Rebalancing Loudoun County's Approach to Lyme Disease Mitigation

Position Paper prepared for
Loudoun County Board of Supervisors
and Loudoun Lyme Disease Commission

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Executive Summary

Lyme disease has been identified as a serious public health issue in Loudoun County, Virginia by County officials. Loudoun Wildlife Conservancy and our co-signatory organization members spend much of our time outdoors, and are therefore some of the first constituents to be concerned about the threat of this disease.

We appreciate the commitment our County leaders have shown to our citizens' health, through the 2012 ten-point action plan to mitigate Lyme disease. We also understand that in our fast-paced world, in the face of a health threat that thus far defies human control, it may seem necessary to focus on actions that are quickly implementable. In Loudoun County, these actions have included publicly-funded bifenthrin spraying on County land in 2012 and 2013, and advice on applying permethrin spray to residential vegetation and grass in the brochure "Ticks and Tick-Borne Diseases in Loudoun County".

We believe, however, that two key questions have not been adequately addressed in the implementation of the ten-point plan: are pesticide sprays effective in mitigating Lyme disease, and are they safe for people and for animals, including beneficial pollinators? Our research reveals many reasons to say 'no' to these questions - many reasons to believe that pesticide sprays 1) are ineffective in reducing Lyme disease (though they may reduce tick numbers), 2) present numerous health risks, and 3) give us a false sense of security which discourages us from taking actions that can truly protect us from Lyme disease.

We request that the Loudoun County Board of Supervisors and Lyme Commission rebalance our County's approach to Lyme disease mitigation, by promoting measures that will both better protect our community from this disease, and also protect us from the risks of toxic chemicals. We base our recommendations on the Connecticut Agricultural Experiment Station's definitive *Tick Management Handbook*; on the latest studies from the Centers for Disease Control, the Environmental Protection Agency, and other authoritative sources; and on a survey of Lyme mitigation approaches in other high Lyme incidence states.

Specifically, we request the following:

1. Promote the highest-efficacy, lowest-toxicity, lowest-cost Lyme prevention methods - particularly personal protective measures such as tick checks and wearing long sleeves and pants and light colors. DEET-based repellents and permethrin-treated clothing have also been shown to have high efficacy, and can reasonably be among promoted methods if their moderate toxicity risks are clearly communicated.

2. Emphasize the data collection, education, and communication points in the Loudoun Lyme Commission ten-point action plan. Implement the concluding recommendations in the Loudoun County 2012 Lyme Disease survey with respect to broadening future surveys, and begin tracking information about homeowner association and other private sector pesticide spraying. Update County informational materials, including online literature and the brochure "Ticks and Tick-Borne

Diseases in Loudoun County," to reflect current research regarding tick ecology, and the fact that chemical products most commonly used to control ticks carry toxicity risks and have not been shown to reduce Lyme disease incidence. Follow through with Points 4, 5, and 6 of the ten-point plan, to educate and inform the public about advances in Lyme disease prevention and treatment. Communicate with the Loudoun County School Board and Administration regarding the risks of chemical spraying.

3. Cease using public funds to spray for ticks on public lands, unless and until this method is shown in scientific studies to reduce Lyme disease incidence (vs. reducing total numbers of ticks or numbers of infected ticks). Based on our research, spraying for ticks on public lands is extremely rare in other U.S. high-Lyme incidence locations - including in states and counties that employ experts who have dedicated their careers to researching and preventing the spread of Lyme disease. If and when such spraying is under consideration, better channels for public notification and consultation must be provided; and data collection and analysis must be rigorous.

Additionally, we recommend that when evaluating development applications, the Loudoun County Planning Commission consider research showing that forest fragmentation may be a factor in increasing Lyme disease risk.

A. The Situation Today

Reported Lyme disease cases as a percent of the Loudoun County population have held steadily in the 0.07-0.08% range since 2008, after peaking at 0.10% of the population in 2007. Although these cases represent less than one percent of Loudoun's population, our County Lyme disease incidence has been high in relation to state incidence figures compiled by the CDC. In 2012, Loudoun County Lyme incidence was on par with Maine, the second-highest Lyme incidence state.

Our research indicates that it is very rare for high Lyme incidence communities elsewhere in the United States to spray their parks or other public properties as a means of tick control. In these communities, residential yard acaricide [pesticide that kills ticks and mites] is often presented by public health authorities as one possible Lyme mitigation option - but this is balanced with substantial information about non-chemical tick control alternatives, and with cautionary information about the risks to people and animals and the circumstances in which acaricide sprays are not effective. Loudoun County's approach to Lyme disease mitigation, currently skewed in favor of using pesticide sprays to control ticks on both public and private land, should be brought into better balance with best practices of other high Lyme incidence locations as one point of reference.

1. Lyme disease overview

In the eastern and north central United States, the *Borrelia burgdorferi* bacteria that cause Lyme disease are spread through the bites of infected blacklegged ticks (*Ixodes scapularis*) - primarily those at the nymphal stage.[1] Spread of the Lyme disease bacteria from an infected tick to a person generally occurs after the tick has been attached to the person's body for at least 36 hours.[2]

The first symptom of Lyme disease is often but not always a 'bull's eye' rash around the site of the tick bite. This rash may be accompanied by joint pains, chills, fever, and fatigue, which in many instances are overlooked or mistaken for the flu. Most people who contract Lyme disease can be treated successfully with a few weeks of antibiotics - but in those who do not receive treatment, infection can spread to joints, the heart, and the nervous system.[3]

A human Lyme vaccine was approved by the Food and Drug Administration in 1998, briefly put on the market, and then withdrawn in 2002 due to slow sales and concerns about possible side effects. Progress toward a new vaccine is being reported in scientific literature, but appears to be years away from completion.[4]

2. Lyme disease incidence

Nationwide, approximately 30,000 cases of Lyme disease are reported to the Centers for Disease Control and Prevention (CDC) each year, representing approximately 0.01% of total population. New estimates released by the CDC in

August 2013 indicate that the number of Americans diagnosed with Lyme disease each year is actually closer to 300,000, representing approximately 0.09% of the population.[5] Comparing this incidence rate to that for other diseases helps to put perspective on Lyme disease prevalence. This percentage compares, for example, to an estimated 8.3% of the total U.S. population[6] (and 7.1% of the Loudoun Health District population[7]) who have asthma, and to 8.3% of the U.S. population[8] (and 3.4% of the Loudoun Health District population[9]) who have diabetes.

Virginia Department of Health 2012 provisional data, shown in Figure 1 below, places Loudoun County in the 50.01-100.00 reported Lyme disease cases per 100,000 population tier, joining seven other Virginia counties in this second-highest tier. Two Virginia counties have reported more than 100 cases per 100,000 population.

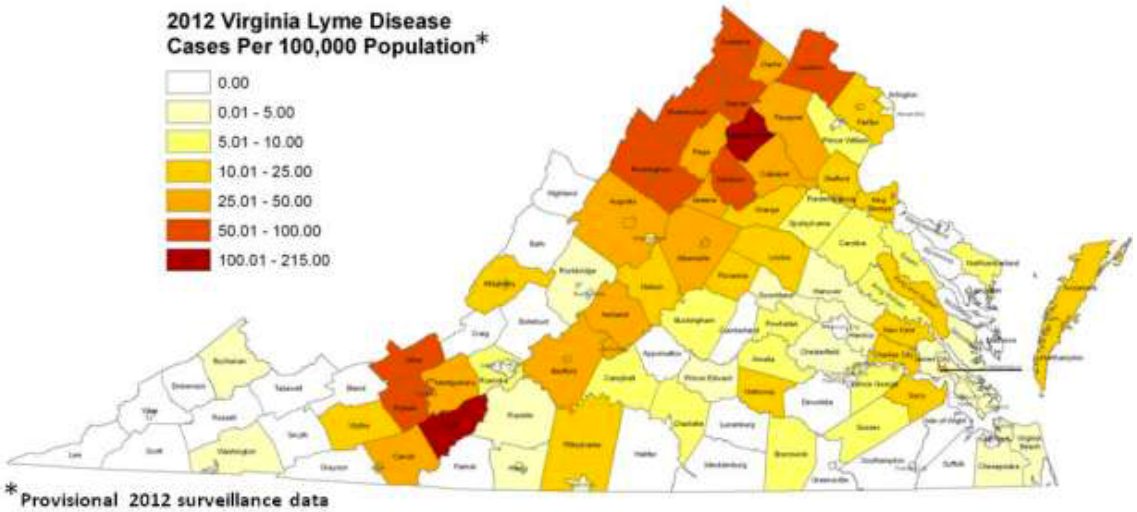

Figure 1. Source: Virginia Department of Health. Romero, C. (April 29, 2013). Lyme Disease in Virginia. Retrieved October 6, 2013, from http://www.vdh.state.va.us/clinicians/pdf/Lyme%20Disease%20in%20Virginia.pdf

Table 1 below summarizes Loudoun County government data on population and Lyme disease from 2007 through 2012. Although reported Lyme disease cases may represent only a fraction of actual Lyme disease incidence, it is encouraging to note that the peak year for reported Lyme cases was 2007 - both for the total 293 reported cases, and for the 101.25 cases per 100,000 population, which can also be stated as 0.10% of the population. Reported cases as a percent of population have hovered in the 0.07-0.08% range for the most recent five consecutive years, 2008-12.

	Loudoun County			
Year	Population	Reported Lyme Cases	Reported Cases per 100,000 Population	Reported Cases as Percent of Population
2007	289397	293	101.25	0.10%
2008	298420	235	78.75	0.08%
2009	304964	201	65.91	0.07%
2010	312311	223	71.40	0.07%
2011	320583	261	81.41	0.08%
2012	328533	219	66.66	0.07%

Table 1. Population data per Loudoun County, VA Demographic Estimates and Forecasts. Population, Housing Units, Households, Employment (Updated January 17, 2013) Retrieved October 6, 2013 from http://www.loudoun.gov/index.aspx?NID=1913#Estimates. Reported Lyme cases per Loudoun County, VA. Frequently Asked Questions. (n.d.) Retrieved October 6, 2013 from http://www.loudoun.gov/FAQ.aspx?QID=231.

Despite the number of reported Lyme disease cases being less than one percent of Loudoun's population, this number is high in relation to average state figures compiled by the CDC, as reflected in the following summary of the 14 highest-incidence states in 2012.[10] With 66.66 reported cases per 100,000 population in 2012, Loudoun County was below only New Hampshire, with 75.9 reported cases per 100,000 population, and exactly on par with Maine, the second-highest Lyme disease reporting state per 100,000 population.

State	2007	2008	2009	2010	2011	2012			
						Confirmed	Probable	Incidence*	Confirmed Cases as Percent of Population
New Hampshire	896	1211	996	830	887	1002	448	75.9	0.08%
Maine	529	780	791	559	801	885	226	66.6	0.07%
Vermont	138	330	323	271	476	386	136	61.7	0.06%
Delaware	715	772	984	656	767	507	162	55.3	0.06%
Massachusetts	2988	3960	4019	2380	1801	3396	1742	51.1	0.05%
Connecticut	3058	2738	2751	1964	2004	1653	1004	46.0	0.05%
Pennsylvania	3994	3818	4950	3298	4739	4146	887	32.5	0.03%
New Jersey	3134	3214	4598	3320	3398	2732	884	30.8	0.03%
Wisconsin	1814	1493	1952	2505	2408	1368	398	23.9	0.02%
Maryland	2576	1746	1466	1163	938	1113	538	18.9	0.02%
Minnesota	1238	1046	1063	1293	1185	911	604	16.9	0.02%
Rhode Island	177	186	150	115	111	133	84	12.7	0.01%
New York	4165	5741	4134	2385	3118	2044	954	10.4	0.01%
Virginia	959	886	698	911	756	805	305	9.8	0.01%

Table 2. Sources: Centers for Disease Control and Prevention. Reported cases of Lyme disease by state or locality, 2003-2012 (Updated September 16, 2013). http://www.cdc.gov/lyme/stats/chartstables/reportedcases_statelocality.html . Incidence = confirmed cases per 100,000 population. 2012 state population data from U.S Census Bureau, http://quickfacts.census.gov/qfd/

3. Summary of Lyme mitigation approaches in U.S. high-incidence locations

As indicated in the Sept 5, 2012 document "Loudoun County Staff Tick Spraying Recommendations for Autumn 2012":

"Communities that have studied the issue do not spray their parks or other public properties. a. Fairfax County has a well-established Disease Carrying Insects Program that includes an entomologist and conducts surveillance, outreach and other activities to help keep their citizens safe from Lyme disease. Fairfax County does not conduct any spraying for blacklegged ticks as part of these Lyme disease control efforts. b. Connecticut has been battling Lyme disease since 1975 ... During an informal discussion with the author of Connecticut's *Tick Management Handbook*, Dr. Stafford was not aware of any county in that state that conducted acaricide spraying in its parks."[11]

Loudoun Wildlife Conservancy similarly found no evidence of other high-Lyme incidence communities spraying their parks or public properties, based on our own correspondence with the above-mentioned Dr. Stafford and with authorities responsible for Lyme mitigation in six other high-incidence states. These authorities indicated either that their state had no program for using chemical sprays for tick control, or that there might be such a program at the local level but they knew of no specific examples. A New York State Bureau of Communicable Disease Control statement was representative: "We do not see large scale spraying of large swaths of public land for two reasons. One is the cost and the second is that it is not that effective." Many state representatives also cited citizen concerns about the risks of pesticides - especially in New England fishing communities.[12]

Loudoun Wildlife Conservancy also studied the health department websites of Fairfax County, Virginia, and of the highest Lyme incidence states, to determine the Lyme mitigation information and recommendations being provided to private citizens. While many of these websites do list residential yard acaricide spraying to reduce tick numbers as one possible Lyme mitigation option, three points are worth noting:

First, some of these official websites - Massachusetts, for example - specifically recommend that when citizens select a pesticide applicator, they ask the applicator to provide information about non-chemical pest control alternatives.[13]

Second, some of these websites clearly indicate circumstances under which acaricide sprays are not effective. The University of Rhode Island TickEncounter Resource Center website states, for example: "In most situations, treatment is NOT needed on open or sunny LAWNS!! Ask your professional where they will be applying the product. If they say over the entire yard, then they don't really know that blacklegged tick nymphs require exceptionally high humidity only found in

shady, leaf-covered areas."[14]

Third, many of these websites provide cautionary information about the risks to people and wildlife of applying acaricide sprays. The New York State website notes, for example, that "animal studies indicate that permethrin may have some cancer causing potential." The same website also cautions: "Do not use any pesticide near streams or any body of water, as it may kill aquatic life or pollute the water itself."[15] The Rhode Island TickEncounter website states: "Pyrethroid products should not be applied around fish-containing ponds or streams." The Fairfax County, Virginia website states: "Permethrin is toxic to fish. For that reason, EPA has established specific precautions on the label to reduce such risks, including restrictions that prohibit the direct application of products to open water or within 100 feet of lakes, streams, rivers or bays. Permethrin is also highly toxic to bees, and possibly other beneficial insects."[16]

4. Loudoun County: public sector approaches

In March 2012, the Loudoun County Board of Supervisors adopted a 10-point action plan to mitigate Lyme disease, which is posted at the Loudoun County Health Department Lyme Disease website.[17] The action items cover four functional areas: a) data collection, b) public information, c) education, and d) insecticide applications.

a) Data collection

This component of the plan was addressed through action plan point 2, which called for an updated Lyme survey "as a follow-up to the 2006 *Lyme Disease in Loudoun County* survey, to determine the current key risk factors for contracting Lyme disease as well as any other relevant statistics that will enable a better determination of where work and funding should be directed."

Results of the 2012 survey were released February 1, 2013 by the Loudoun Lyme Commission in the report "Risk and Protective Factor Survey of Lyme Disease Cases in Loudoun County, Virginia - 2009-2011."[18] As with the 2006 survey, samples in the 2012 survey consisted of all persons with a case of Lyme disease reported to the Loudoun County Health Department for a three-year period. The date range for the 2012 survey was January 2009-December 2011, and the date range for the 2006 survey was January 2003-February 2006.

The report presented as successes the fact that "compared to 2006, respondents in 2012 were more likely to receive care within the first month of symptom onset, to regularly check for ticks, and to control ticks on their property both through the use of pesticides and by removing brush and leaf litter." The report found that improvement was needed in "other preventive measures, such as use of insect

repellent, dressing appropriately, and using gravel or fence barriers." Only 29% of survey respondents had a known tick bite. This group was then asked what activity they were engaged in when bitten by a tick. 40% (30 individuals) listed gardening/yard work; 23% (17 individuals) listed unknown; 19% (14 individuals) listed hiking; 11% (8 individuals) listed recreational sports; and 3% (2 individuals) each listed hunting, farming, and indoor activities. On this basis, the report concluded that "of those who had a known tick bite, performing yard work on their own property constituted the most common risk factor for contracting Lyme disease."

The report noted that based on the survey inclusion criteria, subjects were limited to patients infected with Lyme disease who met the CDC case definition of a probable or confirmed case, and who had access to the healthcare system. The report also noted "a significantly higher representation amongst residents who are white and non-Hispanic." The report recommended that Loudoun County conduct a broader survey in future, to include not only persons with known cases of Lyme disease, but also those not infected with Lyme disease and those who were diagnosed with Lyme disease but did not meet criteria to count as a case.

b) Public information

This component of the plan was addressed primarily through points 3, 6, 7, and 8.

Per point 3, a high profile link was added to the County's home page, pointing to a Lyme Disease webpage designed to increase community access to relevant information. Resources on the page include the Virginia Department of Health *Preventing Tick-Borne Diseases in Virginia*, the Connecticut Agricultural Experiment Station *Tick Management Handbook*, and *Tick Tips from the CDC*.[19]

Point 6 called for working with local newspapers to place a series of monthly news articles during the first year, and quarterly articles thereafter, to keep the public up-to-date with advances in prevention and treatment as well as to publish a spraying schedule. While there has been sporadic coverage in local newspapers of 10-point plan activities - notably one educational forum and one round of park spraying each in 2012 and 2013 - there have not been regular articles, and spraying schedules have been communicated with little notice.

Point 7 called for establishing a list of doctors that specialize in the diagnosis and treatment of Lyme disease and providing this information on the County's Lyme webpage. Compiling this information may not, in fact, be feasible. The Health Department - Lyme Disease - Frequently Asked Questions page[20] includes a link to a CDC website for "a national list of doctors." The CDC link points to the homepage of the American Lyme Disease Foundation, http://www.aldf.com, whose "Find a Local Physician Knowledgeable About Infections Diseases" link points in turn to Castle Connolly Medical Ltd., http://www.castleconnolly.com. The

Loudoun County page also indicates that the Health Department cannot evaluate the professional qualifications and competence of individual doctors.

Point 8 called for "developing information for homeowners on the costs and benefits of spraying their yards for ticks". The primary vehicle for this is apparently the pamphlet *Ticks and Tick-Borne Diseases in Loudoun County*[21], which dedicates one of seven sections to "Applying Permethrin to Vegetation and Grass" in yards, and has been widely distributed throughout the county in addition to being posted on the County Health Department Lyme Disease webpage.[22]

Featuring a photo of a woman spraying a stream of liquid into shrubs, this piece presents a list of benefits such as "provide temporary relief from ticks," with no mention of costs or hazards such as evidence that permethrin is a likely human carcinogen that is highly toxic to fish and bees, and also toxic to cats (discussed in section B, below).[23] No decision tree or criteria for spraying are provided to help readers make decisions about spraying in their particular residential environment.

The Loudoun County pamphlet is modeled closely on a Fairfax County VA publication, which also does not mention permethrin risks in the pamphlet itself. The Fairfax pamphlet does, however, include a link to the county webpage http://www.fairfaxcounty.gov/fightthebite), and from there, readers can find extensive, balanced information about permethrin at http://www.fairfaxcounty.gov/hd/westnile/permethrin.htm.

The Loudoun County pamphlet also includes a section on how to discourage deer, without mention of the role that other animals play in the life cycle of ticks (discussed in section C3a on Blacklegged Tick Ecology, below).

c) Education

This component of the plan was addressed primarily through points 4, 5, and 9.

Point 4 called for a set of educational materials targeting different age groups, and working with Loudoun County Public schools to distribute them. The Loudoun Lyme webpage has included links to educational resources specifically aimed at children.[24] These emphasize personal protective measures, with one reference to permethrin spraying and one graphic of an adult spraying an unspecified liquid into shrubs.

Point 5 called for organizing a series of Lyme Education Forums. To date, one such forum has been held: “Keeping Kids Safe from Lyme Disease” on May 9, 2013, where a panel of speakers including two students spoke about the impact of Lyme. Over 100 people, including Congressman Frank Wolf, attended the event.[25]

Point 5 also called for facilitating the formation of Lyme Support groups in underserved geographic areas of the county. There is no indication that this has yet occurred.

Point 9 called for providing education awareness briefings to all children enrolled in Parks and Recreation outdoor programs. County documents indicate that in 2012 a total of 10,095 participants attended such presentations and received written materials on protecting themselves from Lyme disease, and that these presentations continued in 2013.[26]

d) Pesticide applications

Point 10a called for "studying the cost and feasibility of spraying county-owned properties", in addition to immediately implementing a program of spraying six public parks "based upon their small to moderate sizes, geographic locations, and logistical ease of spraying" - criteria which show surprisingly little connection to the goal of mitigating Lyme disease.

Blake Landscaping, based in Leesburg, was selected as the County contractor for the immediate spraying project.[27] In April-May 2012 that company sprayed nine Loudoun parks - Franklin Park, Woodgrove Park, Lucketts Community Park, Ashburn Park, Conklin Park, Phil Bolen Park, Nell Boone Park, Mickie Gordon Memorial Park, and Claude Moore Park. The rationale for selecting those parks was not explained to the public.[28]

At its September 18, 2012 Business Meeting, the Board of Supervisors voted that "prior to any further spraying, Loudoun County establish a Request for Proposal for the development of a strategy to perform spraying in the most efficient, effective and environmentally sensitive manner" and that Chairman York and Supervisor Buona be given decision-making authority over the implementation of this project.

Clarke Environmental Mosquito Management, Inc. ("Clarke") was chosen for this contract, and began work in March 2013. Clarke used tick drags and traps to evaluate 27 county parks between March 11 and 21, 2013 in consultation with the Loudoun County Department of Parks, Recreation & Community Service. A total of 3,698 ticks were found, of which 137 (3.7%) were blacklegged ticks. 69% of the blacklegged ticks found were trapped in six parks: Banshee Reeks, Brambleton Community Park, Claude Moore Park, Conklin Park, Franklin Park, and Phillip A. Bolen Memorial Park. It was reported that in these and eight other parks, some blacklegged ticks tested positive for the bacterium that causes Lyme disease. The minimum infection rate was calculated to be 31.1%, though the precise number/percentage of infected ticks is unknown due to the method used for testing.

On May 10, 2013 Chairman York and Supervisor Buona authorized targeted spraying at these parks. The County website announced as of June 17, 2013 that spraying had been completed in four parks - Phil Bolen Park, Franklin Park, Conklin Park, and Claude Moore Park. The status of Brambleton Park West was not clearly announced. Banshee Reeks was not on the final list, due to its special status as a nature preserve.[29]

Both rounds of spraying used the chemical bifenthrin (Talstar), a pyrethroid classified by the EPA as a possible human carcinogen, and highly toxic to bees, fish, and aquatic invertebrates.[30] In both cases, Loudoun County citizens and especially beekeepers' groups voiced concern that the decision to spray was made without public consultation, and the spraying carried out with little advance notice.[31] The total cost of the 2012 spraying was $10,359.[32]. We understand that the cost of spraying in 2013 was $2,300, with an additional $9,900 spent for the pre-spraying tick drags and $930 for tick testing.[33] After the spraying was complete, no tick drags or other data collection or analysis were conducted to determine effectiveness, and there have been no correlations between tick spraying and reduction of Lyme disease incidence.

Meanwhile, according to *Leesburg Today*, Loudoun County Public Schools administrators announced that they would "follow the county's lead on this," and proceeded with spraying 13 elementary schools using "the same process as the county government." [34]

Point 10b calls for working with the Virginia Department of Game and Inland Fisheries (DGIF) to study the feasibility of developing a county pilot program for the issuance of permits for the application of acaricides to deer via four-poster devices.

Based on a Virginia law prohibiting the application of chemicals to animals that might be legally hunted for human consumption, four-poster deer feeders are prohibited in the Commonwealth unless the purchasing entity obtains a special permit from the Virginia Department of Game and Inland Fisheries (DGIF). Fairfax County is currently the only Virginia county using these stations, under a pilot program with 20 feeders costing approximately $380,000. We understand that Loudoun County and DGIF representatives have held multiple discussions regarding four-poster deer feeders, and that Loudoun County is not actively pursuing this strategy at this time.[35]

5. Loudoun County: private sector approaches

a) Loudoun County survey

According to the Loudoun County 2012 Lyme Survey summary discussed above, which was limited to those with a case of Lyme disease reported to the Loudoun County Health Department, the most common risk factor for exposure to ticks was yard work. 2012 survey respondents were more likely than those in 2006 to take multiple actions intended to prevent Lyme - including using pesticides for tick control. 19% of the 2012 respondents reported using pesticides for tick control either before or after their Lyme diagnosis, as compared to just 4% of the 2006 respondents.[36]

b) Homeowner Associations

Leesburg Today reported on March 21, 2012, that the Loudoun County Board of Supervisors had decided to send a letter to the county's homeowner associations with information on spraying for them to consider including with their landscaping efforts.[37]

Leesburg Virginia-based Blake Landscapes, which won the 2012 contract to spray in Loudoun County parks, promotes tick management services including bifenthrin spraying to its private sector clients. Blake's blog post from August 14, 2013 indicates that the number of HOAs using its tick treatment program is growing, though it does not mention any specific HOAs."[38]

In October-November 2013, we reviewed the websites of 35 homeowner associations listed on the Loudoun County website - including association newsletters and board and committee meeting minutes, where publicly available.[39] The majority do not discuss the subject of tick control or Lyme mitigation.

However, Countryside, one of the largest Loudoun County HOAs with over 2,500 homes, addressed the subject in multiple ways in June 2013. Its newsletter provided advice about a variety of personal protective measures.[40]
According to minutes from the Countryside grounds committee June 2013 meeting, and our communication with HOA residents, ValleyCrest Landscape Maintenance applied tick treatments around the HOA tot lots and pools "in a fashion similar to the treatments applied to the County Parks by Loudoun County," and was authorized to bill the HOA up to $1725 for this service.[41]

Broadlands is one other HOA which addresses tick control and Lyme mitigation on its website. A National Wildlife Federation certified wildlife habitat, its literature provides information about a variety of alternatives to broad-based chemical spraying.[42]

B. Why This Matters

To date, evidence has not shown pesticide spraying to reduce Lyme disease incidence. Considerable evidence has, however, shown toxicity risks from the most common chemical tick control products such as the pyrethroids bifenthrin and permethrin. There is evidence that low level exposure to these chemicals, which are classified as possible human carcinogens, is a particularly serious threat to children's health. Overexposure to these products has caused severe reactions in pets, and even death for cats. These chemicals are highly toxic to bees and other beneficial pollinators that are critical to Loudoun County's agricultural sector. They are also highly toxic to fish and aquatic organisms, and toxic to birds.

1. No evidence that pesticide spraying reduces Lyme disease incidence

Our research has revealed no studies indicating that Lyme disease incidence is reduced by pesticide spraying on public lands - and as discussed above, our outreach to the health departments of the highest Lyme incidence U.S. states has revealed no specific examples of such spraying.

Meanwhile, multiple CDC-affiliated studies have investigated whether spraying residential property with acaricides reduces the risk of Lyme disease - and to date, none has established such a link. In fact, data has consistently shown that pesticide sprays do nothing significant to reduce the incidence of Lyme, though they do reduce the number of ticks.

A 2008 CDC study of 709 Lyme disease case patients and 1,128 control subjects in Connecticut, published in the journal *Emerging Infectious Diseases,* concluded that spraying acaricides on property was not effective in preventing Lyme disease.[43]

Dr. Paul Mead, CDC Medical Epidemiologist in the Division of Vector-Borne Infectious Diseases, stated in a 2011 EPA conference presentation: "residential acaricide use has not been shown to reduce tick-borne diseases in humans."[44]

During 2011-12, the CDC conducted a study of 2646 households in partnership with the Connecticut Emerging Infections Program of the Yale School of Public Health, the Maryland Department of Health and Mental Hygiene, and the New York State Department of Health. These households were randomly assigned to receive a single application of commercially available bifenthrin or placebo on their yard in spring, according to industry standards. While final analysis of 2012 data is still pending, the study summary presented to the 13th International Conference on Lyme Borreliosis and other Tick-Borne Diseases, Boston, MA, August 18-21, 2013 stated: "Although acaricide application was effective at reducing tick abundance in both years, data from 2011 indicate no reduction in tick encounters or disease.[45]

2. Risks to people of pesticide spraying

Pyrethroids including bifenthrin and permethrin are currently classified as Group C carcinogens (possible human carcinogens). Overexposure to bifenthrin and permethrin can cause bleeding from the nose, tremors, and convulsions; dermal exposure can cause rashes, numbing, burning, or tingling; while ingestion may cause a sore throat, nausea, abdominal pain and vomiting.[46]

There is evidence that low level exposure to pesticides is a serious threat to children's health, "condemning them to life-long health problems that can also affect their own children."[47] Many states including Connecticut either restrict or ban the use of pesticides in school buildings or on school grounds.[48]

Yale University professor and CDC advisor John Wargo recently stated with respect to bifenthrin in particular, “I’m always a skeptic of spraying persistent chemicals, especially where children might be playing. It’s really important not to trade Lyme disease with another health threat.”[49]

Childhood leukemia and brain tumors—the two most common childhood cancers—have increased by more than 20% since 1975. Asthma approximately doubled in prevalence between 1980 and 1995 and has stayed at the elevated rate. There is increasing evidence that direct childhood exposures and parental exposures to pesticides are associated with these diseases.[50]

A global report including studies of U.S. populations found bifenthrin in meconium and breast milk, and permethrin in cord blood and neonate plasma, indicating pollution impact on infants.[51] Bifenthrin has been linked to increasing likelihood of autism when pregnant mothers are exposed to it.[52]

An understanding has begun to emerge that what ails adults can often be traced back to the womb – that the exposure of the unborn fetus leads to chronic and debilitating conditions in the old-aged, termed the fetal origins of disease, or developmental origins of adult disease.[53]

For historical context, when DDT was widely used in the mid-1900s to combat malaria, typhus, and other insect-borne human diseases, people directly exposed to the pesticide appeared to be unaffected. The pesticide was thought to be so harmless that it could be applied in and around homes, including in children's rooms, as illustrated by the advertisements shown below. DDT's classification as a class B2 carcinogen (probable human carcinogen) - together with evidence of its toxicity and damage to the reproductive cycles of numerous birds, mammals, fish, aquatic invertebrates, and amphibians - came only after years of widespread use.[54]

Figure 2. Source: Woman's Day Magazine. June 1, 1946. http://graphic-design.tjs-labs.com/show-picture?id=1225290969

Figure 1. Source: Woman's Day Magazine. June 1, 1947. http://graphic-design.tjs-labs.com/show-picture?id=1225290969

3. Risks to animals of pesticide spraying

a) Cats and dogs

Dogs and cats exposed to bifenthrin or permethrin may experience vomiting or diarrhea, hyperactivity followed by loss of coordination, dilated pupils, twitching of the ear, paw flicking, or unusual drooling. Some veterinarians have reported additional signs such as head bobbing, partial paralysis, and tremors. Cats that have been exposed by accident to products with high (45-65%) levels of permethrin may die from the exposure.[55]

b) Bees and other pollinators

Bifenthrin, permethrin, and other pyrethroid chemicals are highly toxic to bees - meaning that bees die upon direct contact with the spray and with chemical residues.[56]

At sublethal concentrations, bifenthrin reduces the reproductive capacity of bees, decreases the rate at which bees develop into adulthood, and increases their immature periods.[57]

A study using organophosphorus and pyrethroid insecticides on bees and other beneficial pollinators[58] describes the following results: visible deformations in adult individuals exposed to pesticides during the larval stage; spatial orientation and communication issues causing disorientation and loss; disruption in the ability to locate food due to reduced olfactory capacity; disruption of coordination of insect nervous and hormonal systems necessary to successful egg deposition; impaired learning processes in pollinator models and, more specifically, in honey bees.

Bees and other insects pollinate three-quarters of all crops, making them vital for global food production. Most of the fruits and vegetables we enjoy as mainstays of a healthy diet are wholly dependent on insect pollination, as are many field crops such as peanuts, soy beans, sugar beets, cotton, and the alfalfa that serves as a food source for beef and dairy cattle.

In Loudoun County, bees play a vital role in Loudoun's rural economy by pollinating many crops. The application of pyrethroids like bifenthrin and permethrin, or others, such as neonicotinoids, could have a significant impact on Loudoun's agricultural community.

Honey bee keepers have reported up to 90% losses of their hives due to Colony Collapse Disorder (CCD), a worldwide phenomenon. Worker bees disappear suddenly, failing to return to their hives after leaving to forage for pollen. Without these worker bees, the hives cannot sustain themselves and die.

The USDA Agricultural Research Service is studying the role of environmental stressors in CCD. Such stressors include accidental or intentional exposure to pesticides at lethal or sublethal levels, as well as access to contaminated water.[59] It could be five years before a determination is made.

c) Aquatic life

Permethrin and bifenthrin are highly toxic to fish and aquatic organisms, and should not be applied near water sources. These pyrethroids are hardly soluble in water, so nearly all will stay in the sediment where they are very harmful for aquatic life. Even in small concentrations, fish and other aquatic animals are affected.[60] In cold water bifenthrin is even more dangerous. Calcium concentration and pH are also factors that influence the toxicity.[61]

d) Birds

Many populations of bird species have declined significantly in recent decades, a phenomenon thought to have resulted in part from loss of invertebrate species on which the birds feed. A 2007 Audubon Society report, *Common Birds in Decline*, showed that populations of 20 of the most common bird species in North America had declined by an average of 68 percent since 1967. Some species populations declined by as much as 80 percent, and all 20 birds included in the Audubon Society's report lost at least 50 percent of their population - in just four decades.[62]

While pyrethroids are not the primary class of pesticides directly involved in the decline of avian species, their high bio-concentration factor can affect higher-level predators such as hawks, owls, and eagles, which prey on small mammals and aquatic species that also come in contact with the chemicals.[63]

In addition to bioaccumulation in the larger predatory birds, the strong insecticidal effectiveness of pyrethroids such as bifenthrin and permethrin is recognized as a main cause of a general reduction of food sources for birds, reducing reproductive success as well as general population numbers.[64]

C. Options and Alternatives

Dr. Paul Mead, Chief of Epidemiology and Surveillance Activity for the CDC's Division of Vector-Borne Diseases, has observed that while an array of Lyme disease prevention methods are available, there is currently no single, widely-accepted method." [65] Indeed, at present, there is no single method that has been found to be completely effective in all relevant scientific studies. Nevertheless, a review of the available scientific research reveals more evidence for the efficacy of some Lyme prevention methods than for others. Moreover, many of the methods which studies indicate to be most effective are also low- or no cost, and carry low or no risk. Community resources should focus on promoting and employing the highest-efficacy, lowest-cost, lowest-toxicity Lyme prevention methods - particularly tick checks and protective clothing (long sleeves and pants and light colors). DEET-based repellents and permethrin-treated clothing have also been shown to have high efficacy, and can reasonably be among promoted methods if their moderate toxicity risks are clearly communicated. Following is a brief summary of the primary methods other than broad-based chemical spraying that have been employed in the U.S. in recent years.

1. Personal protective measures

a) Tick checks and prompt removal

The definitive *Tick Management Handbook* states that "checking for ticks and prompt removal of attached ticks is probably the most important and effective method of preventing infection!"[66] - and indeed, most scientific studies have supported this assertion. A 2005-07 Connecticut study of 364 case participants and 349 control participants, published in 2009, concluded that "practical activities such as checking for ticks and bathing after spending time in the yard may reduce the risk of Lyme disease in regions where peridomestic risk is high."[67] A 1998-99 Pennsylvania study of 294 case participants and 449 controls, published in 2001, found tick checks to be "unequivocally associated with a reduced risk of Lyme disease."[68] A 1992-93 New Jersey study of 62 cases and 62 controls, published in 1998, similarly showed tick checks during or immediately after outdoor activity to be a factor in preventing Lyme disease.[69]

The only possible cost is for informational resources on how and where to perform tick checks - such as the TickSmart™ Daily TickCheck Shower Cards and Toilet Stall Cards sold by the University of Rhode Island TickEncounter Resource Center[70] - and for basic tools, such as tweezers, required to remove any ticks that are found.

The tick check and removal protection method carries none of the toxicity risks

associated with chemical use. The only real risk is that ticks - particularly nymphs the size of a pin head - may go unnoticed during a personal check.

b) Protective clothing

The *Tick Management Handbook* recommends wearing light-colored clothing with long pants tucked into socks to make ticks easier to detect and keep them on the outside of the clothes.[71] Although the evidence for efficacy of this method is mixed, a 2008 CDC Connecticut study of nearly 2,000 individuals found protective clothing - defined as "long pants, long-sleeved shirts, or light-colored clothing" to be 40% effective in preventing Lyme disease.[72] Wearing this type of protective clothing is a risk-free prevention method.

c) DEET on skin or clothing

The CDC recommends using repellents that contain 20 to 30% DEET on exposed skin and clothing for protection that lasts up to several hours.[73] The *Tick Management Handbook* states that when applied to clothes - especially shoe tops, socks, and the lower portion of pants - 30% and 20% DEET have been shown to be 92% and 86% effective against the blacklegged tick, respectively, while skin applications are 75 to 87% effective.[74]

Such DEET products are widely available for purchase, and may cost as little as $10 per person per month during periods of regular use.

Based on available scientific information, the human toxicity risks of DEET are relatively low as compared to other chemical products used for tick protection. However, the American Academy of Pediatrics (AAP) has recommended that DEET not be used on children younger than 2 months of age, that it be applied no more than one time per day for children older than two months, that products used on children have the lowest DEET concentration available, and that the product not be used on children's hands or around their eyes and mouths. [75] In addition, there is evidence that the use of DEET in combination with permethrin may facilitate enhanced dermal absorption of permethrin.[76]

With respect to wildlife and the environment, because DEET is used by so many people, it has been found in wastewater and in places where waste water moves into other bodies of water. Tests have found that DEET is toxic to freshwater fish and insects, although only at very high levels.[77]

d) Permethrin-impregnated clothing

Small-scale studies have shown permethrin-treated clothing to be highly effective against ticks, particularly when applied to shoes and socks - although only the skin surface covered with treated clothing is protected.[78] A North Carolina study found that subjects wearing permethrin-impregnated clothing had a 93% reduction in the total incidence of tick bites compared to subjects using other common tick protection measures.[79] A Rhode Island study found that subjects wearing permethrin-treated sneakers and socks were 73.6 times less likely to have a tick bite than subjects wearing untreated footwear, while subjects wearing permethrin-treated shorts and T-shirts were 4.74 and 2.17 times, respectively, less likely to receive a tick bite in areas related to those specific garments than subjects wearing untreated shorts and T-shirts. The Rhode Island study found, further, that there was no statistically significant difference in number of tick bites between commercial permethrin treatment and a do-at-home permethrin application method.[80]

Permethrin-treated clothing is available from selected outdoor equipment retailers, generally at a cost of $25-$100 per item. Permethrin spray for home application can cost as little as $10, which covers application to four complete outfits.

Available information indicates that the risk of using permethrin-impregnated clothing is substantially lower than the risk of using permethrin in other ways. In 2009, the EPA evaluated multiple exposure scenarios for permethrin factory-treated clothing, including toddlers wearing or mouthing the clothing, and military personnel who wear permethrin-treated uniforms on a daily basis - and concluded that this clothing is unlikely to pose any significant acute or chronic hazard to wearers. Still, the EPA specifically notes that permethrin products are not intended for application to underwear, and that permethrin-treated clothing should be washed separately from other non-treated clothing.[81] The organization Beyond Pesticides notes that this means the permethrin comes off in water - and that therefore, a) rainy weather, sweating and other factors may increase the rate at which the pesticide transfers from the clothing to the human body, and b) the product may cause water contamination.[82] The *Tick Management Handbook*, in a section on permethrin-based repellants, presents a long list of cautions - including "Apply to CLOTHING ONLY. Do not apply to skin."[83]

2. Landscape management

a) Tick-safe zones

According to a study referenced in the *Tick Management Handbook*, the blacklegged tick is found mainly in densely wooded areas (67%) and in transitional edge ecotone habitat between woodlands and open areas (22%), which provide

the relatively high humidity necessary for their survival. Fewer ticks are found in ornamental vegetation (9%) and lawn (2%).[84]

The *Tick Management Handbook*, CDC and other sources recommend that families create tick-safe zones in lawns and play areas around their homes - isolating these zones from tick habitat with a wood chip or gravel barrier of approximately 3 feet, and then increasing exposure to sun and air in those zones. The *Tick Management Handbook* notes that acceptable alternatives to lawn include butterfly gardens, vegetable gardens, formal herb gardens, colonial style gardens, wildflower meadows and hardscapes.[85]

These measures have been shown to reduce tick numbers on the subject property, with Alaska Yellow Cedar sawdust in particular impeding crossing by nymphal ticks.[86] However, a recent study showed them not to be significantly protective against Lyme disease[87] - and the *Tick Management Handbook* concludes that "landscape management alone may not reduce disease incidence, as the undetected bite of only one infected tick is required for transmission of *B. burgdorferi*."[88]

There is no real risk associated with this type of landscape management. The cost will vary depending on lot size and existing landscaping.

b) Replacing exotic invasives with native plants

No studies to date have directly correlated invasive plant prevalence with Lyme disease incidence - but multiple studies have shown that controlling invasive plants, especially Japanese barberry, helps to reduce both total tick numbers and infected tick numbers. Two Maine Medical Center Research Institute studies[89], and the *Tick Management Handbook*, indicate that blacklegged ticks are significantly more abundant in areas dominated by exotic invasive plants, particularly Japanese barberry, than areas dominated by native shrubs.[90] A 2010 Connecticut study indicates that control of Japanese barberry - either through cutting off the above-ground portion or using a flame treatment - "reduced the number of ticks infected with *B. burgdorferi* by nearly 60% by reverting microclimatic conditions to those more typical of native northeastern forests."[91]

Cost and labor involved in removing exotic invasives may range from little or nothing, to significant time and expense, depending on the number and size of plants on a property. Invasive removal alone may in some cases be sufficient for natives to return to the area - though in some cases, there may be cost and labor associated with acquiring and planting new natives.

Invasive plant removal carries no risk except for that associated with use of standard garden tools. The removal result carries no risk and many environmental benefits.

3. Host animal management and treatment

a) Background: blacklegged tick ecology

Ticks have four stages in their life cycle: egg, larva, nymph, and adult. At the larval, nymph, and adult life stages, they find and feed on a different animal host. According to the *Tick Management Handbook*, 98% of Lyme disease cases are associated with the bite of the nymphal stage of the blacklegged tick, of which 10-36% may carry Lyme disease.[92]

Ticks become infected with the *B. burgdorferi* bacteria that causes Lyme disease when they feed on a host that is a "reservoir", or source of infection. Larvae and nymphs feed on small animals - including mammals such as mice, chipmunks, and shrews; as well as birds, reptiles, and amphibians.[93] Adult ticks feed on medium-to-large mammalian hosts, including deer, raccoons, opossums, skunks, and foxes.[94]

According to the *Tick Management Handbook*, over 90% of adult blacklegged ticks feed on deer - and because the ticks each lay 3,000 eggs, deer are key to the reproductive success of the tick.[95] However, studies on the relationship between deer abundance and tick density have yielded mixed results - with some showing a strong relationship between deer abundance and tick density, and others showing no such linkage.[96]

Still more importantly, experts agree that deer do not infect feeding ticks with Lyme disease bacteria[97] - contrary to a misconception that arose from early studies, and was then perpetuated for many years by use of the non-scientific term “deer tick” to refer to the blacklegged tick.[98] In fact, research suggests that deer may even help to reduce incidence of Lyme disease. Deer have near-zero "reservoir competency", or likelihood of passing along the Lyme disease bacteria to the ticks that bite them. Thus, if more ticks attach to deer, and fewer attach to other animals with higher reservoir competency, infection may become less prevalent in the tick population.[99]

Some evidence suggests that tick abundance and Lyme disease prevalence may be determined more strongly by abundance of white-footed mice than by numbers of deer. However, according to leading Lyme disease researcher Richard Ostfeld, "inconspicuous hosts can sometimes be at least as important as the usual suspects, such as white-footed mice, that are the easiest to catch and inspect for ticks." Tick infection prevalence may not, in fact, be tightly linked to any one host species - and predicting how many infected nymphs will occur in any given time and place may require knowledge of the entire community of hosts rather than of only one or two species.[100] Not surprisingly, therefore, Lyme mitigation methods that target deer and mice, briefly reviewed below, have produced mixed results.

b) Deer-targeted methods

i. Controlled deer hunts

The *Tick Management Handbook* cited five studies from the 1980s through the early 2000s, describing geographically separated peninsulas and islands where controlled deer hunts totally or virtually eliminated deer populations - and a reduction in tick numbers soon followed. Two of these studies also indicated a reduction in human Lyme disease.[101] Such deer population elimination is infeasible on the mainland, however, because areas without deer are quickly recolonized by deer from neighboring areas.[102] Recent studies on the effects of mainland deer culling efforts have not shown deer population reduction to lead to declining disease incidence. A 2002-2005 New Jersey study published in 2007 in the Journal of Medical Entomology concluded: "There was no apparent effect of the deer culling program on numbers of questing *I. scapularis* subadults in the culling areas, and the overall numbers of host-seeking ticks in the culling areas seemed to increase in the second year of the program. The Lyme disease incidence rate generated by both passive and active surveillance systems showed no clear trend among years, and it did not seem to vary with declining deer density."[103] A Connecticut study co-authored by *Tick Management Handbook* author Kirby Stafford, published in 2011, analyzed Lyme disease cases in one community from 1992 to 2006, with case defined as a physician-diagnosed erythema migrans (EM) rash. This study concluded "we did not find a statistically significant effect of the deer hunt on EM rash incidence."[104]

The cost and labor associated with large-scale deer hunting is considerable. One study of a Princeton, New Jersey deer culling program found the cost per deer to equal $354.[105] Hunting carries the risk of unintentional killing or injury of people or of non-target animals, or unintentional destruction of property.[106]

ii. Deer exclusion

Richard Ostfeld summarizes the research on deer exclosures thus:

> "Several research groups have constructed deer exclosures to test the hypothesis that tick populations will be reduced where the host is excluded. The results have been striking in their inconsistency .... An intriguing synthesis of research on deer-exclosure impacts on ticks showed that small (~1 hectare) exclosures consistently increase tick abundances, whereas medium-sized exclosures (2-4 hectares) have no impact, and only those larger than about 4 hectares reduce tick populations .... In small exclosures, rodents can easily import ticks from the edges of surrounding unfenced areas into the interior of the exclosure, whereas in larger deer-free zones, tick importation declines in the interior .... It is critical to note that

> the threshold deer exclosure size of 1-2 hectares, or 2-4 acres, within which tick populations are likely to increase corresponds closely to the size of individual private properties that people are likely to surround with fences in order to reduce Lyme disease risk. Interestingly, whenever deer are eliminated, reduced by hunting, or excluded by fencing, the next several years sees an increase in the proportion of immature ticks that are infected with Lyme disease spirochetes. Apparently, many of those immature ticks that would have fed on deer instead feed on other hosts, such as small mammals. Because deer are highly unlikely to transmit a spirochete infection to feeding ticks, but many small mammals are quite likely to transmit infection, the result is an increase in tick infection rates."[107]

Deer exclosures create no risk, but require either many hours of labor or an investment of hundreds or even thousands of dollars on the part of a property owner.

iii. Deer acaricide treatment

The four-poster deer feeder has been the subject of multiple studies on treating deer with insecticide/acaricide to kill ticks. The device is constructed of two PVC posts that hold amitraz or permethrin-impregnated paint rollers vertically on either side of a trough filled with corn - and when deer come to feed, they rub their heads and necks against the rollers. A USDA-funded five-state study found a 71% reduction in blacklegged tick nymphs over a six-year period, and asserted on this basis that Lyme disease risk had been reduced.[108] The above-referenced 2011 Stafford et al. Connecticut study concluded that the four-poster device was "effective in decreasing the incidence of EM rash in an endemic area."[109]

The cost and labor involved in installing and maintaining four-poster deer feeders are, at least at this point, significant. The Fairfax County Virginia three-year pilot project involving 20 feeding stations is estimated to cost approximately $380,000, including personnel and operating expenses associated with purchase and maintenance of the treatment stations.[110]

There are also significant risks associated with four-poster deer feeders. The 10% permethrin formula registered with the EPA and most commonly used with these feeders compares with the 0.5% formulation in common aerosol sprays sold for use on clothing and gear - and the product label indicates that it is not to be used less than 100 yards from any place where children might be present without adult supervision. Another risk is unintentionally attracting other animals - for example, bears have been found at feeding stations in Fairfax County, in locations where they had not previously been seen for many years.[111]

c) Mouse-targeted methods

i. Lethal mouse control

Lethal control of mice is generally ineffective, as new populations of mice quickly move in to replace the mice that have been killed in a given location. According to the CDC, "During a study in Dutchess County, New York, all rodents were removed from a one-acre plot, but it was an enormous task. And, after the study was concluded, the rodent population rebounded within two months."[112]

In addition to being inhumane, lethal mouse control is also costly, and carries the risk that the lethal method may harm non-target animals.

ii. Mouse exclusion

The *Tick Management Handbook* and other sources recommend common-sense approaches to keeping mice away from the immediate perimeter of homes - such as sealing house foundations and stone walls near the home, moving firewood away from the house, and cleaning up spilled feed from bird feeders.[113] Such approaches carry no risk, and offer multiple benefits in addition to possible protection from Lyme disease.

iii. Mouse treatment

Damminix® tick tubes and SELECT TCS™ Tick Control System bait boxes are two commercially available devices for chemical treatment of mice and other rodents.

Damminix® Tick tubes are cardboard tubes of cottonballs treated with permethrin. Their effectiveness is dependent upon the mice collecting and using the cotton as nesting material. Although reductions in tick numbers were reported in two Massachusetts studies, subsequent research in Connecticut and New York showed no reduction in the number of infected, host-seeking blacklegged tick nymphs.[114]

One box of 24 tubes, sold online for approximately $70, is designed to cover 1/2 acre of land. The product label cautions "keep out of reach of children," and includes instructions to call a poison control center or doctor immediately if the product is ingested, or even comes in contact with skin or clothing. Given that the product design calls for placing the tubes around yards and gardens, it seems impractical to keep the product away from children. The label also warns that the product is extremely toxic to fish and other aquatic organisms, and should not be applied directly to water or to areas where surface water is present. [115]

SELECT TCS™ Tick Control System bait boxes attract mice and other small

mammals into a breadbox-sized plastic box, where an overhanging wick applies fipronil to their backs. Fipronil is the active ingredient in many companion animal flea and tick control products such as Frontline® - and according to the CDC, the amount of fipronil in the bait boxes is 10 times less than that found in products used on pets. A study of bait box use on a Connecticut island showed a substantial reduction in the prevalence of Lyme infection among mice, and also a substantial reduction in nymphal tick populations. The Connecticut Emerging Infections Program, the Connecticut Department of Public Health, Western Connecticut State University, and the Centers for Disease Control and Prevention are now conducting a study on the Connecticut mainland to investigate whether tick-borne diseases can be prevented with the use of bait boxes.[116]

The SELECT TCS website points to ProTech as the only certified installer of their bait boxes serving Loudoun County. Certified installers indicate that price is dependent on individual property and the number of boxes needed, and that the service is "comparable to a thorough pesticide application."[117]

Fipronil is highly toxic to many species of birds, fish, and aquatic invertebrates, and its toxicity to bees is a particular concern.[118] According to a news report on the current Connecticut study, there is not a direct path for the pesticide on rodents to reach honeybees, but "bumblebees could be affected because they often make their nests in abandoned mouse nests."[119]

d) Promotion of vertebrate biodiversity

Recent research on Lyme disease mitigation points to a whole new paradigm, suggesting that we should focus not on culling or excluding one or two specific species, but rather on fostering life for many species.

Literature from the Cary Institute for Ecosystem Studies explains the principle thus:

> "In forested landscapes of the eastern and central United States, the white-footed mouse is typically one of the most abundant vertebrates.... If a tick is born in a habitat that favors white-footed mice, and/or in a year of high mouse density, the tick has a high probability of obtaining its first blood meal from a mouse. Because a high percentage of white-footed mice carry the spirochete bacterium that causes Lyme, it is very likely the tick will be infected. When it molts from a larva into an infected nymph during the spring or summer, it will be dangerous to humans....When host diversity is high, there is a lower probability that ticks will feed on a white-footed mouse host. Larval ticks are less likely to become infected with *B. burgdorferi* when they feed on other vertebrate animals, such as chipmunks, lizards, or ground-dwelling birds. When ticks obtain their larval blood meal without becoming infected, they are not dangerous to humans when they feed as nymphs the following year."[120]

At the homeowner or property manager level, one way to promote vertebrate diversity is by replacing exotic invasive plants with natives, as discussed in item 2b above, and by restoring habitat diversity, health, and complexity. As entomologist Douglas W. Tallamy writes, "because animals directly or indirectly depend on plants for their food, the diversity of animals in a particular habitat is very closely linked to the diversity of the plants in that habitat."[121]

Some research shows that at the community planning level, a key way to promote vertebrate diversity and thereby reduce Lyme disease risk is to discourage land-use practices that fragment our forests. This is because forest fragmentation tends to favor a small number of species that are relatively likely to infect ticks, while reducing populations of other species that are unlikely to be infected with Lyme disease bacterium.[122]

4. Botanical products

Studies of botanical options have shown effectiveness in controlling ticks, though these studies have not specifically shown a reduction in Lyme disease incidence.

In a 2011 EPA conference presentation*, Tick Management Handbook* author Kirby Stafford summarized studies of five botanical tick control products: Mosquito Barrier, *Metarhizium anisopliae* F52, *Beauveria bassiana*, EcoEXEMPT IC2, and Nootkatone.

Mosquito Barrier is a garlic-based spray (99.3% garlic juice) which in 2009 and 2010 trials appeared to suppress or control blacklegged tick activity for 2-3 weeks.[123] The Mosquito Barrier website indicates that birds and bees are not harmed by garlic sprays, but cautions against spraying directly on butterflies.[124]

Metarhizium anisopliae F52, found in products such as Tick-Ex G, is a fungus. Applications of this product have provided 53-74% blacklegged tick control in tests. Evaluations to date have shown no adverse effects on human health or on birds or mammals. A study on the risk of this product to bees showed that when exposed to powder with 10^7 spores per gram, bees were not harmed. However, at higher levels (10^9 spores per gram) high toxicity to bees became evident.[125]

Beauveria bassiana is a fungus, which has provided 38-75% control of the blacklegged tick in tests. *Beauveria bassiana* has been shown to be harmful to bee populations.[126]

Rosemary oil-based EcoEXEMPT IC2, which has been replaced by Essentria IC3, was tested directly against bifenthrin and found to be similarly effective at reducing tick populations. Essentria IC3 is intended to target a wide range of arachnids and insects, including bees.[127]

Nootkatone, a component of essential oil in grapefruit peels, has been shown in multiple studies to achieve up to 100% control of blacklegged tick populations. Further study will be needed to determine the impact of Nootkatone on bees and other non-target species.[128]

In sum, while some of these products appear safer than their synthetic counterparts, some have already been shown to be toxic to non-target species, while the toxicity of others has not yet been adequately researched.

D. Recommended Alternatives and Next Steps

1. Highest efficacy, lowest toxicity, lowest cost

Promote Lyme prevention methods that best meet the three criteria of highest efficacy, lowest toxicity, and lowest cost.

As discussed in the Options and Alternatives section above, research to date indicates that these criteria are best met by using personal protective measures such as tick checks and wearing long sleeves and pants and light colors. DEET-based repellents and permethrin-treated clothing have also been shown to have high efficacy, and can reasonably be among promoted methods if their moderate toxicity risks are clearly communicated.

Limiting forest fragmentation, as part of our County's overall approach to development planning, may also be effective in reducing Lyme disease risk at the macro level.

2. Data collection, public information, and education

Emphasize the data collection, education, and communication points in the Loudoun Lyme Commission ten-point action.

a) Data collection

i. Begin tracking information about private sector pesticide spraying - starting, for example, by recording information about major homeowner association spraying actions, as discussed in section A5b above.

ii. Implement the concluding recommendations in the Loudoun County 2012 Lyme Disease Survey - especially, to conduct a broader survey including not only persons with known cases of Lyme disease, but also those not infected with Lyme disease and those who were diagnosed with Lyme disease but did not meet criteria to count as a case.

iii. Broaden the next survey with more balanced representation of non-white Hispanic citizens - an implied recommendation in the 2012 Lyme Disease Survey, is also worthy of citizen support.

b) Public Information

i. Update County informational materials, including online literature and the brochure "Ticks and Tick-Borne Diseases in Loudoun County." These materials should encourage citizens to use the personal protective measures and landscaping management techniques discussed above. These materials should also note that a) spraying chemicals such as permethrin carries toxicity risks, and has not been shown to reduce Lyme disease incidence, and b) tick ecology is more complex than originally believed, with many animals serving as hosts.

ii. Fully communicate to homeowner associations and homeowners the lack of evidence that pesticide spraying provides protection against contracting Lyme disease.

iii. Follow through with Point 6 of the ten-point plan, which called for working with local newspapers to place a series of monthly news articles during the first year, and quarterly articles thereafter, to keep the public up-to-date with advances in Lyme disease prevention and treatment. Periodic conferences such as the International Conference on Lyme Borreliosis and other Tick-Borne Diseases and the EPA-CDC Tick-Borne Disease IPM Conference, and research institutes such as the Cary Institute of Ecosystem Studies, are among possible sources of such information.[129]

c) Education

i. Follow through more proactively with Point 4 of the Loudoun Lyme 10-point plan, working with Loudoun County Public Schools to distribute educational materials and conduct educational activities regarding high-effectiveness, low-toxicity, low-cost Lyme prevention measures.

ii. Communicate with the Loudoun County School Board and Administration regarding risks of the chemical spraying that has recently been conducted on school grounds.

iii. Follow through more proactively with Point 5 of the 10-point plan, facilitating the formation of Lyme support groups in underserved geographic areas of the county. This may include expanding from the single page *Información sobre la enfermedad de Lyme en el Condado de Loudoun*, http://www.loudoun.gov/index.aspx?nid=2714, to a broader range of print resources in Spanish and other languages other than English.

3. Pesticide spraying conditions

a) Await scientific evidence of effectiveness in reducing Lyme disease incidence

Cease using public funds to spray for ticks on public lands, unless and until this method is shown in scientific studies to reduce Lyme disease incidence - vs. reducing total numbers of ticks or numbers of infected ticks.

If and when such spraying is under consideration, the following additional conditions should be met.

b) Channels for public notification and consultation must be provided

i. Schedule and announce Lyme Commission meetings in a manner that facilitates public attendance - e.g. schedule meetings during early evening hours, and adhere to meeting dates as published on the loudoun.gov calendar.

ii. Provide information for taxpayers regarding how remediation companies are selected, what chemicals are used in what volumes, the cost of spraying and associated actions, and data on the correlation between tick numbers and Lyme disease incidence.

iii. Publicly announce planned spraying actions weeks rather than days in advance.

c) Data collection and analysis must be rigorous

Any spraying action should be accompanied by a comprehensive plan for pre- and post-spray data collection and analysis, including:

i. Blacklegged tick abundance and infection rates in the location to be sprayed.
ii. Lyme disease incidence in relation to exposure to the locations to be sprayed.

4. Community organization support available

Loudoun Wildlife Conservancy and our co-signatory organization members conduct numerous public education programs for children and adults, which include instruction in practices that can help to prevent Lyme disease - from basic safety tips for outdoor activities, to native plant landscaping and creating diverse backyard wildlife sanctuaries. We stand ready to support the Loudoun Lyme Commission in rebalancing our County's approach to Lyme mitigation, by sharing information with our fellow citizens regarding the highest-effectiveness, lowest-toxicity, lowest-cost Lyme prevention methods currently known.

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