 1998
- Letter sent to homeowners Feb. 2000 summarizing findings/recommendations and requesting donations for DeNicola aerial deer count.

Findings

- There is a direct correlation between the incidence of Lyme disease and the proliferation of deer.
- New Canaan had highest DVAs/mi^2 in CT.
- Deer herd can double in 2 ½ years.
- Bow hunting is safe.
- Removing leaves, clearing brush, cutting tall weeds can reduce tick density.
- Up to 50% adult/25% nymphal ticks are infected with Lyme.
- One deer can carry 1,000 ticks and eat 5-10 lbs of foliage/grass/flowers etc.
- FDA has not approved deer contraceptives.
- June/July are highest-risk tick-borne disease risk months due to difficult-to-detect nymphs.
- Lymerix vaccine found to prevent 76% of Lyme disease cases but unavailable to most vulnerable (under 15/over 70) and ineffective against other tick-borne diseases.
- Reducing female deer before breeding season is effective in controlling deer population.
- Many experts have determined that hunting is most effective/least expensive deer population measure.
- Most deer stay within ½ sq mi range.
- Bowhunting allowed for 108-day season; firearm hunting allowed for 3-week season; no limit on female deer.
- Homeowners with >4 acres should alert neighbors of firearm hunting.
- Hunting not recommended next to schools while school is in session.
- Venison can be donated to food banks.

Survey

- Survey conducted by Center for Survey Research and Analysis at UCONN- Dec. 2000.
- The majority of residents (52%) feel that Lyme disease is a very serious problem and an additional (34%) feel it is a somewhat serious problem.
- Residents are already taking precautions to prevent Lyme disease. (87% have tended to most often check for ticks on themselves after being outdoors).
- More than half of residents have also used insect repellents (68%) and (54%) avoided grassy or wooded areas to avoid ticks.
- Fewer than half (43%) have tucked their pants into their socks.
- 74% reported that they or a member of their household have found a tick on themselves.
- The vast majority of residents (84%) report having seen deer or evidence of deer on their property.
- Significant concern re DVC risks, with half residents reporting they are "very concerned" and an additional (31%) reporting somewhat concerned.
- 21% of residents reported that they or a member of their household have been involved in a DVC in New Canaan.
- 74% support reducing the deer population as a means of reducing the risk of Lyme disease.
- Residents prefer non-lethal measures over lethal measures and among lethal measures bow hunting above firearms.

Recommendations

- Engage expert to conduct deer population count.
- Invite Kirby Stafford to evaluate tick density; consider pyrethrum sprays in high-risk areas.
- Amend zoning to allow 8-ft deer fencing.
- Appeal to state to modify deer-related laws.
- Encourage landowners to allow hunting.
- Work with DEP to conduct controlled hunt on large public/private lands.

Results

- Deer manager hired to encourage hunting on private land.
- DEP Deer data.

- 2009 Deer density: 59.6/sq mi (Greenwich/Stamford/New Canaan transect).
- Deer Harvest
    - 2005-09 Annual average (all hunting): 97 total, 4.3 d/mi^2
        - Newtown: 315 total, 5.5 d/mi^2
    - 2010 (bowhunting through 12/30): 73 total, 3.2/sq mi
        - Newtown: 166 total, 2.9 d/mi^2

Redding

Public/Private Programs

- Controlled hunting adopted in 2005 (no published report available).
    - Deer Warden appointed.
- Be Safe Redding (private group designed to encourage hunting on private land) formed 2009 (see Summary of Speaker Appendix).

Results

- 2009 Deer density: 63.6 d/mi^2 (Ridgefield/Redding and Redding/Newtown/Monroe transects)
- Deer Harvest
    - 2006-09 Annual average (all hunting): 282 total, 8.8 d/mi^2
        - Newtown: 306 total, 5.5 d/mi^2
    - 2010 (bowhunting through 12/30): 165 total, 5.1 d/mi^2
        - Newtown: 166 total, 2.9 d/mi^2

Weston

Weston Deer Management Committee

- Report Published May 2006.

Findings

- Weston deer herd decreased 26% from 2000 to 2004 to 25 d/mi^2 (possible factors: greater proportion of open forest vs. edge habitat, historical recreational hunting patterns, Devil's Den hunt, coyotes).
- Less pressing need to act than other Fairfield County towns, although risk of herd growth and Lyme disease, deer/auto accidents and ecological damage.
- Studies have shown that reducing deer can reduce Lyme disease risk.
- "Black box" mouse boxes tested in Weston/Westport promising, but expensive.
- Deer/auto accidents most common on rural roads with 55mph or greater speed limits (Routes 53 & 57 most common DVC roads in Weston).
- Fencing is most effective means to avoid DVCs but is expensive and impractical.
- Temporary deer warning signs can be effective if displayed only during peak season.
- Strieter-Lite system has shown DVC reduction promise.
- Deer browsing can lead to decline of native plants, increase in invasive species and reduction in wildlife diversity.
- Advances have been made in deer birth control, but hunting remains only practical, currently available method to reduce deer population in open areas.
    - No known accidents, but increased concern about hunting safety and unwanted intrusion of hunting activities.

Recommendations

- Monitor deer herd density and impacts, including changes in Lyme disease cases, deer/auto accidents, forest ecology damage.
- Monitor deer birth control/tick control developments.
- Encourage Lyme disease education.
- Continue participation in "black box" trials.

- Educate residents about peak deer/auto accident season.
- Increase speed limit enforcement and consider temporary warning signs during peak season.
- Encourage brush/grass clearing from roadsides.
- Test Strieter-Lites on selected segment of Rt. 53 or 57.
- Establish vegetation plots for monitoring deer damage.
- Encourage residents to contact Nature Conservancy or other groups for landscaping/gardening information.
- Remind local residents of hunting regulations.
- Consider keeping municipal list of licensed hunters available for private property hunting.
- Encourage residents to notify neighbors about planned hunting.
- Residents should be advised to be judicious about whether hunting is appropriate on small properties.
- Encourage residents to call DEP, ACO or police about illegal hunting.
- Seek funding for additional DEP Conservation Officers.

Results

- DEP Data
    - 2009 Deer density: 67.6 d/mi^2 (Wilton/Weston/Easton transect)
    - Deer Harvest
        - 2005-09 Annual average (all hunting): 90 total, 4.6 d/mi^2
            - Newtown: 315 total, 5.5 d/mi^2
        - 2010 (bowhunting through 12/30): 46 total, 2.3 d/mi^2
            - Newtown: 166 total, 1.6 d/mi^2
- Jan. 2010 Remarks by Dr. Steve Patton, Devil's Den Preserve:
    - Deer management program has reduced Devil's Den density to 25–30 d/mi^2 after 10 years; "substantially less than we understood it to be" previously.
    - Noticeable difference in deer browse and increase in some native shrubs, woodland grasses and flowering forest plants.

Westport

Unique Circumstances/2010 Hearings

- Hunting prohibited by ordinance since 1971
    - Accordingly, DEP Harvest Data very low:
        - 2006-09 Annual average (all hunting): 12 total, 0.6 d/mi^2
            - Newtown: 306 total, 5.5 d/mi^2
        - 2010 (bowhunting through 12/30): 6 total, 0.3 d/mi^2
            - Newtown: 166 total, 2.9 d/mi^2
- Impact?
    - Not included in 2009 aerial survey.
    - No indication of increased deer-related problems as compared to towns with hunting or hunting/controlled hunts (limited data).
- Sept. 2008: The Westport/Weston health district updated position statement on deer management and Lyme Disease and now state that the size of the tick population is directly related to the size of the deer population.
- Joint Environment/Public Protection/Health & Human Service Committee hearings convened September 2010 to consider deer management issues.

Bernards Township, NJ

Deer Management Committee

- Deer Management plan implemented in 2003 (no ex ante published report available).
- Committee publishes annual reports.

Management Plan Elements

- Controlled archery and shotgun hunts on 35 parcels of town and county-owned land ranging from 2.6-488 acres.
    - Shotguns used on largest parcels.
- Controlled hunt constitutes bulk of total town harvest (67% in 2008-09).
- Private property owners encouraged to volunteer their land for hunting (37% of the total deer harvest).
- Extended hunting season (through end of March).
    - 11% of 2008-09 harvest during extended season.
- DVC monitoring.
- Deer processing paid by town (avg cost $70/deer/$7,910 total).
- Total program cost 2008-09 = $93/harvested deer.

2004 Mail-in Survey

- More serious economic impact of deer overpopulation than anticipated.
- Deer damage to your property in the past 3 years?
    - 86% yes and 73% judged it significant.
    - Estimated damage in the 3 year period totaled, $13,487,000.
    - Damage to vegetable gardens- $683,000
- Deer tick insecticide - $653,000.
- Anti deer fencing- $3,422,000.
- Deer repellent - $1, 165,000.

- 40% reported 1 or more DVC's.
- 39% reported 1 or more cases of diagnosed Lyme disease (average medical cost = $1,500).
- 20% reported a household pet had been diagnosed with Lyme disease.
- 70% reported having a deer tick on themselves or family member in BT.
- **TOTAL** projected costs were $19,410,000 or $6,470,000 per year not including communal living properties.
    - Bernards Township survey data used as input to calculate costs in FCMDMA deer cost report.

Annual Report Highlights

- Perfect safety record.
- No shot deer went unretrieved.
- 4.8 tons venison donated to food banks.
- Although it is too early to consider a follow up survey, there have been numerous anecdotal reports of reduced property damage coincident with the continuing reduction of to Township's deer population.
- After the last 7 seasons evident that deer population has been significantly reduced.
- Current projection is 20, mainly due to large pockets of deer not accessible to hunting.
- Major improvement from 118 in 2002.
- Results continue to be encouraging, but the goal has not yet been achieved.

Results

- Deer Density:
    - Pre-hunt density = 118 d/mi^2.
    - Estimated current density 46 d/mi^2 (based on 2011 aerial survey)[13]
        - Estimated by model; no full survey since 2002.

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[13] Some data from this study was completed following the release of the Bernards Township report and is discussed in the body of the main report.

- Partial 2008 survey showed 30 d/mi^2 in unhunted area.
- Stable last three seasons.
- 2010 aerial survey to be conducted in conjunction with CDC-funded tick study.

- Deer Harvest
  - 2003-05, 2008-09 annual average (all hunting): 481 total, 19.6 d/mi^2
    - Newtown: 315 total, 5.5 d/mi^2
    - 2009-2010 season: 381 deer
- Tick/Lyme Population
  - 2007 Jordan study found no reduction in tick population/Lyme disease as of 2005.[14]
  - Follow-up study underway in 2010.
- DVAs: Substantial reduction
  - Police count:
    - 2001: 289
    - 2002: 258
    - 2003: 243
    - 2004: 223
    - 2005: 196
    - 2006: 147
    - 2007: 94
    - 2008: 131
    - 2009: 102

[14] Analysis suggests that initial study period may have been insufficient to measure TBD incidence reaction to cull.

        - 2010: 108
    - Police count adjusted for estimated off-road/Interstate kills.
- Annual estimated cost of vehicle damage by deer in Bernards Township declined from $935,700 in 2001 (prior to deer management program) to $340,062 in 2009.

Lower Makefield Township, PA

Deer Management Evaluation

- Deer Management Plan by consultant (Natural Resource Consultants, Inc.) submitted May 2007.

Plan Executive Summary

- Lower Makefield Township experiencing deer/human conflicts such as DVAs, garden damage, Lyme disease, as well as negative environmental/wildlife impacts.
- Dealing with overabundant deer impacts is a value-based decision. Lower Makefield values = protecting open space, reducing conflicts in a safe, humane, and responsible manner.
- Lower Makefield presents deer management challenges.
    - most land used for single family homes with spacious "lawn forests," which, in combination with preserved land and larger private holdings, provide excellent deer habitat.
- Contraceptives/recreational hunting unlikely to achieve deer management goals.
    - Township deer vulnerability is low, deer refugia abundant and deer density goal low.
- Sharpshooting in suburban landscapes has been shown to be an effective management tool.
- The exclusion, elimination, or reduction of deer has been shown to substantially reduce tick abundance.
- Recommended tick/Lyme monitoring.
    - Consider 4-Posters if tick/Lyme levels remain above acceptable levels..
- Monitor compliance/effectiveness.

Deer Management Goals

- Maintain white-tailed deer as a valued component of Township's fauna while implementing a restoration plan mimicking the effects of natural predators on deer in order to protect, maintain and restore the structure, diversity and function of the township's forests and open space.

- Reduce the probability of contracting Lyme disease within Township.
    - exclusion, elimination, or reduction of deer has been shown to substantially reduce tick abundance.
- Reduce deer/human conflicts, particularly deer/vehicle collisions and agricultural, ornamental and garden damage.
- Manage deer in a safe, humane, socially responsible manner.
- Establish a permanent, quantitative monitoring program to assess deer impacts on forest vegetation.
- Reduce deer impacts to levels that allow forest understories to meet quantitative standards for advanced forest regeneration in hardwood stands (Marquis et al. 1992).
- Reduce deer impacts to a level that result in deer browsing intensity of less than 50% on preferred woody species using standardized browse sampling techniques (Benner, 2006).
- Reduce deer impacts to levels that allow similar species richness, equability, structure, robustness and percent flowering within deer exclosures and adjacent control plots with a special focus on native wildflowers.
- Reduce tick abundance by 75% and reduce Lyme disease cases by 70% by reducing overall deer density and possibly placing 4-Posters.
- Reduce agricultural, ornamental and garden damage to levels acceptable to township farmers, gardeners and landscapers.

Background Discussion

- 110 d/mi^2 estimated via aerial survey.
    - Discussion of limitations of deer counts.
    - Ongoing aerial deer density measurement not recommended once a deer reduction program is initiated for three reasons:
        - The goal is not a particular deer number per se, but rather a quantifiable reduction in deer impacts. Focus on effective monitoring program that abates those conflicts, for which the deer reduction was initiated, not an arbitrary deer density.
        - In the diverse landscapes that make up urban, suburban and exurban environments, little data relates deer density to the abatement of a range of deer conflicts, thus making deer density goals somewhat speculative and arbitrary.
        - As deer numbers are reduced infrared surveys become unreliable.

- Instead of monitoring deer numbers, it is recommended that deer presence and reproduction be monitored. So long as deer are fawns are observed, the goal of maintaining a viable, reproducing population of deer will be confirmed.

- Exurban habitat deer management issues:
  - Small home ranges (100 acres or less) enable localized management.
  - Deer vulnerability declines in mosaic of huntable and unhuntable habitat.
  - In healthy populations, 25-40% of does must be removed annually to stabilize herd, more to reduce population.
  - detailed deer management discussion.

- Deer management stakeholders:
  - Community Members (preference for non-lethal methods, support for safe, humane, affordable and effective lethal methods).
  - Animal Rights Advocates (opposition to lethal methods, support for non-lethal methods).
  - Recreational Hunters (support for increased hunting, possible opposition to non-traditional techniques like sharpshooting).
  - Organized Suburban Hunting Groups (effective resource where deer vulnerable, belief that recreational hunting will work everywhere).
  - Game Commission (emphasis on traditional hunting/trapping, Pittman-Robertson funding).
  - Conservation/Environmentalists (value deer as part of balanced ecosystem, support for hunting where effective and appropriate).
  - Sharpshooting Contractors (varying effectiveness depending on program design and implementation; payment should be based on achievement of goals rather than time or # deer removed).

Options Considered

- No Action: Not recommended (continued negative impact).
- Mitigation Techniques: Not recommended (fencing, repellents, deer-resistant plants etc. valuable for individuals but impractical on community scale).
- Restoration of Predators: Not recommended (introduction of cougars and other predators impractical).
- Trap and Transfer: Not recommended (ineffective).

- Contraception: Not recommended (theoretically promising, but not approved by regulators and experimental, unproven, time-consuming).
- Trap and Euthanize: Not recommended (inhumane, ineffective).
- Recreational Hunting: Recommended with Reservations.
    - Primary management tool absent predators.
    - Effective in stabilizing population in many landscapes.
    - Published literature does not support conclusion that traditional recreational hunting would achieve goals.
    - "no quantitative, science-based evidence that recreational hunting, even with bait, can successfully achieve and maintain the deer management goals established for Lower Makefield Township with the type of residential landscape presented there." (p. 29)
    - As deer density declines, "Recreational Threshold" results in reduced hunting.
    - Reduced deer vulnerability in suburban areas.
- Sharpshooting: Recommended
    - Removal of up to 90% of deer within single year, citing DeNicola, Sharpshooting Suburban White-Tailed Deer Reduces Deer-Vehicle collisions.[15]
    - Efficient, safe and humane.
    - Costs range from $100-$350/deer.
- Integrated Program: Recommended with Reservations.
    - Integrated programs using multiple tools are often the most effective program.
    - Unclear whether integrated program in Lower Makefield would improve effectiveness (possible increase in deer wariness).
    - No current organized deer hunting efforts in Lower Makefield. By itself, recreational hunting may make deer removal more difficult due to deer wariness, <u>but</u> would provide some recreational hunting for those citizens wishing to pursue hunting.

[15] Analysis suggests that the cited article does not support this statement.

- "The primary management goal for LMT is to mimic the population-stabilizing effects of natural deer predators, to protect, maintain and restore the structure, diversity and function of the township's forests and open spaces, while reducing deer/human conflicts. Based on current experience and published evidence, traditional hunting cannot achieve that goal, but hunters could." (with special training and participation in deer removal program).

Lyme Disease Options Considered

- Area-Wide Acaricide Sprays: Not recommended (community opposition, town ordinances). Individual property owners interested in sprays should check with township and licensed pesticide companies.
- Vegetation Management/Landscape Modification: Recommended (citing Stafford Tick Management Handbook).
- Bait Boxes: Not Recommended (high cost, withdrawal from market).
- Deer Reduction: Recommended. (citing Kilpatrick and LaBonte (2003) Mumford Cove article reporting that incidents of Lyme disease decreased by 83% following a 92% reduction in deer).
- 4-Posters: Not Recommended at This Time
    - Issues: utilization low when other food available, increased deer concentration in immediate area of 4-Poster stations, need for maintenance, time required to show effectiveness, pesticide use.
    - Cost- $22 per acre intial year, $11 per acre subsequent years.
    - Properly maintained and deployed, 4-Posters may reduce tick populations to acceptable levels. If tick populations/Lyme disease remain at unacceptable levels following deer removal, consider 4-Poster use.
- Other Lyme Disease-Related Recommendations:
    - Monitor tick population with standardized tick drags.
    - Monitor community Lyme disease case trends.

Other Recommendations

- Establish quantitative monitoring program to assess deer impacts on forest vegetation. Maintain existing deer enclosures and build additional enclosures.
- Monitor trends in the abundance of ticks on the property using standardize tick drags. Estimates of absolute tick density are unnecessary and expensive. "Managing Lyme Disease means managing tick bites which means reducing tick numbers."

- Monitor trends in the number of cases of Lyme disease in humans within the community with an annual survey of Lyme disease cases.
- Monitor deer presence/reproduction with low cost yet effective cameras.
- Compliance monitoring – implement formal process to document that the program is being applied as designed and data properly recorded.
- Effectiveness Monitoring – track a group of indicators to quantitatively measure the success of the program. The best indicator of the program success would be a downward trend in the cases of Lyme disease within the township.

Data Sources

- No Speakers
- 100+ Peer-reviewed articles
- Government/misc publications

Results

- Deer Management Plan approved April 2009
- Big Oak Whitetail Management (bowhunting) hired as Pennsylvania Game Commission condition to sharpshooting permit
- Multi-stage hunt in late 2009 removed 27 deer in first three stages (of four)
- White Buffalo (DeNicola) hired to remove 200-300 deer in 2010 at cost of approximately $60,000; 94 removed according to *Bucks Local News* report

Nantucket, MA

Nantucket Tick Borne Disease Committee

- Report published Nov. 2009, revised Dec. 2009.

Findings: Summary

- High tick-borne disease incidence on Nantucket Island represents significant public health problem.
    - Exact incidence difficult to determine, but data supports the conclusion that there is a high incidence of tick-borne disease that requires intervention.
    - CDC has listed Nantucket among the top three Lyme disease counties since 1992.
    - TBDs such as anaplasmosis and babesiosis are on the rise in Nantucket.
    - Dec. 2008-Jan 2009 survey reported that 60% of households had been infected with TBD.
    - TBD healthcare and social costs associated include high medical costs & lost school and work time.
    - Detailed discussion of TBD medical aspects, societal costs and epidemiology.
- Nantucket offers ideal tick habitat (dense vegetation, substantial unbuildable tracts).

Recommendations: Summary

- Integrated, long-term and sustainable 6-part program to reduce tick-borne disease.
- Managed deer reduction to fewer than 10 d/mi^2
    - Reduction to be accomplished in 5 phases over several years.
    - Long-term community support to be measured and obtained before starting reduction program.
- Island-wide and individual property owner vegetation management directed at limiting human exposure to ticks.
- Prudent use of pesticides.
- Strategic use and deployment of 4-Posters on an experimental basis at appropriate locations such as high-risk neighborhoods.
- Widespread spraying in open areas of Nantucket not recommended .
- Establishment of program to monitor the level of acaricides in environmentally sensitive areas.

- Public Education
    - Personal protection instruction in schools.
    - Information for property owners on property landscape management.
    - Information for island visitors.
    - Seminars by members of the Tick-borne Disease Committee and experts on the science of tick-borne disease.
- Improved Passive and Active surveillance system.
- Continuation of TBD Committee to monitor progress.
- "We understand that a deer reduction program will be controversial; however, of the tick-borne disease intervention methods considered feasible for use on Nantucket, we believe that reducing deer herd density to 8-10 deer/sq mile is key to decreasing the enzootic prevalence and human incidence of tick-borne diseases island wide."
- Reduce deer population from 50 d/mi^2 to less than 10 d/mi^2 in multi-phase effort over 12-16 years (estimate of Mass DFW).

Recommendations: Modes of Intervention

- Personal level
    - Appropriate protection and awareness.
    - First line of defense; includes wearing appropriate clothing, using tick repellents, daily bathing and prompt tick removal.
    - Source reduction around homes by proper habitat and landscape management.
    - Host-targeted pesticides (acaricides).
- Community level
    - Habitat and landscape management.
    - Host-targeted pesticides (acaricides).
    - Deer reduction.

Findings/Recommendations: Hunting

- Blacklegged tick density directly linked to deer density.
    - Islands in Narragansett Bay RI that lack deer do not sustain deer tick populations even with alternative hosts available.

- Monhegan Island in Maine, Great Island in Mass, Mumford Cove in CT and Crane Beach in Mass. are all examples of notable examples of successful reduction programs.
    - Studies indicate that if deer density is reduced to 8-10 d/mi^2, tick numbers can be lowered to levels that decrease risk of human disease.
- Bernards Township study, Ostfeld study did not show similar correlation.

- Targeted deer density levels for TBD similar to ideal density levels for other purposes (deer/vehicle accidents, ecological damage, etc.).
- Public hunting requires minimal funding and is the most cost effective method for reducing deer populations on Nantucket.
- Current Nantucket hunting rates remove 20% of population annually for stable population. MA DFW estimates that increasing removal to 35% of annual population would achieve density goals in 10-12 years.
    - Hunter success/satisfaction will decline with reduced deer density, potentially requiring regulatory changes and/or sharpshooting.
- Annual removal of 15% of population would keep population at desired levels during maintenance phase.
- Political, economic, and social factors are primary obstacles to successful deer reduction (2004 special hunt generated community opposition).
- Reduce deer population from 50 d/mi^2 to <10 d/mi^2 in multi-phase effort over 12-16 years (estimate by Mass DFW).
    - Reduction program divided into several hunting stages:
        - Planning/enlistment of landholder support/regulatory modifications (2-4 years).
        - Expanded public hunting/special hunting for 5-6 years to reach 25-30 d/mi^2.
        - Increase special hunting or employ sharpshooters over additional 5-6 years to achieve threshold density of 8-10 d/mi^2.
        - Ensure ongoing hunting programs maintain deer density at necessary levels to prevent TBD resurgence.
- Some TBD would remain following a successful deer reduction but incidence rates would be much less and other intervention methods could be curtailed or discontinued.

Findings/Recommendations: Landscaping

- Encourage reduced brush in yards, fewer shrubby thickets on conservation land, well-mowed grass.
- Exclusion of deer by fencing can be effective deer/tick landscape management tool.
- Open grass habitats contain fewer immature ticks than high shrub areas.
- Greatest tick-borne illness risk in areas close to homes.
- Because ticks require humidity, excessive watering should be discouraged.

Findings/Recommendations: 4-Posters

- Strategically deploy 4-Posters on experimental basis in high-risk neighborhoods and areas with high human traffic.
- Studies have shown the device to be effective in reducing tick density.
    - USDA study in five eastern states concluded that the 4-Poster technology was an efficacious, safe, and environment-friendly alternative to area-wide spraying of acaricide to control populations of ticks, with a 71% reduction in nymphal ticks after 5 years in the USDA study.
    - Adult, nymphal and larval ticks were reduced by 91-100% from sample plots and nymphal and larval ticks were reduced 70-95% on sampled mice in a study conducted at a NASA facility in Maryland.
- 4-Poster concerns include:
    - Potential spread of chronic wasting disease.
    - Deer feeding during hunting season illegal in Mass.
    - Potential for ticks to develop permethrin resistance, which may eventually reduce our limited personal protection arsenal (this also applies to spraying).
    - The availability of corn may induce eruption of rodents (the attraction of rodents noticed in the Shelter Island experience).
- Shelter Island study is monitoring permethrin levels in deer hunted in 4-Poster areas. Limited data indicate no residue or residue within accepted levels.
- Significant costs
- Various steps needed before deployment
    - Regulatory approval.
    - Identification of optimal locations and personnel.

- Obtaining permission from landowners.
- Legal review.
- Funding.

Findings/Recommendations: Education

- Develop education program including civic associations, garden clubs, neighborhood associations, schools and tourist-related businesses.
- Emphasize personal responsibility measures (daily tick checks, scrubbing with long-handled brush, protective clothing, repellants).
- Educate homeowners re maintenance of grass at 3" or less, possible acaricide spraying, pet collars, possible Damminex placement, trimming of property perimeters, installing deer-resistant fencing.
- Use schools for tick awareness beginning in elementary school.

Findings/Recommendations: Monitoring & Community Approval

- Endpoint of efforts is only valid if before and after incidence of TBDs can be accurately measured.
- To date there is significant TBD underreporting due to several factors.
- Develop/implement accurate TBD monitoring:
  - Enlist the support of local hospitals/physicians to provide computer lists of appropriate ICD codes for TBDs reported on Nantucket.
  - Educate seasonal physicians regarding TBDs.
  - Consider introducing a local active reporting system on Nantucket with an employee to collect and collate data.
- Develop community support (community seminars, possible island-wide vote on deer reduction).

Rejected Interventions

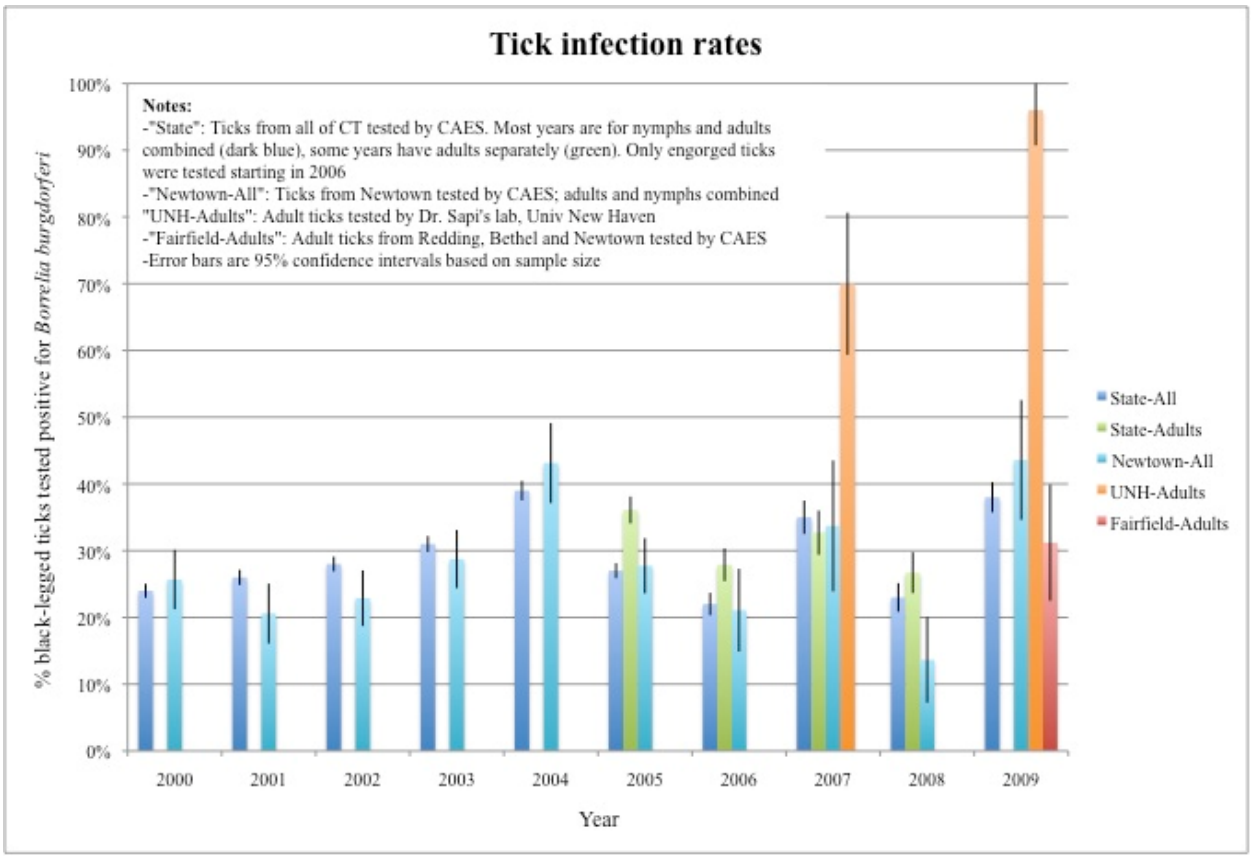
- Acaricidal spraying: not recommended on island-wide basis; although effective, insufficient environmental data to support or condemn use by individual property owners.
- Damminex tubes: effectiveness unclear.
- Bait boxes: removed from market.

- Biological controls (wasps, fungi, nematodes): experimental, not fully tested. Continue to monitor.
- Mouse control. Broad-scale effectiveness unsupported; reduction mouse habitat (dense vegetation, ground cover) by property owners encouraged.
- Deer birth control: experimental.

Data Sources

- Speakers:
    - Tim Lapore (Nantucket physician)
    - Sam Telford
- Other communications:
    - Rob Deblinger, Sonja Christensen (MA Dept. of Fisheries and Wildlife)
    - Susan Walker (Cornell Cooperative Extension)
    - Rae Lapides (Shelter Island Deer and Tick Management Committee)
- Publication:
    - Approx. 30 peer-reviewed articles
    - Government/misc publications

APPENDIX C. TICK INFECTION RATE REPORT



The Connecticut Agricultural Experiment Station

123 HUNTINGTON STREET BOX 1106 NEW HAVEN, CONNECTICUT 06504

Founded 1875 Putting science to work for society

April 16, 2010

Doug Hartline RS
Health Officer
Town of Redding
P.O. Box 1028
Redding Center, CT 06875

Dear Mr. Hartline:

The *Ixodes scapularis* adult ticks, both males and females, submitted by the Redding Health Department in coordination with Dr. Georgina Scholl from Redding, Newtown, and Bethel, Connecticut were tested at your request.

There were 109 ticks submitted and tested by PCR with 34 positive (31.2%) for *Borrelia burgdorferi*, the causal agent of Lyme disease. The rate in females was higher (31 of 54 positive or 57.4%) and particularly low for males (3 of 55 or 5.5%) in this sample. There is a significant difference ($z = 5.64$, $P < 0.001$) between the proportion of male and female ticks infected with *B. burgdorferi*. Spread sheets summarizing the results and the testing for each town and location are attached.

In 2009, a total of 3,669 *I. scapularis* feeding on humans from CT were submitted to The Connecticut Agricultural Experiment Station for identification and 1,768 were tested for the presence of the Lyme disease spirochete, of which 666 (37.7%) were found to carry the spirochetes. From Redding, 67 ticks were submitted, 30 were tested, and 12 were positive (40%). From Newtown, 299 ticks were submitted, 117 were tested, and 51 were positive (43.6%). From Bethel, 46 ticks were submitted, 19 were tested, and 9 were positive (47.4%). These numbers include both nymphs and adults of *I. scapularis*.

If you have any questions, please feel free to call me at 203-974-8485 or contact me at Kirby.Stafford@ct.gov.

Best Regards,

Kirby C. Stafford III, Ph.D.
Vice Director, Chief Entomologist
Department of Entomology

cc: Dr. Georgina Scholl

Phone: (203) 974-8500 Fax: (203) 974-8502
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09-12-09

Pat Sesto/ Chairman

Georgina Scholl MD/ Research Chair

Fairfield County Municipal Deer Management Alliance

RE: Report on the contract (dated 11-29-08) between the University of New Haven and the Fairfield County Municipal Deer Management Alliance

As described in this contract, the University of New Haven agreed to collect and analyze deer tick (/Ixodes scapularis/) samples for *Borrelia burgdorferi* and or *Babesia microti* infections in 4 Fairfield County towns in Fall 2008 and Spring 2009. The University of New Haven was able to finish the tick collection in all towns as of 06-07-09. We also finished the collection and testing of Ridgefield town which was not finished in the 2007 contract.

As of 06-07-09, the University of New Haven has collected **899 deer tick** samples and performed PCR based tests for *Borreli burgdorferi and Babesia microti* (**911 total tests**).

Based on our finished Fall/Spring testing the overall *Borrelia burgdorferi* infection rate was **90%**, ranging from **88%-96%.** The overall *Babesia microti* rate was lower, averaged at **30%** and ranging from **28%-33%**. The summary of all data for each town and the sites is presented as tables below.

The collection sites were designed to represent sites where children or families have outside activity, including school playgrounds or state parks. Ticks were collected for 60-90 minutes, within a few yard perimeters from these playgrounds at each site, using the dragging method as described below.

The live deer ticks were transported to the University of New Haven and stored until further analyses in a -80^0 C freezer. The deer tick DNA samples were analyzed for the presence of /Ixodes scapularis /(control) and /Borrelia burgdorferi/ and *Babesia microti* DNA using the standard and real time polymerase chain reaction techniques as described below.

Abbreviations: NT =not tested

Table 1. BETHEL SITES (collection dates 10-23-08)

Name of the Bethel Site	# Collected Deer Tick/ one hour	# Borrelia Positive Ticks	Borrelia Positive Tick%	# Babesia Positive Ticks	Babesia Positive Tick%
Johnson School	31	29	94%	10/31	33%
Freebairn Baseball Field	71	62	87%	21/71	29%
Terre Haut Park	71	66	93%	15/50	30%
Chestnut Ridge Reservoir	23	NT	NT	NT	NT
Total# collected/#tested	**195 collected/172 tested for Borrelia and 152 tested for Babesia**	**157 positive/172**	**91%**	**46 positive/152**	**30%**

Johnson school has a wooded property at the back of the school used by the students for recreational activities. This site is a typical wooded environment with obvious signs of animal activities. Several high grass areas located next to the soccer field and similarly to last time the tick collection was performed we found a lot of ticks in the grass. On the Freebairn Baseball field we found a very dense area with overgrown bushes around the field as well as high grass with a lot of ticks. Terre Haut Park is located at an industrial park in a very wooded and secluded site with a lot of signs of animal activities. This park is one of the sites we would like to return to if we need ticks because we always found a large number of ticks regardless of the season.

Table 2. NEWTOWN SITES (collection dates March 09)

Name of the Newton Site	# Collected Deer Tick/ one hour	Borrelia Positive Ticks	Borrelia Positive Tick%	# Babesia Positive Ticks	Babesia Positive Tick%
Head o' Meadow School	41	40/41	98%	15/41	36%
Orchard Hill Nature Center	59	11/12	92%	13/59	22%
Walnut Tree Hill Ball	23	NT	NT	NT	NT
Total # collected/#tested	**123 collected/ 53 tested for Borrelia and 100 ticks tested for Babesia**	**51 positive/53**	**96%**	**28 positive/100**	**28%**

Head O' Meadow site was a school property. We dragged the property at the back of the school. There were a lot of overgrown bushes and stones walls which are ideal places to support mice populations therefore it is not surprising that we have found significant amounts of ticks despite the fact it was a rainy day. Orchard Hill Nature Center is a typical wooded property. There were several high grass areas where we found most of the ticks. Walnut Tree Hill Ball is surrounded by overgrown bushes and again we have found most of the ticks on these bushes.

Table 3. REDDING SITES (collection dates 11-14-08)

Name of the Redding Site	# Collected Deer Tick/ one hour	# Borrelia Positive Ticks	Borrelia Positive Tick%	# Babesia Positive Ticks	Babesia Positive Tick%
Fox Run Road Trail	153	134	87%	43/145	30%
John Read Middle School	43	NT	NT	NT	NT
Topstone Park	28	25	89%	1/8	12,5%
Total# collected/#tested	**224 collected/181 tested for Borrelia and 153 tested for Babesia**	**159 positive/181**	**88%**	**44 positive/153**	**29%**

Fox Run Road trail was an ideal place for ticks: it had the muddy /rocky and shady fern vegetation as well as the barberry bushes to shelter ticks. We collected the most ticks right at the entrance (Raccoon trail) and the top of the hill. On White and Blue trails however we found only very few ticks.

John Read School we collected ticks right behind the school, especially at the climbing ropes.

At Topstone Park we collected the most ticks deeper in the woods and at the lake (there were very few ticks however on the wider trails).

Table 4. RIDGEFIELD SITES (10-06-08*, 12-04-08, 07-06-09***)**

Name of the Ridgefield Site	# Collected Deer Tick/ one hour	# Babesia Positive Ticks	Babesia Positive Tick%
Beaver Brook: 2 sites	67* (2 hour collection)	22/67	33%
Shadow Lake	98*; 55** 120***	11/33	33%
Lake WindWing	5**	NT	NT
Total tick collected/#tested	**345 ticks collected and** **100 ticks tested for Babesia**	**33 positive/100**	**33%**

We have visited Ridgefield 3 different times and collected over 300 ticks. Beaver Brook site was chosen by Karen and it was a very overgrown site with a lot of barberry bushes with red berries. There are also paths which we were told that are used by deer to find the nearby lake. We stayed 2 hours on this site choosing 2 main locations one was closer to properties and one was closer to the deer path.

Shadow Lake is a beautiful lake surrounded by woods. There were some prickly bushes around the lake which were covered by adult ticks. Deeper in the wood we have found the same bushes and some low vegetation. The site is always extremely infested with ticks regardless when we visited the site (even in December).

Lake WindWing is a more visited recreational place than Shadow Lake, that could explain the lower numbers of ticks. However we were still able to collect significant amounts of ticks in the high grass/wooded area around the lake.

Table 5. WILTON SITES (collection dates 07-06-09)

Name of the Redding Site	# Collected Deer Tick/ one hour	# Borrelia Positive Ticks	Positive Tick%
Slaughter Field	**12**	**NT**	**NT**

We met Pat Sesto at the site and after gearing up for the sites we tested the site for 1h 15 minutes. The site started with a beautiful high grass area with wild flowers which was not mowed recently. We did not find any ticks there so we moved into the muddy wooded area next to the high grass and we have found mainly nymphal ticks with the exception of one adult tick. The site was actually very ideal for wild life however it is a corner lot with ongoing traffic from the road that might explain the lower number of ticks (on the same day we were able to find a more significant amount of ticks in another Fairfield county site, Shadow Lake, Ridgefield: 120 ticks, so it was not the weather, or time of year).

Methods and Materials:

Tick Collection and DNA Extraction. Adult non-engorged *Ixodes scapularis* ticks were collected from Bethel, Greenwich, Newton, Redding towns using drags made of 1 m^2 canvas cloth, and stored at minus 80^oC. In each site, 3 students and one supervisor dragged for a period of one hour. Each tick was examined to determine the species, sex, and stage of development. DNA extraction was performed by macerating each tick with the edge of a large sterile paperclip in 470µL of TE buffer (10mM Tris-HCl [pH 8.0], 1mM EDTA) followed by the addition of 20 µL of Proteinase K (10 mg/mL) and 25µl of 10% sodium dodecyl sulfate. Samples were incubated for 24 hours at 55^oC. DNA was then further purified with phenol-chloroform method and recovered by ethanol precipitation. All the reagents for DNA isolation were purchased from Sigma-Aldrich (St. Louis, MO).

DNA Amplification by Polymerase Chain Reaction. Borrelia and Babesia pathogenic DNAs were amplified using gene specific primers for the Borrelia fla gene for flagellin (sense primer: 5'-GCATCACT TTCAGGGTCTCA-3', antisense primer 5'-GCTGCTACA ACCTCATCTGTC-3') and gene specific primers for Babesia beta-tubulin gene (sense primer: 5'-GCTGAGGGGTGTGATTGTTT-3, and antisense primer 5'- TTGATGGACGGAA AGTGTTG -3'.

Ixodes scapularis primers were designed to amplify a 16S ribosomal DNA region (sense primer: 5'TAAACAATTAAAAG 3' antisense primer: 5' antisense primer AATCGCTAAAAACG 3') as a control. All primers were made by Operon Biotechnologies [Huntsville, AL] according to their specifications. Other reaction materials were purchased from Promega Corporation [Madison, WI]. Reactions were carried out using 1.0 µg of DNA template, 50 microM of forward primer, 50 microM of reverse primer, 2.5 U Taq DNA polymerase, 2.5 µL of 10X Taq DNA polymerase reaction buffer with 20 mM $MgCl_2$, 1 µL of 10 mM dNTPs, and autoclaved de-ionized water to create a total reaction volume of 25 µL. Each samples were analyzed in separate tubes under the same thermocycler [Eppendorf Mastercycler, Westbury, New York] program consisting of an initial denaturation at 94°C for 5 min, 45

cycles of 94°C for 45 s, 50°C for 45 s, 72°C for 1 min, and a final extension step at 72°C for 2 min. Approximately 0.01 µg of pure *Borrelia burgdorferi* genomic DNA of was used as positive controls which was kindly provided by Bonnie Hamid [Agricultural Experiment Station, New Haven, CT]. For Babesia we have used a previously amplified and sequence confirmed DNA piece which was isolated in our laboratory. Autoclaved de-ionized water was used in place of template DNA in all negative controls. Products were visualized on 1.5% agarose gels with 0.5 µg/mL ethidium bromide using 1X TBE (0.09 M Tris, 0.09 M borate, 0.002 M EDTA) buffer with 0.1 µg/mL ethidium bromide. All tick samples were also checked for positive Borrelia DNA by Real- time PCR technology using Cyber Green protocol from Applied Biosystem following manufacturer's instruction for the same flagellin gene target we have used in the standard PCR protocol.

APPENDIX D. NEWTOWN MUNICIPAL LANDS FOREST HEALTH ASSESSMENT

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Joseph P. Barsky
Agricultural Research Technician I

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24 March 2010

Newtown Municipal Lands Forest Health Assessment

Initial descriptions and conditions:

• Four properties walked in order: Raynolds Property (≈ 29 acres), Grady Property (≈ 31 acres), Brook Heights (≈ 23 acres), Pole Bridge (≈ 50 acres)

• Walked on 19 March 2010 from 0900-1400
• Dr. Scott C. Williams and Joseph P. Barsky representing the Department of Forestry and Horticulture of The Connecticut Agricultural Experiment Station
• Weather was clear and sunny, approximately 65 degrees F, soils saturated, water table high, many invasive plant species beginning to leaf out, maples and elms beginning to flower

The properties were visited at the request of Newtown's Tick-Borne Disease Action Committee to obtain a snapshot of the overall condition of forested properties owned by the Town of Newtown. Many underlying concerns, such as forest management practices, parcelization/fragmentation of open-space, the positive impact that has had on white-tailed deer (*Odocoileus virginianus*) populations, and invasive species establishment were discussed throughout the course of the meeting. These issues are common,

and unfortunately, recurrent throughout southern New England. In this report, our perspective of a "healthy forest" is a balanced matrix of forest successional stages, native floral and faunal species diversity, and limited invasive species presence.

Raynolds Property

Background –It is evident that this property had an agricultural history, as it is bordered by stone walls and is surrounded by active agricultural areas, and newer single family homes. Based on the composition and size class of the trees on the property, it is estimated that agriculture was abandoned on this site anywhere from 1920-1940. A washed out, unmaintained, town road provided access to the property. It is unknown if any hunting occurred on the surrounding properties.

Site characteristics-From what was observed, the property is completely surrounded by active agriculture or residences, which could be seen in nearly all directions from the middle of the property, classifying the majority of the property as edge habitat. Based on the size and diversity of trees on the site and its agricultural past, soils could be classified as very fertile on this upland site. The stand is mainly dominated by red maple (*Acer rubrum*), black gum (*Nyssa sylvatica*), some oak (*Quercus* spp.*)*, and occasional American beech (*Fagus grandifolia*) and eastern redcedar (*Juniperus virginiana*). Invasive plants were witnessed on the property edges, including but not limited to, Japanese barberry (*Berberis thunbergii*), Asiatic bittersweet (*Celastrus orbiculatus*), garlic mustard (*Alliaria officinalis*), and Japanese stiltgrass (*Microstegium vimineum*). Several deer pellet piles were witnessed and based on this, the surrounding land use, and lack of understory vegetation, the deer population is likely at or in excess of the current Connecticut Department of Environmental Protection (DEP) deer estimate for the Town. The forest looks similar to the remainder of the Connecticut forest, characterized as an even-age stand. Based on a lack of stumps, tree size and composition (the origin of the majority of the stand was derived from soft mast sources, rather than hard mast), it is evident that this site has been allowed to grow back from an open field setting to its current state with no management, resulting in an intact overstory canopy. This canopy severely limits light penetration to the forest floor and in concert, browsing by overabundant deer has, and will continue to, limit regeneration of native species. This too was evident by the dearth of tree seedlings and saplings. The predominant regeneration was black cherry (*Prunus serotina*), which are unpalatable to deer.

Overall health and concerns- As it stands, this property can be classified as a small sawtimber forest with too many deer, some invasive species, and virtually no beneficial regeneration. With careful management, the site has potential to become productive. A forest management plan would need to be established and address the overabundant deer, invasive species, even age class, and limited light penetration to encourage beneficial and productive tree and shrub regeneration. Overall health assessment: Poor.

Grady Property

Background –This property was most likely not in agriculture due to the lack of stone walls and by the fact that Rob Sibley informed the group that the whole area was once owned by the Waterbury area brass mills and was used in charcoal production. This was evident by the large mature hardwood trees with multiple stem sprouts on the property. The property is contiguous with 1200 acres of the Paugussett State Forest and 480 acres of private land, and the Iroquois gas pipeline bisects the property. The adjacent state forest is actively managed by the Division of Forestry of the DEP, receives heavy recreational deer hunting pressure, and as a result, the local deer population is likely around half that of the DEP projection for the town.

Site characteristics-The property has a diversity of age classes in its trees, likely because it was probably not pastured. The land was likely harvested at regular (+/- 30 year intervals) for charcoal production, likely employing a coppice-type practice. The property seems to be dominated by upland habitat with many red and black oaks, an occasional American beech and eastern hemlock (*Tsuga canadensis*). The

wetland portion of the property also had oak in the upland vicinity, with tulip poplar (*Liriodendron tulipifera*), yellow birch (*Betula alleghaniensis*), and some beech along with a sweet pepperbush (*Clethra alnifolia*) and spicebush (*Lindera benzoin*) understory. That stated, there is limited shrub/tree sapling component to the upland forest due to deer browse. The interior sections of the parcel had few invasive species. The invasives witnessed were primarily along the edges of the treeless pipeline corridor. The adjacent managed state forest made for a great illustration of the impacts of targeted forest management under the same pressure from browsing deer. Selected harvest of trees has allowed sunlight to penetrate to the forest floor, resulting in regeneration of desirable native trees with the limited establishment of invasive plant species. The juxtaposition of a managed and unmanaged forest under the same pressure from browsing deer provides an excellent educational opportunity for the town to better understand the benefits of proper forest management techniques.

Overall health and concerns-The major concern on this property is the limited tree regeneration resulting from browsing deer. At this point, the invasive plants are minimal and can be controlled. Overall health assessment: fair to high.

Brook Heights

Background –This property also has a rich history of land use, principally from prior railroad activity, a possible mill, evidence of a river impoundment, some timber harvesting activity, and a recent road cut as a secondary disturbance. The parcel had been slated for a housing development until the opportunity arose for town acquisition. Also observed were several perk test wells, and a few sections of snow and silt fence. The property also adjoins another, larger parcel for which there is a conservation easement/development protection.

Site characteristics- In areas adjacent to railroad beds, a higher percentage of fire-tolerant species are typically observed. These plant species include oak, hickory (*Carya* spp.), American chestnut (*Castenea dentata*). However, the site was dominated by small diameter sawtimber trees, notably: sugar maple (*Acer saccharum*) and sweet birch (*Betula lenta*) with a minor component of eastern hemlock, and the previously mentioned species. Perhaps this is due to the northeast aspect of the property, prior harvesting practices, wetter site conditions, or as likely, a combination. Also to be addressed is the recent overstory removal for the creation of a right-of-way. This opening was the mechanism that allowed the property to be exploited by invasive herbaceous and woody plant species noted elsewhere in this assessment, and should serve to illustrate how a hasty action can have adverse impacts on a parcel. The deer population is also on the high side, evidenced by the browsing damage on the winged euonymus *(Euonymus alatus)*, and scarcity of native forest regeneration. An old "No Hunting" sign was observed, leading us to believe that there was limited deer hunting on the property or maybe by the former property owners only. Deer density in this area also appears consistent with the DEP estimate. As a matter of concern for the future development of this forest stand, and reducing the future risk for tick-borne diseases, the invasive plants need to be aggressively addressed and contained.

Overall health and concerns- As noted throughout this report, controlling invasive plant species and white-tailed deer should serve to mitigate the risk of tick-borne illnesses. Those two actions, in concert with other forest rehabilitation practices, could also serve to protect the nearby stream, Pond Brook. Inasmuch as we are specialists in our respective professions, there are many interdependencies in the natural world; vis-à-vis our call to a holistic approach to conserving the natural resources. Overall health assessment: Fair

Pole Bridge

Background- The parcel is an upland location, and undoubtedly had some prior agricultural/forestry activities. Its proximal location to a large body of water, and major thoroughfare likely indicate heavy

use. Several stone walls and barbed wire fencing were noted. Charcoal mounds were indicated in the discussion.

Site characteristics- The site was dominated by large sawtimber eastern hemlock and mixed oak. A clear stand delineation can be viewed along the southeast section of the property where a stone wall divides an early successional shrubland (full of invasive species), from the intact, relatively mature oak/hemlock stand. The hemlock had thin crowns, likely due to elongate needle scale (*Fiorinia externa*) and hemlock wooly adelgid (*Adelges tsugae*). Were it not for the accidental introduction of chestnut blight fungus (Cry*phonectria parasitica*), American chestnut would likely have been a major component of this site. Many deer scats and buck rubs were noted in the hemlock forest. There was relatively little regeneration in the hemlock areas, but this is typical of most hemlock forests as the dense needle canopy severely restricts light from reaching the forest floor. Deer density in this region is likely at the DEP estimate and they are probably consuming what little regeneration is occurring under the hemlock canopy. The adjoining shrubland was dominated by autumn olive (*Elaeagnus umbellata*), Japanese barberry, and multiflora rose (*Rosa multiflora*) and from an ecological point, serves as ideal habitat for blacklegged ticks (*Ixodes scapularis*, commonly referred to as the "deer tick" and thankfully noted on signage), white-tailed deer, eastern cottontail (*Sylvilagus floridanus*), and rodents.

Overall health and concerns-Clearly, the area of greatest concern to us was the shrubland. It was completely dominated by invasive plants, but seems that this area is to be addressed and controlled with bush hogging by town staff. As with the overstory removal at the Brook Heights Property, active management of this area can aid in the restoration of his habitat. Overall health assessment: fair to high.

Concluding Thoughts

White-tailed deer numbers have been reported to be excessively high in Newtown. This was confirmed by our site visits to the four properties. The presence of deer (the primary host of the adult blacklegged tick) and invasive plants (which provide a microclimate favored by blacklegged ticks) are of concern both to the health of the residents of the town as well as the health of the town forests. We feel that these two factors should be the top concerns when establishing a town-wide comprehensive forest management plan.

NOTE: THE TBDAC requested follow-up information regarding this report. Below are answers provided by Dr. Scott Williams.

Overall response Scott Williams:

I have responded to your question below each one in italics. I have solicited information from colleagues as well. In the responses, 1 am SCW, JSW is Dr. Jeffrey Ward, Chief Scientist of the Department of Forestry and Horticulture here at the Agricultural Experiment Station, and JPB is J. P. Barsky, Forestry Technician here. You (or anyone else) can check on Dr. Ward and my qualifications here http://www. ct. eov/caes/cwp/view. asp? a=2812&q=345282 if you so choose. Scott

Questions submitted by members of TBDAC and answers from Scott Williams:

Re: "Newtown Municipal Lands Forest Health Assessment", March 24, 2010

Thank you again for the time you and JP spent with us last Friday on the Newtown field walk, and for your report we received in time for our Committee meeting on Wednesday evening. Since your paper will become part of the report that will go to our Selectmen for their review and ultimate decision making, and will also be a resource for the Newtown Conservation Commission and other town commissions, we would like to make this report as inclusive of the information we learned from you as possible. We would also like to be very specific in our report and recommendations. As was mentioned on our walk, we repeatedly have heard speakers from other towns state that "at least they are doing something" and "it's better to do something than nothing", although what they are doing typically is a knee-jerk reaction without thought and scientific research behind it. We would hope that when Newtown officials read our report, your report, and all the speaker summaries, they will be able to develop a plan that is well thought out as well as scientifically sound.

Deer-density Questions:

1) Your recommendation sections for most properties and your conclusion state that a "deer reduction program" should be part of a management plan. Can you clarify the deer density that should be achieved for (a) forest regeneration and (b) maintenance of an established healthy forest? Our previous research has suggested 5 deer/square mile and 20 deer/square mile, respectively. Is this also your view?

SCW Response: I am not a big fan of using exact density numbers, because the numbers are never exact. Getting an accurate deer density count is a very difficult task to accomplish. That said, target deer density for the abovementioned management goals should be 0 deer/miles. While this is neither feasible nor desirable, with 10-15 deer/mile2, you will see some damage, but it will be minimal and will allow desirable forest regeneration, which is what I assume you mean. Forests will regenerate at current densities in Newtown, it will just be the non-palatable trees, shrubs, and invasives that do.

2) During our walk a hypothetical question was asked: If one could halve the deer population, would browse damage also be halved? Your answer indicated that you would not necessarily expect linearity. We are aware that this has not been studied formally, but could you give us your opinion as to what would happen?

SCW Response: The overall browse damage would likely be temporarily halved, until the next breeding season when reproductive rates would dramatically increase due to reduced competition and an increase in available resources. That said, with less competition from others, remaining deer will shift their preferences to desirable species, as there will be more available with fewer deer. So while overall browse damage will technically be halved, it will be shifted such that you will likely see the same amount of damage on those preferred species (oaks, maples) as you had previously. Deer will likely stop consuming less desirable species (and often less palatable), reducing damage, and promoting their growth. If any type of deer management is to be addressed, it needs to be a consistent, sustained effort over time to continue to reduce browse damage to all vegetation.

Forest Health Issues:

3)Would you recommend that a comprehensive 30- or 40-year forestry management plan that addresses multiple facets: appropriate tree cutting, deer management, eliminating or reducing invasive species,

avoiding creation of more edge habitats, etc., would be the best way to engender healthy forests in our town?

SCW Response: Yes I would. I believe that we are now at a time where municipalities, non-profits, etc. have concluded the majority of their open space acquisitions, and now is the "what now? " phase. Meaning now that these agencies have spent time and resources acquiring parcels, comprehensive management plans need to be created to insure their long term health.

4) Do you think that hiring a forester for Newtown to work with the Conservation Commission and other town commissions that deal with our town land and open space would be a good investment for the future health of Newtown's forests?

SCW Response: Absolutely. A forester can objectively inform the Town the best way to manage parcels long term. Doing so will improve/maintain forest health conditions and also provide the Town with a potential revenue source (timber) for the short and long term.

5) Could you comment on the idea that there are many different ways to think about forest health and ways to measure such (as JP commented in response to a question)?

JPB Response: The concept of forest health has been professionally debated for the last 150 years. There are a wide range of metrics, from species diversity to forest stand growth, which serve as a guiding principle for evaluating forest health. We employ measurements from a pool of disciplines to help us in assessing forest health. Principally, we focus on species diversity (i.e. the number of different species one would find in a given area) and tend to focus on herbaceous and woody plant species diversity, as that is our discipline. In concert with that, we look to what is growing on the ground to give us a prediction of what would be the next stand of the forest (if there are only invasive species in the understory, you will not get eastern white pine as your next crop). Another method we employ are annual and or decadal measurements. We investigate forest stand growth (cubic and board foot volume) which helps us to predict what the future yields from a stand may be.

6) How important is forest fragmentation to the succession of forest species (trees, invasive plants, deer, small mammals, rodents, insects etc.)?

SCW Response: Not quite sure of the question here. Fragmentation has little to do with forest succession, succession being the predictable change in plant species, diversity, and structure over time. All forest fragmentation does is promote invasive plant species by increasing the amount of hard edge habitat (defined as an area where one habitat type abruptly changes into another with no transitional habitat, such as where a forest meets an agricultural field or lawn) and also increases the deer population by bringing a diversity of ornamental plants and agricultural species into the deer's range, many of which are available year-round. The invasive plants can kill established trees (Asiatic bittersweet) and will hamper regeneration. I would imagine that increased fragmentation is synonymous with increased residential areas, which would likely increase the rodent population. And increased fragmentation would lead to a corresponding decrease in the bird and bat populations, which would then increase the number of undesirable insects (mosquitoes). Blacklegged ticks (deer ticks) would also increase due to the increase in the deer population.

Forest History Questions:

7) During our walk, as we noted the stone walls that indicated prior agricultural properties, you (or JP) told us that Connecticut was 25% forest 100 years ago, and is 65% forest today. Do you know (approximately) what the percentage of forest was in the 1960s and 1970s?

JSW: Response: Fairfield County was 47% forested in 1972 (have reference if needed).

8) Do you know what the state of the forests in Newtown might have been during the 1960s and 1970s (pre-deer population increase)? Do you think they were healthy, with young, middle-aged and mature trees and healthy understory, and that deer are the sole reason that these forests are in decline?

JSW Response: The forest in Fairfield County was 34% sapling-seedling stands, and 37% pole stands. Therefore, 71% of stands were less than 50-yr-old. The stands probably had healthy understories, but that is only speculation as we have no data. CL&P and DEP might have some inventory data on their forested properties in Newtown.

9) Would poor land management with repeated divisions of tracts contribute to creation of edge habitats that attracts deer, invasive species, etc.?

SCW Response: Absolutely yes. Repeated divisions of tracts will dramatically increase the ratio of hard edge to intact forest habitat. It is well known that invasive plants thrive in hard edge habitats and will gradually invade the forest interior as disturbance events occur. It is not the edge habitat that attracts deer per se, it is the suburbanization of intact forest blocks that improves their health and reproduction due to an increased and readily accessible food supply. The deer were there already.

March 26, 2010

APPENDIX E. SUMMARY AND COMMENTS YALE FORESTRY REPORT

Summary of "Management Plan for the Stone Bridge, Pole Bridge and Pond Brook Properties" as done by the Yale University School of Forestry and Environmental Studies, February 2011

This study was commissioned by the Newtown Conservation Commission to provide guidance for the management of three Open Space parcels. The five objectives of the study were: maintaining forest health and controlling invasive plants; improving wildlife habitat; providing environmental education; creating trails and other recreational opportunities; and addressing white-tailed deer (*Odocoileus virginianus*) and black-legged tick (*Ixodes scapularis*) issues.

Forestry Issues:

Many forestry issues were addressed in this report. However, the topics of particular relevance to the TBDAC included the regeneration of forest species and the effect that deer may have on that process. One issue is whether limited understory is attributable to low light from a dense forest canopy, to deer overbrowse, or to a combination of the two. A second issue is whether we can expect our forests to evolve to the next state, understory reinitiation, and if so, under what conditions.

This study presented forestry issues in the context of the natural succession of a forest, which is a somewhat different perspective than offered by some forest experts consulted by the TBDAC. It found that "most of the forested stands are in the late stem exclusion phase of stand development, when the light conditions at the forest floor are at their lowest." (p.41). It goes on: "This partly explains why tree regeneration is very low in most stands. A second factor that may be contributing to the low seedling and sapling populations recorded is deer herbivory."

Regarding Stone Bridge, "There is a browse line present at Stone Bridge and the population of deer could be inhibiting forest regeneration. (p.57) However, despite the deer browse, a further section states that "The health of this forest [Stone Bridge] was the best of the parcels surveyed and its priority for management should be considered when making decisions." (p.59)

A discussion of Pole Bridge concludes that "it is not possible to make the direct correlation that higher tree regeneration is caused by lower deer herbivory." It states "It is likely that all of these factors [distinct site conditions, unique vegetation and land use history] contribute to the paucity of groundstory vegetation, but it is unknown how much each contributes at this time. This should be kept in mind when making decisions about how to approach deer management and forest health issues."(p.42)

The study concludes by anticipating that these forests will advance to the next stage of succession. "While the phase of the forest is currently in stem exclusion it will migrate to understory reinitiation. The future of the forest is understory reinitiation and then old growth." (p.56).

Tick- Related Issues:

Regarding deer culling as a tool to manage TBD, the report states, "Efforts to manage tick-borne diseases with deer culling and removal have had mixed results: while total elimination of deer has resulted in significant decreases in tick populations and cases of Lyme disease, partial reductions have had varied and often indiscernible impacts (e.g. Clark et al. 2008)." (p.69). The study takes no specific position either for or against a deer cull.

In Summary, recommendations for tick control are:

1) Land use planning and conservation acquisitions to target intact, minimally fragmented parcels as a way to address Lyme disease; continued stakeholder engagement (through the committee and other arenas).
2) Work with neighboring landowners to control invasives, create yards that are not palatable/accessible/inviting to deer.
3) Education; 4-post devices; rodent targeting; enhance opportunities for predators.

NOTE:

In a follow-up email to Dr. Mark Ashton, Director Yale School of Forestry, he states that "the high populations [of deer] that you have in Newtown have nothing to do with the town forests - and more to do with the surrounding deer-desirable habitats of field and gardens." Dr. Ashton has had experience with deer culls in the Yale-Myers Forest which had positive results in terms of forest regeneration when they did both deer reduction and an active forest regeneration program. However, he points out that the size of the Yale Forest (about 7,800 acres) is very different from our small, fragmented forested areas (30-50 acres) which are impacted by surrounding suburban habitats including fields, private yards and gardens.

NOTE:
Dr. Scott Williams, from the Connecticut Agricultural Experiment Station, reviewed the management plan and a summary of his comments are as follows:

Vegetation regeneration is limited by both light penetrating the overstory and deer herbivory. Newtown's forests are even-aged due to the reforestation of abandoned agricultural lands. The canopy limits light to the forest floor and thereby limits regeneration. In places where regeneration is occurring, the over abundant herds of deer are consuming nearly everything. This is essentially halting ecological succession.

"The management plan was very good from a forestry perspective, but will not work without reducing the number of deer."

"They found <u>one</u> tree sapling in 35 plots sampled across three properties. Newtown has a tree regeneration problem that cannot be simply attributed to stem exclusion alone."

Stems regenerate in light gaps from disturbance events are being consumed by overabundant deer. Deer are very much a problem for the future of Newtown's forests.

Dr. William's recommendations to improve the health of Newtown's forests are three fold and direct. "1.). initiate a forest management plan to open up canopies to allow light to penetrate to the forest floor; 2.) reduce the number of white-tailed deer available to consume what vegetation regenerates due to the increased light penetration; 3.) control invasive species."