Evaluation of Strategies and Programs to Reduce/Eradicate Tick Populations

Town of Southold Tick Working Group
Town of Southold, New York

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James Duggan
Laura Klahre
Maureen Massa
John J. Rasweiler IV, Ph.D. (Chair)
Louis H. Wirtz

Mission of the Working Group. The Town Board of Southold established this Tick Working Group on June 16, 2015 and requested that it evaluate current strategies and programs to reduce/eradicate tick populations. Specifically, the Working Group was charged with the task of examining these strategies and programs for their effectiveness, cost, environmental impacts, and viability of being implemented in Southold. This was to be pursued through a review of relevant studies/data, field visits, and consultations with professionals in related fields.

Specifically, the Working Group was asked to:

- Evaluate four-poster programs implemented on Shelter Island and elsewhere
- Evaluate the success of pesticides currently available and in use, especially by government agencies
- Relationship (if any) of wildlife/pest management and tick populations
- Identify and evaluate any new proposals/products contemplated for use in eradicating tick populations

Summary conclusions and recommendations of the Working Group

- Given the limited options that the public presently has for effective protection against ticks and tick-borne diseases, the use of acaricides for yard treatment must unfortunately remain one of them. As these products kill many beneficial and harmless organisms, however, their use is not a desirable blanket solution to our tick problem.
- Better information is required on the relative efficacy of available acaricides and the best application protocols. Presumably the duration of acaricide effectiveness is limited by rainfall, frequent yard irrigation, and the movement of tick-bearing wildlife onto treated properties.
- The Working Group is opposed to the widespread, open field use of acaricides and the spraying of trails in parkland within the Town of Southold. These lands were set aside for the protection of wildlife.
- Four-poster deer deticking stations would be unworkable and unaffordable in the Town of Southold for multiple reasons: The Town is large (32000 acres not including Fishers Island), much of our land is devoted to uses that are legally incompatible with the placement of these devices, they must be used at a minimum density (>1 device/100 acres) for any hope of efficacy, and they are very expensive to purchase and operate.
- A four-poster program would do nothing to address deer degradation of our natural environment, deer-vehicular collisions or economic damage to our important agricultural sector.
- Because four-posters concentrate wildlife, they are likely to create conditions that may promote the spread of a variety of dangerous zoonotic diseases and the development of difficult rat problems.
- The continued attraction of deer by four-posters will prevent the regeneration of surrounding forest lands that have already been severely damaged by over-browsing,

with concomitant harm to the maintenance of biodiversity. Four-posters should therefore not be placed on parklands.

- Because four-posters repeatedly attract a variety of wildlife species that are not treated and deticked, they are incapable of completely eliminating ticks in a non-island environment. Even some deer in treatment areas will not be deticked.
- The Working Group has been unable to find evidence that four-posters significantly reduce tick-borne diseases in humans. Previous studies have generally indicated a reduction in tick levels immediately around four-posters (if deployed at adequate densities), but significant numbers of ticks were still present.
- By serving as reproductive hosts for our two most problematic tick species, deer in recent years have fueled tremendous expansion of the tick populations and the frequency of dangerous tick-borne diseases in humans.
- Recent efforts to reduce our excessive deer population in Suffolk County have been inadequate, resulting in an annual harvest of only about 15% of the herd each year. Most deer management experts agree this will not address our deer-related problems.
- New initiatives must be taken to substantially increase our deer harvest.
- Studies elsewhere indicate that these initiatives must include some combination of professional hunters, skilled/trained residential hunters working under nuisance permits, and our broader recreational hunting community. At least for the present, traditional recreational hunting by itself is incapable of reducing our excessive deer population.
- Efforts should also be made to legalize the use of crossbows in Suffolk County, open up more private lands to recreational hunting, and incentivize recreational hunters through the payment of bounties on harvested deer.
- The Town and/or Suffolk County should continue to monitor research on new methods that may be useful in tick control or the prevention of tick-borne diseases. This will require much greater expertise on the possible harmful effects of control measures to other beneficial or harmless organisms, as well as the epidemiology of zoonotic diseases, than currently seems to be available.
- The Town and/or Suffolk County could better educate our residents on protection against ticks and the gravity of the tick-borne diseases now present in our area.

Nature of the problems. In recent years, deer populations have exploded in much of the United States (including the Town of Southold) because of changes in land use and the reduction or total absence of natural deer predators. This has resulted in an epidemic of serious tick-borne diseases in humans, a marked rise in deer-vehicular collisions, severe damage to the natural environment and biodiversity (because of the over-browsing of vegetation by deer), and painful economic losses for our agricultural community.

Deer play a central role in the epidemiology of tick-borne diseases, because they provide a bountiful source of blood for ticks at the ticks' adult reproductive stage. Before explosion of the deer population, black-legged/deer and lone star ticks, as well as the diseases they transmit, simply were not serious problems on most of eastern Long Island. Furthermore, several scientific reports have documented that a significant reduction or elimination of deer in study

areas greatly reduced or eliminated Lyme disease in the human residents (Rand et al, 2004; Kilpatrick et al, 2014).

At least in New York State, the Department of Environmental Conservation (DEC) has thus far been unable to devise a productive management plan to reduce our excessive deer populations. Despite repeated efforts to tweak applicable hunting regulations, the annual deer harvest by recreational hunters on Long Island has essentially remained flat for a number of years at less than 15% of the estimated deer population (see: http://www.dec.ny.gov/outdoor/42232.html). Experts agree that this is insufficient to reduce the herd and all of our deer-related problems (Boulanger et al, 2014).

Gravity of our tick-borne disease problem. In the last 20-25 years, there has clearly been a marked increase in the severity of our local tick-borne disease problem. Nationally, the reported number of cases of the most prevalent diseases has also dramatically increased. Furthermore, the U.S. Centers for Disease Control and Prevention (CDC) has recently estimated that the actual number of cases of Lyme disease in our country is about 329,000 per year, rather than the 30,000 previously reported (Mead et al, 2015; Moyer, 2015).

Long –time residents of the Town of Southold know that there has long been a problem with dog ticks (*Dermacentor variabilis*), which can serve as vectors for two serious diseases (Rocky Mountain spotted fever and tularemia). The risk of picking up dog ticks was generally manageable, however, through the use of repellents and the performance of tick checks after spending time in high-risk environments.

Since the 1990's, the populations of two other tick species have exploded in our area. These are the black-legged or deer tick (*Ixodes scapularis*) and the lone star tick (*Amblyomma americanum*). The expansion of both tick populations was presumably fueled by the concomitant arrival and proliferation of white-tailed deer in areas of the Town that had previously supported few or no deer (at least in recent years). In marked contrast to smaller mammals (e.g., mice and chipmunks), deer can support large numbers of adult ticks as they engorge with blood and develop to reproductive maturity. Each female tick then drops off the deer to lay thousands of eggs (approximately 2000-8000 per female depending upon species). By serving as ***reproductive hosts*** for the ticks, the deer have a pronounced multiplier effect upon the abundance of ticks. This lies at the heart of our current epidemic of tick-borne diseases.

Black-legged and lone star ticks can serve as vectors for a variety of tick-borne diseases. Black-legged ticks are thought to be the main vector for transmitting *Borrelia burgdorferi*, the organism responsible for Lyme disease. In Connecticut, recent studies have shown that a third of the black-legged tick population carries *B. burgdorferi*. Black-legged ticks can also transmit *Borrelia miyamotoi* (responsible for a febrile illness, sometimes with flu-like or other symptoms similar to Lyme disease) and Powassan virus, as well as the organisms responsible for babesiosis and anaplasmosis. Lone star ticks can transmit the organisms responsible for ehrlichiosis, tularemia, and the southern tick-associated rash illness (STARI), and their bites can cause persons to develop an unpleasant allergy to non-primate mammalian meat and meat products.

There is recent evidence that lone star ticks may also carry and transmit human pathogenic Lyme group *Borrelia* strains (Clark et al, 2013). This is significant, because lone star ticks (which are more tolerant of hot, dry conditions and quest for hosts more aggressively; Schulze &

Jordan 2006) seem to have supplanted black-legged ticks as our most abundant tick species. This may explain an apparent paradox: Lyme disease continues to be an extremely serious problem in our area, while the relative abundance of black-legged ticks (generally considered to be the main vector for transmitting *B. burgdorferi*) has decreased.

Most of these diseases can make some individuals very sick, sometimes chronically for the remainder of their lives, and can even kill – especially when infected individuals belong to a variety of not-uncommon high risk groups. In the case of Lyme disease, up to one in five patients develop long-term and potentially life-threatening symptoms (including heart, vision, or memory problems, or debilitating joint pain) (www.cfsph.iastate.edu/Factsheets/pdfs/**lyme** disease.pdf *;* Moyer, 2015). Furthermore, some people become infected simultaneously with more than a single disease. The web site of the U.S. Centers for Disease Control and Prevention (CDC) (http://www.cdc.gov/diseasesconditions/) is an excellent source of further information on each of these diseases. See also: www.cdc.gov/lyme/resources/TickborneDiseases.pdf .

Several of these tick-borne diseases are supposed to be reported to our public health authorities, although that is not always done. Furthermore, testing is not always accurate, leading to the under-reporting of disease frequency.

The incidence of four of these diseases in Suffolk County, along with their rank (#) relative to other NYS counties and New York City, may be found on the web site of the New York State Department of Health (http://www.health.ny.gov/statistics/diseases/communicable/). For 2014 these were as follows: anaplasmosis – 46 cases (#4 in NYS), babesiosis – 197 cases (#1), ehrlichiosis – 67 cases (#1), Lyme disease – 654 cases (#3). In comparison, the number of cases of two other serious diseases reported for all of NYS in 2014 was as follows: measles – 32 cases, and West Nile fever/virus – 26 cases.

According the CDC (http://www.cdc.gov/measles/about/complications.html), the mortality rate for measles is about 0.1-0.2% of the cases reported in the United States. In contrast, the mortality rates for anaplasmosis, babesiosis and ehrlichiosis are significantly higher, but seldom publicized. Given that many of the Town's residents are only familiar with Lyme disease, it seems clear that the gravity of our overall tick-disease problem is seriously under-appreciated.

Finally, we should be very concerned that new tick species or serious tick-borne diseases could be introduced to Long Island at any time via migratory birds (Dietrich et al, 2010; James et al, 2011; Hasle, 2013; also see http://aem.asm.org/cgi/reprint/AEM.02656-15v1?ijkey=8gOCfkilz81kM&keytype=ref&siteid=asmjournals) or animals transported into the region. This threat has been recognized in two recent authoritative reviews (Moyer, 2015; Mead et al, 2015). Furthermore, Anthony S. Fauci, M.D., Director of our National Institute of Allergy and Infectious Diseases has noted "Ticks spread more different kinds of infectious microbes to people and animals than any other arthropod group" (http://www.nih.gov/news-events/news-releases/tick-genome-reveals-secrets-successful-bloodsucker).

As an example of the risk of introduction of new diseases, one can point to infections with tick-borne encephalitis viruses (TBEV) that are common and often serious across large parts of Europe and Asia, according to the CDC and the World Health Organization. These can cause long-lasting or permanent neurologic sequelae and have mortality rates varying from one to five percent for the European form and 20 to 40 percent for the Far Eastern strain. TBEV are harbored and spread by *Ixodes* ticks. On Long Island, we have plenty of black-legged ticks

(*Ixodes scapularis*), the local vector of Lyme disease, and cases of TBEV have been detected in U.S. travelers to Europe and China.

Although the first principle of good public health policy is to practice prevention, we are presently incapable of dealing with the tick-borne diseases we already have.

Possible strategies to reduce or eradicate our tick populations.

Use of pesticides. The Working Group investigated and was unable to find evidence that pesticides (specifically acaricides) are currently being used with any success by government agencies for widespread tick control. Some government entities have, however, reviewed the chemical products commonly used for tick control (Schulze & Jordan 2006; Stafford, 2007). Although these are valuable reviews, they have not adequately considered some of the serious shortcomings of the use of acaricides and other control methods discussed below.

In the Town of Southold, many private companies (including pest control firms, landscapers and tree care companies) are employed to treat yards with acaricides. Although we made an effort to survey which products are currently being used, only a single company agreed to provide the requested information. This helpful respondent indicated that most applicators appear to be using products containing permethrin (a synthetic pyrethroid compound), although some are prepared to use natural/organic compounds instead.

Permethrin is commonly used as both an insecticide and acaricide. At the recommended levels of usage, it is not known to be directly harmful to most mammals and birds. Indeed, it has been highly recommended for use as a safe tickicide when sprayed and dried on clothes (http://www.lymeneteurope.org/info/deet-versus-permethrin-as-a-tick-repellent). Permethrin is not intended for direct application to the skin.

[*Consumer Reports* has recently published ratings of mosquito and tick repellents for their effectiveness (http://www.consumerreports.org/insect-repellents/mosquito-repellents-that-best-protect-against-zika).]

On the other hand, permethrin is a neurotoxin and, even when used as directed, extremely toxic to bees, beneficial insects, and butterflies. Many affected insects provide important food sources for other animals (e.g., birds). Baby birds of many species depend heavily upon a diet rich in insects and other invertebrates, which contain high quality animal protein necessary for rapid growth.

Whether permethrin is applied as an ultra-low volume spray or powder, it forms a coating on the ground and surrounding flowers and foliage. It is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds (http://www.cdms.net/LDat/mp7GD005.pdf). As it is a contact poison, permethrin is particularly harmful to bees living in the ground such as bumblebees - 65% of New York's native bees are ground nesters. Insecticidal dust deposited in and around a nest entrance will adhere to the bees leaving and reentering, killing the entire nest within a few days (Hahn et al, 2015). Foliage sprayed with permethrin can also have lethal and sublethal effects upon adult and immature butterflies. For example, monarch butterfly caterpillars reared on milkweed leaves collected from areas where a routine permethrin barrier treatment was applied, had significantly lower survival, even on leaves collected 21 days after permethrin treatment. Development was significantly slower as well in caterpillars reared on permethrin-treated milkweed plants in the laboratory (Oberhauser et al, 2006).

A just-completed assessment by the United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (http://www.ipbes.net/article/press-release-pollinators-vital-our-food-supply-under-threat) has concluded that populations of many wild pollinators are in serious decline. This is a threat to the production of many major crops and more widely to the preservation of biodiversity. The Tick Working Group is of the opinion that we should not be contributing to this problem locally in a major way through the increasing use of acaricides, when our superabundance of ticks is caused by an inadequate deer management policy.

Permethrin is also highly toxic to aquatic invertebrates, tadpoles and fish, often at minute concentrations (e.g., parts per billion in water) (http://www.cdms.net/LDat/mp7GD005.pdf; http://www.epa.gov/ingredients-used-pesticide-products/pyrethrins-and-pyrethroids-reregistration-and-labeling#reregistration). For these reasons, it is recommended that pesticides (including permethrin) should not be applied near wetlands or water bodies (Stafford, 2007). The product label for one acaricide used in the Town of Southold (Astro Insecticide) specifically notes that drift and runoff from treated areas may be hazardous to aquatic organisms (www.beetles.mt.gov/Preventing/PDF/PermethrinCommLabel.pdf).

The Working Group was not in a position to determine if acaricides are always applied to yards to minimize collateral damage to other organisms. We can only note that many properties being treated are on or close to wetlands and water bodies, and that pesticide drift and storm water runoff are potential ways for permethrin to be carried into adjacent water bodies. As permethrin binds strongly to soil particles, there is little risk of it leaching into groundwater; however, permethrin bound to soil particles could be carried into water bodies in storm water runoff. These risks will increase as more residents turn to yard spraying for protection from ticks. The Working Group has been advised that on Shelter Island alone approximately 400 properties are being sprayed each year with acaricides.

We were also unable to assess the efficacy of acaricides currently in use in the Town. It simply is not clear that anyone is doing careful studies for the presence of tick larvae, nymphs and adults at various intervals after acaricide application. Doing proper tick sweeps and examination of the flagging cloths would be time-consuming and therefore expensive for commercial applicators. Permethrin has a limited half-life (= residual effect) in the environment. Furthermore, some ticks will always be protected from exposure to acaricides, for example because they are hiding in leaf litter or dropped by animals that move in and out of treated areas. Presumably the duration of acaricide effectiveness is limited by rainfall, frequent yard irrigation, and the movement of tick-bearing wildlife onto treated properties.

Spraying clearly is no panacea. It has been the experience of one Working Group member that ticks can be picked up during the briefest exposure (e.g., < 30 seconds) to non-treated areas. Furthermore, the Working Group heard the story of one homeowner who had his yard acaricide-sprayed three times before mid-summer; however, he still contracted a life-threatening case of a tick-borne illness, and the yard was heavily infested with ticks upon his release from the hospital. We do not know what acaricide was used, and the possibility exists that the infected tick was picked up off of his property.

Use of acaricides possibly less detrimental to other organisms. The Working Group agrees that movement towards the use of acaricides that are less damaging to beneficial or harmless

organisms would be highly desirable. At least two local pesticide applicators clearly recognize that as well and have engaged in lengthy discussions with one member of the Working Group about the available options.

One product used locally and alleged to be "safer" for the environment is Essentria IC3 Insecticide Concentrate, an emulsifiable concentrate of botanical horticultural oils. According to the manufacturer (www.envincio.com), this product exhibits no toxicity towards aquatic organisms (which would be in contrast to permethrin), but the material safety data sheet indicates that specific information relating to toxicity in fish or other aquatic organisms is not available. Conversations with several pesticide experts indicate that this product is likely to have less residual toxicity and therefore be less effective against ticks than permethrin; however, good data comparing the efficacy of these products following various patterns of application could not be found.

The oils found in Essentria are thought to act as octopamine blockers. This means they would function by disrupting neurotransmitter function in target insects and other invertebrates. The actual list of organisms targeted by Essentria is long and varied. This clearly indicates that the product could also harm beneficial invertebrates (e.g. pollinators, as well as the insects fed upon by desirable animals including songbirds).

Similar arguments could be made about possible shortcomings in the safety and efficacy of other "natural" products that might be used for tick control. These would include cedar oil, rosemary oil (found in the product EcoEXEMPT), and light horticultural oils.

Another approach that is supposedly less harmful to the environment involves the use of *Metarhizium anisopliae strain F52*, a fungus that kills insects and ticks. This is commercially available in a product known as Tick-Ex EC Bioinsecticide. As this fungus will kill quite a variety of insects and other invertebrates, one must again be concerned about collateral damage to beneficial or harmless invertebrates. The product label specifically states that it contains ingredients toxic to fish, and that drift and runoff may be hazardous to aquatic organisms in waters adjacent to treated areas.

Although research continues on the possible use of biological agents like *M. anisopliae* for tick control, none of these agents appear to be fully satisfactory for widespread field use (http://parasitipedia.net/index.php?option=com_content&view=article&id=2662&Itemid=3037).

Conclusions regarding the use of acaricides. After carefully considering the pros and cons, the Working Group is opposed to the widespread, open field use of acaricides. It should be further underscored that the Working Group is opposed to the application of acaricides on any trails in town, county, and state-owned parks within the Town of Southold, as these lands were set aside for the protection of wildlife. All of the available products are going to inflict collateral damage on beneficial and harmless organisms, and this will only increase as more residents of the Town turn to this remedy on their own properties.

Given the limited options that the public presently has for effective protection against ticks and tick-borne diseases, we recognize that the use of acaricides for yard treatment must remain one of them. While some products no doubt reduce tick levels, much better information is required on their relative efficacy and best application protocols.

Use of four-poster feeding stations to detick deer.

What is a four-poster? The four-poster is a feeding station designed to reduce the number of ticks utilizing white-tailed deer as hosts. As the deer feed on corn dispensed from a central storage bin into two troughs, tickicide-treated paint rollers at each corner of the device brush against the animals' necks, heads and ears, where many (but not all) adult ticks have attached. Repeated application of the tickicide will kill ticks on the deer. Four-posters will also attract, but are not designed to treat, a variety of other tick-bearing mammals and birds.

***The Shelter Island Experience*.** Four-poster deer deticking stations have been deployed on Shelter Island since 2008. During 2008-2010, this was done for a scientific study conducted by Cornell University and Cornell Cooperative Extension (Curtis et al, 2011) and involved the deployment of 60 devices (20 on the Mashomack Preserve and 40 on the remainder of Shelter Island). Thereafter, deployment continued, but in reduced numbers because of budgetary constraints. The actual numbers were as follows: 2011 (15 devices), 2012 (19), 2013 (21) 2014 (38), and 2015 (37, with 6 of those on the Mashomack Preserve and 31 on the remainder of the island). Detailed information on Shelter Island's program has been obtained through extensive discussions with members of the Island's Deer and Tick Committee (Michael Scheibel, Scott Campbell, and Marc Wein), as well as investigators who conducted the Cornell study (Paul Curtis and Daniel Gilrein).

The deployment density for four-posters originally recommended was 1 device/40-50 acres. During the Cornell study, the deployment was 1 device/100 acres on both the Mashomack Preserve and the remainder of the island. During 2015, 6 devices were deployed on Mashomack (= 1 device/333 acres) and 31 on the remainder of the island (= 1 device/129 acres). Shelter Island authorities recognize that during 2015 four posters were clearly being under-deployed because of cost considerations.

In a carefully conducted, 5 year study on Cape Cod, Martha's Vineyard, and Nantucket, which also have very serious tick and Lyme disease problems, the deployment of four-posters at a density of 1/150 acres was found to be inadequate. Black-legged tick levels in treatment areas were reduced only by an average of 8.4% compared to control sites (Grear et al, 2014).

Efficacy of four-posters in reducing tick levels on Shelter Island. The effects of four-poster deployment on Shelter Island were assessed by doing 30 30-second sweeps (= a total sweep time of 15 minutes) with a one square meter flag (i.e., cloth on a pole) at study sites (i.e., within 300 yards of four-poster feeding stations). During the Cornell study, the average total count of lone star tick nymphs at treatment sites decreased from 440 in 2008, to 158 in 2009, to 18 in 2010. Decreases in tick populations were also noted during this period at untreated, control sites in North Haven on the South Fork, but these were less pronounced than on Shelter Island. From 2011 to 2015, average lone star nymph counts determined in a similar way on Shelter Island varied between 84 and 31.

Unfortunately, the precise methods used to make these counts in recent years have never been specified, no counts were made at appropriate control sites, and no results have been published in a peer-reviewed scientific journal. It has been noted elsewhere (Daniels et al, 2009) that tick abundance is subject to annual fluctuations, and accurate evaluations of treatment efficacy at a particular site will rely upon comparisons with untreated control sites. These Shelter Island results are inadequate grounds for replicating an expensive tick control program in the Town of Southold that may have a variety of undesirable consequences (see below).

While the use of four-posters clearly reduced tick levels on Shelter Island, several important points deserve to be emphasized: 1) substantial numbers of ticks continued to be picked up when tick sweeps were done at treatment sites; 2) tick sweeps were only done within 300 yards of four-posters, and the effects beyond those limits are unknown; 3) it is unclear what effect four-poster deployment has had upon the incidence of tick-borne illnesses in humans living on or visiting the island and 4) the program is commonly proclaimed to be a success (particularly by non-scientists) since completion of the Cornell study, but without adequate documentation. One must be skeptical about the supposed efficacy of four-posters on Shelter Island after cessation of the Cornell study, because everyone knowledgeable about these devices agrees they have been under-deployed.

Cost of four-poster deployment. According to Shelter Island authorities, it has recently cost about $ 2750/device/year for maintenance and supplies. It is not clear, however, that this includes all hidden costs (e.g., permitting and siting the devices), or the salaries of all participating personnel.

Estimated costs for a four-poster program planned for the Town of East Hampton are considerably higher. They would include $ 700-1000 to buy each device, about $ 4000/four-poster/year for supplies, plus the cost of three employees to run the program (http://www.27east.com/news/article.cfm/General-Interest-EH/97433/Four-Poster-Tick-Management-Program-May-Come-to-East-Hampton-Town). It deserves to be noted that the expectations for this program seem wildly optimistic, as it would involve the deployment of 8 feeding stations in a small part of a town of 247,000 acres. It also envisions no deer-induced environmental damage around the devices and ignores the possible harmful public health consequences of concentrating wildlife.

For a town the size of Southold (approximately 32000 acres not including Fishers Island), just the annual maintenance costs for the widespread deployment of four-posters would clearly be astronomical. In addition, one must consider that the New York State Department of Environmental Conservation has strict regulations on where four-posters can be deployed (see below). The initial positioning and permitting of four-posters within the Town would therefore be complex and almost certainly require the hiring of additional personnel for that purpose.

Other four-poster studies. There are three other four-poster studies (conducted in Westchester, New York, Tennessee and Massachusetts) that are highly relevant to our problems in the Town of Southold. As these have been published in peer-reviewed scientific journals, they deserve serious consideration.

The Westchester study had a treatment area (Bedford, NY) and a nearby control site (Lewisboro, NY) (Daniels et al, 2009). During the last 3 years of the study, tick control in Bedford, as measured by drag sampling for nymphal black-legged ticks, was 63.6% in 2001, 54.8% in 2002 and 80% in 2003. Although the authors concluded that this reduced the risk of exposure to ticks, it was not determined if there was any beneficial effect upon the frequency of tick-borne diseases in humans. Clearly, even after several years of four-poster use – a very expensive control strategy - there were significant numbers of ticks in the treated area. In part, this was probably due to the fact that only 89.6% of the deer in the study area showed evidence of using the feeders. The reduced efficacy of the four-posters in 2002 was thought to be attributable to high acorn production the previous fall, which affected feeder visitation by the deer. On the North Fork, we have extensive oak forests which are also subject to large yearly variations in acorn production (see Abrams & Scheibel, 2013).

Another important study was conducted in a retirement community on the Cumberland Plateau of Tennessee, where abundant wildlife supports large tick populations (Harmon et al., 2011). Several observations are noteworthy:

1) No significant reductions in lone star nymphs or adults were observed more than 300 meters from 4-poster devices, although a reduction in lone star larvae was observed up to 400 meters from the devices (= the outer limit of sampling in the study).

2) Trail cameras recorded very frequent visitation of the four-posters by non-target wildlife, usually without those species coming into contact with the acaricide-dispensing paint rollers. This included squirrels, raccoons, wild turkeys, crows and woodchucks – all of which also occur in the Town of Southold. The authors expressed concerns (shared by our Working Group) that baiting individuals of several different wildlife species to centralized feeding sites could lead to the spread of other zoonotic diseases (i.e., which can be passed between wildlife and humans). For example, recent studies indicate that gray squirrels (which we have in abundance) may serve as important hosts for *Ehrlichia* sp. and *Borrelia lonestari,* as well as lone star tick nymphs capable of transmitting these organisms to humans (Goessling et al, 2012). The human pathogenicity of *B. lonestari* is presently unclear. Although seldom mentioned, other bird species must also frequent 4-poster feeding stations. There is an extensive literature documenting that birds may help to maintain and spread tick-borne zoonotic pathogens (e.g., see: Dietrich et al, 2010; James et al, 2011).

3) The authors recognized that non-target wildlife species attracted by four-posters probably drop early stage ticks within treatment areas, thereby at least partially defeating the purpose of deploying these devices

4) Finally, the authors concluded that, even if the necessary number of devices was affordable, finding a sufficient number of suitable deployment sites in the community was unlikely to be feasible – because of restrictions on their use within 300 feet of residential dwellings (see below).

A third study conducted on Cape Cod, Martha's Vineyard and Nantucket in Massachusetts determined that four-posters were only minimally effective when deployed at sub-optimal densities (i.e., 1/150 acres; Grear et al, 2014).

A recent meta-analysis of 4-poster efficacy by tick experts (which combined the results from 7 previous studies) concluded that complete tick control by these devices may be unattainable (Brei et al, 2009). The authors stated that this may be attributable, in part, to the continued

importation of ticks into treatment from non-treatment areas by birds and mammals with large home ranges. Squirrels, for example, have home ranges that vary from about 1.2 – 50 acres. In addition, squirrels (particularly males) undergo a natal dispersal that can cover long distances (Koprowski, 1994).

Possible deployment of four-posters in part of the Town of Southold. The Working Group is aware that the residents of some areas within the Town (e.g., a relatively isolated peninsula) might wish to assume the cost of deploying four-posters. The extent to which this would be productive in reducing tick-borne diseases is simply unclear. Deer do move across causeways and also have a good ability to swim. A few untreated deer moving into such an area could carry thousands female ticks, each of which is capable of producing thousands of eggs. Other species of untreated wildlife could also drop ticks that are capable of infecting humans with tick-borne diseases.

Studies reviewed by the Bureau of Wildlife, NYS DEC, for registration of the tickicide used on four-posters (see next section for full reference) suggested that the movement of deer into treatment areas in non-island environments would probably be significant enough to defeat the use of these devices.

Restrictions on four-poster deployment. Although the deployment of 4-poster systems is viewed in some circles as a simple, non-lethal (to deer) means of dealing with our tick problem, regulations of the NYS Department of Environmental Conservation actually make this quite complex. These include the following:

1) Because the tickicide is registered for “Restricted Use”, maintenance of the devices must be done by trained personnel familiar with proper pesticide handling techniques.
2) Deployment of each device requires a 6NYCRR Part 189 Deer Feeding Permit issued by the NYS DEC.
3) The devices may not be placed within 300 feet of houses, playgrounds, apartments, or other areas where unsupervised children might be present. Special needs exceptions are only granted with the permission of the NYS DEC and require that each device be surrounded by a fence constructed according to DEC specifications.
4) The devices may not be used within 300 feet of a public highway to minimize collisions between vehicles and deer visiting the four-posters.
5) These devices may only be used by a municipality, landowner association, or private individual/corporation that has control over at least 40 acres of deer habitat.
6) These devices may only be used as a single component of a larger, deer management program, approved by the NYS DEC, and aimed at reducing the overall abundance of deer within the location for which four-poster tickicide use is requested. In order to implement this requirement, a site-specific deer management plan would need to be developed and submitted as part of the application for the 6NYCRR Part 189 Deer Feeding Permit. The Bureau of Wildlife of the DEC would require clear evidence that the harvest/removal of deer was a key part of the overall program, including the use of four-poster tickicide systems.

This information was obtained from the NYS DEC decision letter concerning "Registration of 4-Poster Tickicide (EPA Reg. No. 39039-12) as a Special Local Need Assigned SLN no. NY-120001" and confirmed by discussions with NYS DEC Wildlife Biologist Joshua Stiller.

Based upon these restrictions, it should be obvious that many residential parts of the Town, which currently support intolerable numbers of deer and ticks, would be unsuitable for the deployment of four-posters.

Environmental impact of four-poster deployment. The Cornell Shelter Island study suggested that the deployment of four-poster devices did not lead to any substantial changes on natural or ornamental vegetation. As clearly recognized by the authors and the NYS DEC, however, these findings were likely due in good part to the fact that deer had been overabundant in the study areas for many years (i.e., serious vegetative damage had already been done). One Working Group member has observed that vegetative regrowth was robust inside of a fenced deer exclosure on the Mashomack Preserve, Shelter Island, but minimal on its outside. This was not even close to a four-poster device.

A 2013 survey of Town of Southold forest lands by a team of expert botanists, naturalists and wildlife biologists established that these lands have been widely and severely over-browsed by deer, with a serious diminution of many previously common and desirable plant species, and an absence of any meaningful forest regeneration (Rawinski, 2013). Such severe alteration of the natural environment also has had detrimental effects upon many native animal species (i.e., to the maintenance of biological diversity in general). For example, previously common ground-nesting and –foraging birds have disappeared from deer-decimated forests in the Town, while they still occur on deer-free Plum Island.

Given the current dire state of our town forest lands, the Working Group is of the opinion that it would be foolish to deploy four-posters in such areas. These devices are known to concentrate the deer, and their repeated visitation will simply ensure continued over-browsing of the surrounding lands.

Our views in this regard are strongly supported by the official position of the U.S. National Park Service (NPS). The NPS continues to reject the use of four-posters on federal lands because these devices provide a regular, introduced food source for deer. This contradicts NPS efforts to lower the abundance of deer in severely impacted areas (e.g., the Fire Island National Seashore). The NPS has noted that four-posters have the potential to impact vegetation, unique vegetation communities, special-status plant species, the deer population itself, other wildlife and wildlife habitat, adjacent landowners, and public health and safety (see pp 116-117 in *Fire Island National Seashore. Final White-tailed Deer Management Plan and Environmental Impact Statement* (2015).

Possible four-poster deployment on farm lands. Much of the Town of Southold is currently devoted to agricultural use. As our excessive deer population does substantial damage to crops and orchards, it should be no surprise that the Long Island Farm Bureau is opposed to the deployment of four-posters on farm lands. Furthermore, there is great concern in the agricultural sector about the FDA's new Food Safety Modernization Act. This makes it incumbent upon all but the smallest farms and orchards to prevent contamination of their produce with animal excrement. It has already been documented that deer droppings can

contaminate fruits and vegetables with pathogenic *Escherichia coli,* resulting in serious infections and sometimes death in humans (Besser at al, 1993; http://www.cdc.gov/mmwr/preview/mmwrhtml/00045558.htm; cid.oxfordjournals.org/content/57/8/1129.long). A similar, local outbreak could have devastating economic consequences for our agricultural community.

Conclusions: possible four-poster deployment sites in the Town of Southold. Given that most land in the Town is devoted to residential or agricultural use, with much of the remainder being parkland that needs to be protected and preserved, the Tick Working Group has great difficulty in identifying how four-posters could be effectively deployed at the recommended density. At a minimum, this would be no less than 1 device/100 acres, although the four-poster tickicide label recommends an initial deployment of no less than 1 device/40 acres. At a much lower deployment density, too few of our deer would be treated to significantly reduce tick levels. Finally, it remains to be determined that proper deployment of these expensive devices actually reduces tick-borne disease infections in humans.

As one of the principal investigators on the Cornell Shelter Island study indicated "It is very important to have the appropriate density of 4-poster devices to reach a high percentage of deer…or it is better not to use them at all and create the false hope of successful tick control" (pers. comm., Dr. Paul D. Curtis, Department of Natural Resources, Cornell University). Similarly, Dr. Samuel R. Telford III (Professor of Infectious Diseases and Global Health, Tufts University) – a widely-respected tick-borne disease expert - has noted (pers. comm.) the following about four-posters: "As with any other pesticide treatment, the product must be applied as recommended. If it is not, there should be no expectation of efficacy."

Public health hazards of four-posters. The Bureau of Wildlife of the NYS DEC opposed approval of four-poster deployment because, by concentrating wildlife, this increases the possibility of disease transmission between animals and different species (including humans). Among the species known or likely to visit these devices are deer, raccoons, squirrels, wild turkeys, woodchucks, mice, rats and crows.

Major concerns were expressed by the DEC over chronic wasting disease in deer (which exhibits similarities to mad cow disease) and rabies in raccoons. Chronic wasting disease has never been detected on Long Island, but raccoon rabies has been (http://www.news.cornell.edu/stories/2011/02/cornell-helps-get-long-island-raccoons-rabies-free). There are a variety of other zoonotic diseases of serious concern, however, that generally receive no attention by those advocating the deployment of four-posters:

1) ***Raccoon roundworm.*** Raccoons are commonly infected by a roundworm that can be highly pathogenic in humans and dogs (Sorvillo et al, 2002; Roussere et al, 2003; see https://www.cdph.ca.gov/HealthInfo/discond/Documents/RaccoonRoundworms.pdf.). As eggs of the worms shed in raccoon feces are potentially highly infectious, our Centers for Disease Control and Prevention actually devote a web page to the safe cleanup of raccoon latrines (www.cdc.gov/parasites/baylisascaris/resources/raccoonLatrines.pdf). Among other concerns, the eggs can be readily aerosolized and inhaled; for protection in confined spaces, use of a N95 particulate respirator is recommended. For this reason,

it seems most unwise to concentrate raccoons anywhere close to areas frequented by humans and particularly children. Raccoons were the third most frequent visitors to four-posters (after deer and squirrels) in the Tennessee study (Harmon et al, 2011). Furthermore, roundworm eggs in dry raccoon feces (frequently deposited at the base of trees) could presumably be aerosolized by common landscaper equipment, such as rotary mowers, leaf blowers and weed wackers. Raccoons also carry a variety of other zoonotic diseases (www.dem.ri.gov/programs/bnatres/agricult/pdf/raccoons.pdf).

2) ***Leptospirosis.*** This is a bacterial spirochete that can be highly pathogenic (sometimes causing severe or fatal infections) in humans and dogs. Rats, mice and moles are primary hosts, while dogs, deer, raccoons, opossums and skunks can carry and transmit the disease as secondary hosts. It is usually transmitted in the urine of infected animals, which can contaminate food, soil or water. Effective rodent control is a particularly important preventive measure (which emphasizes the importance of points made in #3 and 4 below). Again, concentration of wildlife anywhere close to areas frequented by humans, especially children, seems unwise.

3) ***Hantavirus.*** Hantavirus is a highly pathogenic virus known to be present on Long Island, with a major local reservoir host thought to be the white-footed mouse (http://www.cdc.gov/hantavirus/rodents/index.html). The virus is spread between rodents in urine, fecal droppings and saliva. Furthermore, white-footed mice are known to be opportunistic breeders and will proliferate in response to an increase in their food supply. The introduction and subsequent disappearance of plentiful natural food supplies due to fluctuations in rainfall , with a concomitant expansion of the deer mouse population (closely related to white-footed mice), was responsible for the 1993 Four Corners hantavirus outbreak in the southwestern United States and the first known human cases of hantavirus in our country (see: http://www.cdc.gov/hantavirus/hps/history.html). Shelter Island is currently introducing a phenomenal quantity of dried corn (about 320,000 pounds per year) into its ecosystem between mid-April and mid-December via four-posters, and corn spillage from these devices is particularly a problem wherever squirrels are numerous. This introduction of food into the environment for just part of each year would seem to replicate one of the conditions that led to the Four Corners hantavirus outbreak. White-footed mice are already common in our area. Indeed, one member of the Working Group has had recurring problems with their invasion of buildings on his property. As noted by the Vermont Department of Health, rodent control in and around the home remains the primary strategy for preventing hantavirus infection (http://healthvermont.gov/prevent/hanta/hantavirus.aspx).

4) ***Rat pathogens transmissible to humans.*** The deployment of four-posters relatively close to population centers on the North Fork may well promote the development of rat problems. In the experience of one Working Group member, rats were attracted by food provided for chickens in a farm setting and for songbirds by a bird feeder in a suburban neighborhood. Shelter Island had to discontinue the use of one of its four-posters when rats appeared there. Rats are known to carry a broad variety of diseases transmissible to humans including leptospirosis (doi: 10.1128/mBio.01933-14 14 October 2014) and can also be very harmful to beneficial wildlife (http://wdfw.wa.gov/living/rats.html).

Furthermore, rats can be problematic to eliminate (http://www.livescience.com/421-world-elusive-rat-dead-18-week-chase.html; http://wdfw.wa.gov/living/rats.html), particularly when they do not have to go to traps for food or poisoned bait. This would presumably be the case, if large quantities of dried corn are being made available via four-posters in their environment. It is not clear that either the Town of Southold or Suffolk County would be prepared to deal with challenging rat problems in multiple locations.

5) ***Borrelia miyamotoi in wild turkeys.*** A recent study found that wild turkeys tested in Tennessee exhibited a high incidence of infection (58%) by *Borrelia miyamotoi* (http://www.bioone.org/doi/full/10.1603/ME10075), a serious tick-borne disease that is now being contracted with increasing frequency by humans in the Northeast (http://www.nejm.org/doi/full/10.1056/NEJMc1215469; http://www.medscape.com/viewarticle/846337). How the concentration of wild turkeys at four-poster feeding stations may affect the spread of this disease in our area is unknown and probably not being studied.

6) ***Powassan virus.*** Powassan is a serious tick-borne virus that exists as two types. Several small to medium-sized woodland mammals (e.g., woodchucks, squirrels, and white-footed mice) can serve as reservoir hosts, and 6 tick species are known to be capable of serving as vectors for the virus (i.e., capable of transmitting it between small mammals or to humans). Black-legged ticks (*Ixodes scapularis*), which can transmit the virus and often bite humans, are a particular concern. Although human infections are rare, they are dangerous. The virus infects the central nervous system, has a significant mortality rate (about 10%), and can leave survivors with long-term neurological problems. Again, it is unclear if concentrating wildlife at four-poster feeding stations may promote the spread of this virus between species.

7) ***Possible generation of acaricide resistance.*** The use of four-posters to detick deer is a strategy with no "finish line"; i.e. these devices would presumably have to be deployed indefinitely, until some better solution is put into practice. This raises the possibility that long-term treatment of the deer with four-posters may result in the development of resistance in our black-legged and lone star tick populations to the permethrin acaricide/pesticide. There is good reason for such concern: First, in many parts of the world cattle ticks have developed resistance to multiple acaricides, including synthetic pyrethroids like permethrin (Kearney, 2013; Abbas et al, 2014). Second, the deer provide an essential reproductive host for these ticks. The vast majority of female black-legged and lone star ticks can only become fully engorged and reproductively mature while attached to deer. Thus, treating the deer for much of the year with permethrin would probably select for the survival of adult ticks with permethrin resistance. Few (if any) adult ticks could avoid permethrin exposure and survive to maturity on smaller mammals. Finally, our tick populations are also being exposed increasingly to permethrin applied directly to properties by homeowners. The development of resistance to pyrethroid-containing pesticides in both mosquitoes and lice is recognized as a problem of growing importance (WHO Global Malaria Program, 2012; Clark et al, 2015).

Given the possibility of an increase of transmissible diseases as a result of the installation of four posters, there would be potential liability on the part of the Town if illness or injury could be attributed to their presence nearby.

New research initiatives on controlling ticks and tick-borne diseases. While progress is being made to develop new vaccines directed against ticks and tick-borne diseases, this research is unlikely to provide completely satisfactory solutions in the short run. Injectable vaccines for humans are likely to be limited to only one or two diseases, while we face the risk of contracting many. A new and potentially improved Lyme disease vaccine has completed safety trials; however, when (if ever) it might be marketed remains uncertain (Moyer, 2015).

Another vaccine designed to immunize deer mice and white-footed mice against *B. burgdorferi* (the organism responsible for Lyme disease) is currently being tested (Moyer, 2015; pers. comm., Dr. Scott C. Williams, Connecticut Agricultural Experiment Station). This can be administered orally via bait – a great advantage; however, all possible reservoir hosts for the disease may not accept the bait. For example, shrews (which we have in abundance in forested areas of the Town of Southold) are reservoir competent hosts for *B. burgdorferi* (Committee on Lyme Disease and Other Tick-borne Diseases: The State of the Science, 2011; www.cfsph.iastate.edu/Factsheets/pdfs/**lyme** disease.pdf), but presumably would not go to baits intended for mice.

Lyme disease and white-footed mice are by no means our only serious concerns. The deer themselves are thought to be the major reservoir host for *Ehrlichia chaffeensis* (a cause of ehrlichiosis in humans). In the case of *Babesia microti* (the organism responsible for babesiosis), shrews, chipmunks and raccoons can function as competent reservoir hosts in addition to white-footed mice. Finally, many species of wild animals have shown evidence of being infected with *Anaplasma phagocytophilum* (which is responsible for anaplasmosis). Various wild rodents and deer are thought to act as major reservoir hosts for *A. phagocytophilum* in North America (Paddock & Childs 2003; Hersh et al, 2012; www.cfsph.iastate.edu/Factsheets/pdfs/**ehrlichiosis**.pdf *).*

Promising work is being pursued in Europe to develop oral bait vaccines that are intended to prevent tick feeding, rather than to immunize reservoir hosts against disease organisms (Sprong et al, 2014). This is conceptually very appealing, because it offers the hope of reducing the tick vectors of more than one disease on small mammals. Ideally, it might be most productive if such a vaccine could be administered orally to deer; however, ruminants (like deer) have thus far proven difficult to immunize via an oral route (pers. comm., Dr. Samuel R. Telford III). It is far too expensive to capture deer in order to administer vaccines by injection. An anti-tick vaccine that could be administered by darting might be more useful, but the problem of distinguishing vaccinated vs unvaccinated animals would remain.

An important new study has deciphered the genome of the black-legged tick (*I. scapularis*) (Gulia-Nuss et al 2016). This provides insights into many unique aspects of the ticks' genome that makes them such effective and dangerous disease vectors. Importantly, it also suggests

promising targets for the development of novel tick-control measures, e.g. more effective or selective vaccines and acaricides.

Wildlife management and tick populations. Because of their essential role as reproductive hosts for black-legged and lone star ticks, deer are a central element in our current health crisis involving tick-borne diseases on eastern Long Island. Although a variety of small mammals (e.g., mice, voles, shrews, moles, squirrels, raccoons and opossums) have long been common in our area, it was only when the deer population began to explode about 25 years ago that these tick species and the diseases they transmit started to assume major importance. If the deer population could be brought back to a more normal level, this would presumably serve to lessen multiple problems – our high frequency of tick-borne diseases, deer-vehicular collisions, unsustainable damage to our natural environment, and serious economic losses for our important agricultural sector.

It is clear from a carefully-conducted, 13 year study in the Mumford Cove area of Groton, Connecticut that reduction of an excessive deer population to about 13 animals per square mile resulted in a 76% reduction in tick abundance and an 80% reduction in resident-reported cases of Lyme disease in the community from before to after a hunt was initiated. (Kirkpatrick et al, 2014).

We have failed to make similar progress in the Town of Southold for three principle reasons: 1) New York State has been very slow to recognize that our deer-related problems are extremely serious and liberalize accordingly the regulations governing the recreational harvesting of deer; 2) recreational hunting alone is now probably incapable of solving deer over-population problems of our magnitude; and 3) recreational hunting must be used in conjunction with professional deer harvesting and/or carefully-trained recreational hunters working under nuisance permits to reduce such populations (Boulanger et al, 2014).

To the credit of Southold's deer management program, our annual harvests have increased more than those of any other Suffolk County towns in recent years (see: http://www.dec.ny.gov/outdoor/42232.html). Using conservative estimates of deer population size in the Town (2500-3000 animals), however, our recreational hunters have only harvested about 19 – 23% of the herd (bucks and does) in each of the past two years. In southern New York about 30-40% of the adult does must be taken each year to keep deer numbers stable and even more to reduce the population size (http://www.dec.ny.gov/animals/7211.html ; https://www.aphis.usda.gov/wildlife_damage/downloads/nepa/2014%20East%20End%20Deer%20Damage%20Management%20Report.pdf.

Our experience in recent years indicates that current management efforts are not going to solve our deer-related problems. Resolution of these problems will also probably require use of the following strategies:

1) ***Legalization of cross-bows.*** The use of crossbows by recreational hunters has now been legalized in upstate New York, but is still prohibited in Nassau and Suffolk Counties. This prohibition needs to be removed, as crossbows have long been legalized in the State of Connecticut and have an excellent safety record. Crossbows are more accurate than standard bows. Furthermore, crossbows are easier than standard bows for younger and older hunters to use.

2) ***Expansion of private lands open to deer hunting.*** Steps need to be taken to increase the amount of private land open to deer hunting. This will require that we expand our efforts to educate the public on the many serious problems created by an excessive deer population and that such hunting can be carried out safely. Recent experience in upstate New York indicates that this will be challenging to accomplish (see: http://www.ithaca.com/news/deer-control-dec-plan-is-not-reducing-numbers-yet/article_260b1828-8284-11e5-80a8-db6db9164211.html) and likely to be only one component of a more productive deer management plan for the Town of Southold.
3) ***Humane professional deer harvesting.*** This can take several forms e.g. a) the use of skilled professional sharpshooters, and b) the trapping or chemical immobilization of deer by darting, followed by humane euthanasia with drugs or captive bolt pistols. As these methods subject the deer to minimal stress and no pain, complaints by opponents that they are "inhumane" are simply untrue. The protection of human health and safety from tick-borne diseases and deer-vehicular collisions should take precedence over such concerns. For those in the recreational hunting community who object to the employment of professionals, this approach should be targeted at large concentrations of deer or those frequenting residential areas, where recreational hunting might be difficult. It is also unlikely that 2 -3 nights per year of hunting in an area by professional sharpshooters will suffice. The Tick Working Group is aware of a Long Island community where professional sharpshooters have been highly productive, but this involved several hunters working for 2 – 3 weeks per year at a total annual cost of about $100,000. Any such use of professionals is likely to be cost effective only with our most serious concentrations of deer. Once these are reduced, this approach simply becomes too expensive for the number of deer likely to be harvested. In the longer run, we must rely upon our recreational hunting community to keep our deer herd at a tolerable level.
4) ***Enhanced recreational hunting under nuisance permits.*** Recent experience in upstate New York indicates that this is a new direction we should also try. Under the guidance of experts from Cornell University, the Village of Trumansburg has successfully used skilled recreational hunters, trained in the intelligent use of baiting (which avoids educating the deer to stay away from the bait), hunting in the evening (5:00 – 11:00 PM) with the assistance of artificial illumination, and operating for many months under nuisance permits to reduce an excessive deer population (http://www.syracuse.com/outdoors/index.ssf/2015/04/trumansburg_deer_cull_program_using_archers_finishes_with_88_deer_killed.html). Also see "deer management" on the website of the Village of Trumansburg, New York. This has proved acceptable to most local residents, and a number of other upstate communities now wish to replicate the program (http://www.syracuse.com/news/index.ssf/2015/07/fed_up_with_too_many_deer_cny_village_moves_to_bait_and_kill_deer_this_fall.html). One of those communities (the Village of Fayetteville) has recently voted to hire professional sharpshooters from the USDA, however, and not to use volunteer archers as originally planned. Creation of a hunting program involving trained recreational hunters in the Town of Southold would require that we employ expert consultants to work with our new deer/wildlife program manager and the local hunting community. Private residents on Ram Island, Shelter

Island have moved to implement an enhanced recreational hunting program this past winter under the guidance of a hired, outside consultant.

5) ***Incentivization of recreational hunting.*** It is clear that none of the steps taken by the NYS DEC in recent years to increase the recreational deer harvest on eastern Long Island have been adequate. In 2013 the Rhode Island Department of Environmental Management filed emergency regulations to reduce the overpopulation of deer on Block Island, stating that the size of the herd presented an imminent risk to health, safety, and the welfare of the island's natural resources. In the 2014-2015 hunting season, steps were taken to pay recreational hunters a $ 150 bounty for each deer harvested, and the program was deemed a success (http://ripr.org/post/deer-reduction-hunt-successful-block-island). New York State should change its conservation law, so that a similar program could be initiated on Long Island.

Fertility control as a deer and tick management strategy. Fertility control by means of female sterilization or contraception is not presently a New York State-approved, stand-alone deer management methodology. These techniques can only be used in scientific research studies that promise to add useful new knowledge (*Management Plan for White-tailed Deer in New York State 2012-2016*). In other words, the methodology used in a research study elsewhere in New York State could not simply be replicated in the Town of Southold. Duplication of such a study would also presumably be in violation of the Federal Animal Welfare Act of 1966.

Even if deer fertility control was to be legalized, it would be an unworkable and unaffordable strategy for the Town of Southold. Either approach requires that the deer be captured, treated and tagged. For the most easily captured deer, this costs a minimum of about $ 500/doe for the administration of a contraception and $ 1000 for sterilization. However, the costs rise steeply from that level for the more difficult to capture females in the herd. Furthermore, the efficacy of the currently-available contraceptive vaccines diminishes after a year or two. To maintain the animals' infertility would require their recapture and the administration of vaccine booster shots. Finally, to have any measurable effect upon deer population levels, at least 90% of the females would have to be treated within a 2-3 year period. That is because untreated animals would continue to produce young. Given the geographic size of the Town of Southold, that target would be unattainable (*Management Plan for White-tailed Deer in New York State 2012-2016*; Boulanger et al, 2014).

Even if a more effective and less expensive method of deer fertility control could be developed and approved for use in New York State, it would not be expected to have any beneficial effect upon tick levels for years. That is because many treated deer would be expected to live long lives.

A review of currently available technologies for fertility control in deer – including the serious shortcomings of each approach – may be found in Appendix D of the *Fire Island National Seashore. Final White-tailed Deer Management Plan and Environmental Impact Statement (2015).*

Conclusions on promising methods of deer management. A recent study by experts who have had extensive experience in dealing with excessive deer populations (*An Integrated Approach for Managing White-tailed Deer in Suburban Environments: The Cornell University Study*, Boulanger et al, 2014) indicates that any management effort that does not incorporate some combination of approaches # 3 and 4 with traditional recreational hunting is destined to fail. In the absence of meaningful deer control, we will continue to face unacceptable risks of contracting seriously debilitating and sometimes fatal infections with tick-borne diseases, frequent deer-vehicular collisions, further deterioration of our natural environment with an attendant loss of biodiversity, and continued economic losses by our important agricultural sector.

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