FINAL REPORT OF THE
SUFFOLK COUNTY TICK AND
VECTOR-BORNE DISEASES
TASK FORCE

Resolution # 689-2011

December 31, 2015

Suffolk County Dept. of Health Services
Dr. Scott Campbell, Chair
360 Yaphank Ave, Suite 2A
Yaphank, NY 11980
Phone 631-852-5255
Fax 631-852-4274
Email: scottc@suffolkcountyny.gov
Dear Interested Party,

This report is the result of the Suffolk County Tick and Vector-Borne Diseases Task Force (TVBDTF) and presents an overview of important topics and recommendations related to vector-borne diseases in Suffolk County, primarily tick-borne and mosquito-borne pathogens and associated diseases. The TVBDTF was created by the Suffolk County Legislature as Resolution #689-2011 to “study the spread of tick and vector-borne diseases, and to develop a comprehensive needs assessment for the County’s approach to this public health and safety issue” (Appendix A). The task force was comprised of 14 members selected as representatives for many entities associated with various aspects of vector-borne diseases. As required, the TVBDTF held a public meeting, which was in Southold on October 10, 2012 (Appendix B).

The TVBDTF was created subsequently to the Suffolk County Tick Management Task Force (TMTF) which provided recommendations and strategies to reduce the tick population and therefore, tick-related diseases in Suffolk County. The TMTF was created by the Suffolk County Legislature as Resolution #1123-2006 to “study the effects of the tick population and the spread of tick-related diseases, and to develop a comprehensive needs assessment for the County’s approach to this public health and safety issue” and the resulting TMTF final reports can be found in the Appendices C and D.

Vector-borne diseases and the associated pathogens are a significant human and veterinary concern impacting the health of humans and animals in Suffolk County and beyond. The pathogens are transmitted primarily through the bites of ticks and mosquitoes, and all efforts should be made to understand the pathogens, their vectors (e.g. ticks and mosquitoes) and the associated diseases. This knowledge allows for a better determination of the strategies for diagnosis and treatment, and the level of impact that these pathogens of public health importance have on the effected human or animal populations.

I would like to thank all task force members for serving on the task force and providing input and considerable effort to generate the following report. Our hope is that it provides insight and guidance regarding tick and vector-borne diseases in Suffolk County.

Most sincerely,

Scott R. Campbell, PhD
SCDHS, Chair of TVBDTF
Task Force Members

Dr. Scott Campbell, PhD, Chair
Representative for the Commissioner of the Suffolk County Department of Health Services
Chief, Arthropod-Borne Disease Laboratory

Dr. Benjamin Luft, MD*
Representative for Suffolk County Executive
Department of Medicine, SUNY at Stony Brook

Ms. Janalyn Travis-Messer
Representative for the Presiding Officer of the Suffolk County Legislature

Ms. Patricia Shillingburg
Chair, Shelter Island Deer and Tick Committee

Dr. Timothy Green, PhD
Representative for Brookhaven National Laboratory
Cultural & Natural Resource Manager

Mr. Dan Gilrein, MS
Representative for Suffolk County Cornell Cooperative Extension
Extension Entomologist

Dr. George Ruggiero, DO*
Representative for Suffolk County Medical Society
Vice President, SCMS, Sound Family Medicine

Dr. Sunil Sood, MD*
Representative for Suffolk County Pediatric Society
Chairman of Pediatrics, Southside Hospital

Dr. Diana Teta, PhD*¹
Representative for Suffolk County Psychological Association

Ms. Carolyn DeFigueroa, RN*
Representative for the Professional Nurses Association of Suffolk County

Dr. Anthony Capobianco, DO*
Representative for the Homeopathic Medical Society of the State of NY

Ms. Eva Haughie²
Representative for the Empire State Lyme Disease Association
President, Empire State Lyme Disease Association

Dr. Dennis Dougherty, DVM
Representative for the New York State Veterinary Medical Society, Inc.

Non-Voting Members

Ms. Joyce Rodler
Representative for the New York State Department of Environmental Conservation
Regional Pesticide Program Manager, Region One

Mr. Vincent Palmer (retired January 2013)
Representative for the New York State Department of Environmental Conservation

¹ Dr. Diana Teta passed away in the summer of 2014
² Ms. Eva Haughie resigned November 2015
*Member of the Medical Team regarding authorship of Chapters 4 and 5
I am extremely grateful to Emily Johnson and Chris Romano of the ABDL for their significant efforts on this report. With their contribution and expertise, the report is much improved and contains superior maps, figures and tables. I am very appreciative to Michele Carruthers for assistance with editing the final draft, Ralph Narain for the seasonal tick activity figures and Grace McGovern (DHS ABDL) for her artistic efforts on the title page. Also, I am truly grateful to Grace Kelly-McGovern (DHS Public Relations Director) and Lori Benincasa (Director, DHS Prevention Education & Training, Health Services) for their review and comments of the Education chapter. In addition, I am very thankful to Dr. Erin McGintee, MD (ENT and Allergy Associates, LLP) for her expertise and assistance with the alpha-gal allergy section. The review and comments provided by Christopher Sortino (SCDHS) are very much appreciated.

Scott R. Campbell, PhD
Chief, Arthropod-Borne Disease Laboratory
Suffolk County Department of Health Services
### List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABDL</td>
<td>Arthropod-Borne Disease Laboratory (Suffolk County)</td>
</tr>
<tr>
<td>AKA</td>
<td>Also known as</td>
</tr>
<tr>
<td>ARDS</td>
<td>Acute respiratory distress syndrome</td>
</tr>
<tr>
<td>ASPCA</td>
<td>American Society for the Prevention of Cruelty to Animals</td>
</tr>
<tr>
<td>BNL</td>
<td>Brookhaven National Laboratory</td>
</tr>
<tr>
<td>CAC</td>
<td>Suffolk County Properties Community Advisory Committee</td>
</tr>
<tr>
<td>CAPC</td>
<td>Companion Animal Parasite Council</td>
</tr>
<tr>
<td>CDC</td>
<td>Centers for Disease Control</td>
</tr>
<tr>
<td>CDESS</td>
<td>Communicable Disease Electronic Surveillance System</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations</td>
</tr>
<tr>
<td>CME</td>
<td>Continuing Medical Education</td>
</tr>
<tr>
<td>CSF</td>
<td>Cerebrospinal fluid</td>
</tr>
<tr>
<td>DFW&amp;MR</td>
<td>New York State Department of Environmental Conservation, Division of Fish, Wildlife, and Marine Resources</td>
</tr>
<tr>
<td>DFW&amp;MR</td>
<td>Division of Fish, Wildlife, and Marine Resources</td>
</tr>
<tr>
<td>DHF</td>
<td>Dengue hemorrhagic fever</td>
</tr>
<tr>
<td>DPW</td>
<td>Suffolk County Department of Public Works</td>
</tr>
<tr>
<td>DS&amp;HM</td>
<td>New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials</td>
</tr>
<tr>
<td>DTV</td>
<td>Deer Tick virus</td>
</tr>
<tr>
<td>DVBD</td>
<td>Division of Vector Borne Disease</td>
</tr>
<tr>
<td>ECL</td>
<td>Environmental Conservation Law of New York State</td>
</tr>
<tr>
<td>EEE</td>
<td>Eastern equine encephalitis</td>
</tr>
<tr>
<td>EGG</td>
<td>Electroencephalography</td>
</tr>
<tr>
<td>EIA</td>
<td>Enzyme immunoassay</td>
</tr>
<tr>
<td>ELISA</td>
<td>Enzyme-linked immunosorbent assay</td>
</tr>
<tr>
<td>EM</td>
<td>Erythema migrans</td>
</tr>
<tr>
<td>FDA</td>
<td>US Food and Drug Administration</td>
</tr>
<tr>
<td>FIFRA</td>
<td>Federal Insecticide, Fungicide, and Rodenticide Act</td>
</tr>
<tr>
<td>FLIR</td>
<td>Forward looking infrared radar</td>
</tr>
<tr>
<td>GH</td>
<td>Gonadotropic Hormones</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
</tr>
<tr>
<td>GNRH</td>
<td>Gonadotropic Releasing Hormone</td>
</tr>
<tr>
<td>HGA</td>
<td>Human Granulocytic Anaplasmosis (formerly human granulocytic ehrlichiosis)</td>
</tr>
<tr>
<td>HGE</td>
<td>Human Granulocytic Ehrlichiosis - see HGA</td>
</tr>
<tr>
<td>HME</td>
<td>Human monocytic ehrlichiosis</td>
</tr>
<tr>
<td>IDSA</td>
<td>Infectious Diseases Society of America</td>
</tr>
<tr>
<td>IFA</td>
<td>Immunofluorescence assay</td>
</tr>
<tr>
<td>IgG</td>
<td>Immunoglobulin G</td>
</tr>
<tr>
<td>IgM</td>
<td>Immunoglobulin M</td>
</tr>
<tr>
<td>IHC</td>
<td>Immunohistochemical</td>
</tr>
<tr>
<td>ILADS</td>
<td>International Lyme and Associated Diseases Society</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated pest management</td>
</tr>
<tr>
<td>KBUSLRL</td>
<td>Knipling-Bushland U.S. Livestock insects Research Laboratory</td>
</tr>
<tr>
<td>MEL</td>
<td>Culiseta melanura</td>
</tr>
<tr>
<td>MIA</td>
<td>Micsphere-based immunoassay</td>
</tr>
<tr>
<td>MMWR</td>
<td>Morbidity and Mortality Weekly Report</td>
</tr>
<tr>
<td>NEATCP</td>
<td>Northeast Area-Wide Tick Control Project</td>
</tr>
<tr>
<td>NIH</td>
<td>National Institute of Health</td>
</tr>
<tr>
<td>NPIC</td>
<td>National Pesticide Information Center</td>
</tr>
<tr>
<td>NYS Ag &amp; Mkts</td>
<td>NYS Agriculture and Markets</td>
</tr>
<tr>
<td>NYCC</td>
<td>New York Codes, Rules and Regulations</td>
</tr>
<tr>
<td>NYSDEC</td>
<td>New York State Department of Environmental Conservation</td>
</tr>
<tr>
<td>NYSDOH</td>
<td>New York State Department of Health</td>
</tr>
<tr>
<td>NYSDOT</td>
<td>New York State Department of Transportation</td>
</tr>
<tr>
<td>NYSSPRHP</td>
<td>New York State Office of Parks, Recreation and Historic Preservation</td>
</tr>
<tr>
<td>NYSPAD</td>
<td>New York State Pesticide Administration Database</td>
</tr>
<tr>
<td>OLE</td>
<td>Oil of lemon eucalyptus</td>
</tr>
<tr>
<td>PCR</td>
<td>Polymerase chain reaction</td>
</tr>
<tr>
<td>PER</td>
<td>Coquillettia perturbans</td>
</tr>
<tr>
<td>PRN</td>
<td>Pesticide Registration Notice</td>
</tr>
<tr>
<td>PHF</td>
<td>Potomac horse fever</td>
</tr>
<tr>
<td>PHIN</td>
<td>Public Health Information Network</td>
</tr>
<tr>
<td>PIMS</td>
<td>Product, Ingredient, and Manufacturer System</td>
</tr>
<tr>
<td>PIP</td>
<td>Culex pipiens</td>
</tr>
<tr>
<td>PMID</td>
<td>Para-methane-3,8-diol</td>
</tr>
<tr>
<td>PMEP</td>
<td>Pesticide Management Education Program</td>
</tr>
<tr>
<td>POWV</td>
<td>Powassan virus</td>
</tr>
<tr>
<td>PRE</td>
<td>Culex pipiens-restuans</td>
</tr>
<tr>
<td>PRNF</td>
<td>Plaque reduction neutralization test</td>
</tr>
<tr>
<td>PZP</td>
<td>Porcine zona pellucida</td>
</tr>
<tr>
<td>QUA</td>
<td>Anopheles quadrimaculatus</td>
</tr>
<tr>
<td>RAMP/ADAPTCO</td>
<td>Rapid Analyte Measurement Platform</td>
</tr>
<tr>
<td>RMSF</td>
<td>Rocky Mountain spotted fever</td>
</tr>
<tr>
<td>RT-PCR</td>
<td>reverse transcriptase-polymerase chain reaction</td>
</tr>
<tr>
<td>SCCCE</td>
<td>Suffolk County Cornell Cooperative Extension</td>
</tr>
<tr>
<td>SCDHS</td>
<td>Suffolk County Department of Health Services</td>
</tr>
<tr>
<td>SCDPW-DVC</td>
<td>Suffolk County Department of Public Works, Division of Vector Control</td>
</tr>
<tr>
<td>SEORA</td>
<td>State Environmental Quality Review Act</td>
</tr>
<tr>
<td>SLN</td>
<td>Special local need registration</td>
</tr>
<tr>
<td>STARI</td>
<td>Southern tick-associated rash illness</td>
</tr>
<tr>
<td>TCS</td>
<td>Tick Control System</td>
</tr>
<tr>
<td>TESS</td>
<td>Toxic Exposure Surveillance System</td>
</tr>
<tr>
<td>USDA-ARS</td>
<td>US Department of Agriculture, Agricultural Research Service</td>
</tr>
<tr>
<td>USDI-NPS-FINS</td>
<td>United States Department of the Interior, National Park Service, Fire Island National Seashore</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>USPHC</td>
<td>United States Public Health Service</td>
</tr>
<tr>
<td>VEE</td>
<td>Venezuelan equine encephalitis</td>
</tr>
<tr>
<td>WEE</td>
<td>Western equine encephalitis</td>
</tr>
<tr>
<td>WNV</td>
<td>West Nile virus</td>
</tr>
</tbody>
</table>
# Table of Contents

Table Force Members ........................................................................................................... 2
Acknowledgments .................................................................................................................. 3
List of Acronyms ..................................................................................................................... 4
Table of Contents .................................................................................................................. 5

## CHAPTER 1: TICK BIOLOGY AND ECOLOGY ................................................................. 7

I. INTRODUCTION ............................................................................................................. 7

II. TICK BIOLOGY AND ECOLOGY ................................................................................ 8

III. TICKS IN SUFFOLK COUNTY .................................................................................. 9

IV. TICK AND TICK-BORNE PATHOGEN SURVEILLANCE ............................................. 13

V. LARVAL LONE STAR Ticks VERSUS CHIGGERS ....................................................... 13

VI. TICK ID SERVICES .................................................................................................... 14

VII. RECOMMENDATIONS .............................................................................................. 14

VIII. REFERENCES ........................................................................................................... 15

## CHAPTER 2: TICK HOST AND HABITAT MANAGEMENT ............................................. 16

I. INTRODUCTION ............................................................................................................ 16

II. DEER ............................................................................................................................ 16

III. MICE AND OTHER SMALL MAMMALS ................................................................... 22

IV. WILD TURKEY AND MIGRATORY BIRDS ................................................................. 22

V. RECOMMENDATIONS ................................................................................................. 23

VI. REFERENCES .............................................................................................................. 24

## CHAPTER 3: TICK MANAGEMENT AND PERSONAL PROTECTION ............................. 25

I. INTRODUCTION ............................................................................................................ 25

II. HUMAN AND PET PROTECTION .................................................................................. 26

III. WEBSITES WITH ADDITIONAL INFORMATION ......................................................... 30

IV. OUTDOOR BROADCAST SPRAYS .............................................................................. 31

V. HOST-TARGETED TECHNOLOGIES .......................................................................... 32

VI. REGISTERED PESTICIDE PRODUCTS ..................................................................... 37

VII. MINIMUM RISK PESTICIDES AND BIOPESTICIDES ............................................ 38

VIII. LAWS, RULES, AND REGULATIONS ..................................................................... 40

IX. RECOMMENDATIONS ............................................................................................... 40

X. REFERENCES .............................................................................................................. 42

## CHAPTER 4: TICK-BORNE DISEASES OF HUMANS ..................................................... 44

I. INTRODUCTION ............................................................................................................ 44

II. REPORTABLE AND NOTIFIABLE CONDITIONS ......................................................... 44

III. DIAGNOSIS AND PREVENTION .............................................................................. 46

IV. ANAPLASMOSIS .......................................................................................................... 47

V. BABESIOSIS .................................................................................................................. 51
VI. EHRlichiosis ........................................................................................................55
VII. Lyme Disease ....................................................................................................59
VIII. Rocky Mountain Spotted Fever .....................................................................63
IX. Tularemia ........................................................................................................... 67
X. Emerging Diseases .............................................................................................71
XI. Recommendations ............................................................................................80

CHAPTER 5: Mosquito-Borne Diseases of Humans ....................................................82
I. Introduction ..........................................................................................................82
II. West Nile Virus ...................................................................................................83
III. Eastern Equine Encephalitis .............................................................................87
IV. Malaria ...............................................................................................................89
V. Dirofilariasis .......................................................................................................94
VI. Emerging Mosquito-Borne Diseases .................................................................95
VII. Mosquito Surveillance and Control .................................................................103
VIII. Personal Protection .........................................................................................105
IX. Recommendations ............................................................................................105

CHAPTER 6: Tick and Vector-Borne Diseases of Animals .......................................107
I. Introduction ..........................................................................................................107
II. Eastern Equine Encephalitis .............................................................................108
III. West Nile Virus ................................................................................................111
IV. Heartworm .........................................................................................................114
V. Anaplasmosis .......................................................................................................118
VI. Anaplasmosis in Cattle .....................................................................................121
VII. Canine Babesiosis ............................................................................................122
VIII. Canine Ehrlichiosis .........................................................................................123
IX. Lyme Disease in Animals .................................................................................125
X. Potomac Horse Fever ........................................................................................128
XI. Rocky Mountain Spotted Fever ......................................................................129
XII. Incidence and Reporting ................................................................................130
XIII. Prevention .......................................................................................................131

CHAPTER 7: Education .............................................................................................132
I. Introduction ..........................................................................................................132
II. Educational Programs and Resources ...............................................................132
III. Who Needs to Be Educated ..............................................................................137
IV. Recommendations ............................................................................................137

CHAPTER 8: The Future: Collaboration and Funding ...............................................139
I. INTRODUCTION

In Suffolk County, there are three tick species that are of public health importance, and are responsible for the transmission of a variety of tick-borne pathogens (Table 1). These three species are the blacklegged tick (AKA deer tick, *Ixodes scapularis*), the lone star tick (*Amblyomma americanum*), and the American dog tick (*Dermacentor variabilis*).

There are four stages of a tick life cycle: the egg, the larva (plural larvae), the nymph, and the adult (male and female) (Figure 1). The larval, nymphal and adult stages actively quest or search for hosts (e.g. mammals, birds, humans) for blood feeding or reproduction. For all tick species, the larva, nymph, and adult female require blood meals for development to the next life-cycle stage (i.e. larva and nymph) or egg production (i.e. adult female). The adult male doesn’t take a blood meal but mates with the female on the host. In Suffolk County, this tick life cycle typically takes two years.

Ticks are capable of acquiring human pathogens (i.e. bacteria, viruses or protozoa) from an infected host (i.e. reservoir host) during the blood meal. These pathogens enter the tick gut during feeding and if the particular tick species is a competent vector for the pathogen ingested, the tick will be able to pass it to the next host in the subsequent blood meal.
Table 1. **Medically Important Tick Species of Suffolk County and Primary Associated Pathogens and Diseases**

<table>
<thead>
<tr>
<th>Primary Habitat</th>
<th>Blacklegged Tick (AKA Deer Tick)</th>
<th>Lone Star Tick</th>
<th>American Dog Tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Hosts - Larvae, Nymphs</td>
<td>Woodlands</td>
<td>Woodlands, Disturbed or Second-Growth Vegetation</td>
<td>Grassy Fields</td>
</tr>
<tr>
<td>- Adults</td>
<td>Deer, Medium-Sized Mammals</td>
<td>White-Tailed Deer</td>
<td>Foxes, Dogs, Medium-Sized Mammals</td>
</tr>
<tr>
<td>Tick-Borne Pathogen, Disease</td>
<td><strong>Borrelia burgdorferi</strong></td>
<td><strong>Ehrlichia chaffeensis</strong></td>
<td><strong>Rickettsia rickettsii</strong></td>
</tr>
<tr>
<td></td>
<td>Lyme Disease</td>
<td>Human Monocytic Ehrlichiosis (HME)</td>
<td>Rocky Mountain Spotted Fever (RMSF)</td>
</tr>
<tr>
<td></td>
<td><strong>Anaplasma phagocytophilum</strong></td>
<td><strong>Borrelia lonestari</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Human Granulocytic Anaplasmosis</td>
<td>Southern Tick Associated Rash Illness (STARI)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(HGA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Babesia microti</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Babesiosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Animal Reservoir</td>
<td>White-Footed Mouse</td>
<td>White-Tailed Deer</td>
<td>Meadow Vole</td>
</tr>
</tbody>
</table>

**II. TICK BIOLOGY AND ECOLOGY**

**Life Cycle**

![Life Cycle of Blacklegged Tick (Ixodes scapularis)](http://www.cdc.gov/lyme/transmission/blacklegged.html)

The ticks listed have a three host life cycle that lasts approximately 2 years (Figure 1). In the summer on Long Island, blacklegged tick larvae feed on small rodent hosts. In the following spring they molt into nymphs, and then
feed a second time, also typically on rodents or other small mammals. In the fall, the nymphs molt into adults and take their third blood meal from and mate on larger mammals such as deer, fox, raccoons, etc. Humans are potential hosts for all life stages of blacklegged and lone star ticks. Only adult American dog ticks will bite humans (CDC 2013).

III. TICKS IN SUFFOLK COUNTY

Blacklegged Ticks

![Blacklegged Tick (Ixodes scapularis)](http://www.cdc.gov/ticks/tickbornediseases/tickid.html)

Figure 2.  [http://www.cdc.gov/ticks/tickbornediseases/tickid.html](http://www.cdc.gov/ticks/tickbornediseases/tickid.html)

Geographic Distribution of the Blacklegged Tick

![Geographic Distribution of the Blacklegged Tick](http://www.cdc.gov/ticks/geographic_distribution.html)

Figure 3.  [http://www.cdc.gov/ticks/geographic_distribution.html](http://www.cdc.gov/ticks/geographic_distribution.html)
The blacklegged tick (*Ixodes scapularis*) (Figure 2) is primarily responsible for the transmission of *Borrelia burgdorferi* which causes Lyme disease in the eastern US (Figure 3). They also transmit Powassan virus, *Babesia microti* and *Anaplasma phagocytophilum*. Blacklegged ticks are abundant in Suffolk County, and generally reside at the edges of forests, in leaf litter, and in residential shrubbery (Sonenshine, 1993). They take blood meals at all life stages, and are active throughout the year. Adults can be active in fall and winter when the temperatures are above 40°F (Duffy & Campbell, 2015) (Figure 4). All three stages feed on humans, and pathogens are typically acquired after feeding on the white-footed mouse. Nymphs and adult females are most likely to transmit pathogens to humans, but due to their small size, nymphs are more likely to go unnoticed long enough to transmit *Borrelia burgdorferi*, the pathogen that causes Lyme disease (Faiman et al., 2014) as well as other pathogens such as *Babesia microti*.

**American Dog Tick**

*American Dog Tick (Dermacentor variabilis)*

[Images of tick life stages]

Figure 5. [http://www.cdc.gov/ticks/tickbornediseases/tickid.html](http://www.cdc.gov/ticks/tickbornediseases/tickid.html)
The American dog tick (*Dermacentor variabilis*) (Figure 5) is primarily responsible for transmitting *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever. Larvae and nymphs feed exclusively on rodents, primarily meadow voles, and adults feed on humans and medium-sized mammals (e.g. fox, dogs). Larval and nymphal ticks acquire the *Rickettsia rickettsii* from feeding on infected meadow voles or larvae can emerge from the egg infected with the pathogen (i.e. transovarial transmission). This species is most active in the spring and summer (Figure 7). They can be found along forest edges, fields and coastal grasslands (Fairman et al., 2014; Benach et al., 1977). Due to ecological changes in Suffolk County over the past several decades (e.g. development of residential communities and secondary forest growth), the environment has become less likely to support the life cycle of the American dog tick.
Lone Star Tick

Lone Star Tick (Amblyomma americanum)

Figure 8. Lone Star Tick [http://www.cdc.gov/ticks/tickbornediseases/tickid.html]

Geographic Distribution of the Lone Star Tick

Figure 9. [http://www.cdc.gov/ticks/geographic_distribution.html]

Activity of Lone Star Tick (Amblyomma americanum)

Figure 10. Activity of Lone Star Tick (Amblyomma americanum)
The lone star tick (Amblyomma americanum; Figure 8) is an aggressive tick that feeds off a variety of birds, reptiles, and mammals, including deer, turkey, and humans. They can “pursue” their hosts by travelling up to 70 feet toward a potential host. They thrive in areas with forest and scrub brush, and the Pine Barrens make an ideal habitat. All stages (i.e. larvae, nymphs and adults) will bite humans. Lone star ticks can be found in large numbers. When this occurs they can impact quality of life around homes and outdoor environments such as parks. This tick species also is responsible for transmitting Ehrlichia chaffeensis and is associated with STAR. Their bite can cause intense irritation and itching.

For a comprehensive look at ticks of the Northeastern US, their associated diseases, personal protection, tick management and control of ticks, please see Appendix E.

IV. TICK AND TICK-BORNE PATHOGEN SURVEILLANCE

The amount of information regarding tick-borne pathogens found in Suffolk County is limited and emphasizes the need to better understand this topic.

A 2010 study found a Borrelia burgdorferi infection rate of 59.6% and 45.8% for Ixodes scapularis adults and nymphs, respectively, from New York State (Crowder et al., 2010). In a 2004 study, 59 of 473 adult Amblyomma americanum ticks and 8 of 113 pools of 5 nymphs from Suffolk County each contained Ehrlichia chaffeensis (Mixson et al., 2004). In a 2006 study analyzing Amblyomma americanum ticks from 29 sites in nine states (including New York), infection rates were found to be 4.7% for Ehrlichia chaffeensis, 3.5% for Ehrlichia ewingii, 2.5% for Borrelia lonestari and 41.2% for Rickettsia amblyommii. Additionally, 4.3% of ticks analyzed were found to be infected with two or more bacteria (Mixson et al., 2006). In a 2013 study from New York’s Hudson Valley, the deer tick virus (AKA Powassan virus lineage II) infection rate was approximately 0.2 to 6% for Ixodes scapularis ticks (Dupuis et al., 2013). Powassan virus has also been detected in Suffolk County (Tokarz et al., 2010).

Coinfections, simultaneously being infected by multiple pathogens, must be taken into consideration when dealing with tick-borne pathogens. Ixodes scapularis ticks, for example, are able to transmit the pathogens which cause babesiosis and anaplasmosis, in addition to Borrelia burgdorferi. The chance of coinfection varies from 1 to 28%, depending on location. Anaplasmosis is the most common coinfection with Lyme disease, occurring in 4 to 45% of Lyme disease infections, with babesiosis occurring in 2 to 12% of Lyme disease infections (Swanson et al., 2006).

V. LARVAL LONE STAR TICKS VERSUS CHIGGERS

During the mid to late summer, the ABDL receives complaints from residents about “chigger bites”. It is believed that these bites are primarily, if not exclusively, the result of larval lone star ticks and not chiggers. Chiggers are larval trombicular harvest mites. Let’s compare the facts:

Larval Lone Star Ticks (Amblyomma americanum):

- Found in Suffolk; rare in Nassau
- Larvae have 6 legs, 0.2 mm in size
- Typically become active in July or August into October
- No moist environment needed
- One emergence per season
- Attach and inject saliva into the bite which causes irritation
- Does not crawl under the skin
- Feed on many host including humans, deer, raccoons, squirrels, birds

Trombicular harvest mites or chiggers (Trombiculidae)
- Larval stage of harvest mites (AKA red mites, red bugs)
- Primarily *Eutrombicula alfreddugesi* (*Trombicula alfreddugesi*)
- 6 legs, 0.18mm in size
- Have not been reported in Suffolk County
- Can become active in spring after a rain event
- Need a moist environment
- Multiple cycles per season (up to 3 in temperate areas)
- Inject digestive enzymes into the skin which causes irritation
- Does not crawl under the skin
- Feed on various hosts including humans, rabbits, squirrels, quail

This evidence that the complaints of “chigger bites” are caused by larval lone star tick and not chigger mites is mostly circumstantial but very compelling. The evidence is:
- Larval lone star ticks are active in late July to October, chiggers are active from spring until fall
- All public complaints of bites to the ABDL have been when larval lone star ticks are active and never in the spring when harvest mites should be active
- Since 1991, ABDL staffers have conducted field work countywide and have never found any harvest mites or chiggers within Suffolk County
- All specimens provided to the ABDL by Suffolk County residents thought to be “chiggers” have been larval lone star ticks; no one has ever provided a chigger sample
- Approximately 24 samples provided by Quality Parks (2005) from complaint areas were lone star tick larvae
- Complaints of “chigger bites” began on the South Fork in the 1990’s and have been moving westward with the expanding lone star tick population

**VI. TICK ID SERVICES**

Tick identification services are available to health care providers and the public through SCDHS Arthropod-Borne Disease Laboratory, Cornell Cooperative Extension, and Cornell University.

- The Suffolk County Department of Health Services’ Arthropod-Borne Disease Laboratory, provides no cost tick identification services. Specimens can be mailed or delivered to the lab located at 335 Yaphank Avenue, Yaphank or photos can be emailed to php@suffolkcountyny.gov.
- Cornell Cooperative Extension has diagnostic labs in Riverhead and Great River, which, for a small fee, will identify the species of tick. CCE does not test the ticks for diseases. Their submission form is available here: https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/4610/Submission_Form_Tick_Identification.pdf?1416326372. More information about their services can be seen here: http://ccesuffolk.org/agriculture/horticulture-diagnostic-labs.
- Cornell University provides tick identification and disease testing for a fee: https://ahdc.vet.cornell.edu/docs/General_Submission_Form.pdf; for veterinarians https://ahdc.vet.cornell.edu/docs/Non_Vet_Tick_Submission_Form.pdf; for the public https://ahdc.vet.cornell.edu/sects/paras/tickID.cfm#humans; for more information

**VII. RECOMMENDATIONS**

- Survey Suffolk County tick populations in order to evaluate tick density and population ranges.
- Create a countywide tick-borne pathogen surveillance program to better understand pathogens present in tick populations and the related public health risk to county residents.
- Be prepared to recognize and respond to new tick species or newly introduced or identified tick-borne pathogens.

VIII. REFERENCES


Medically important ticks of Suffolk County utilize a variety of hosts to complete their life cycles. In general, at least two host species are utilized during the life cycle of a tick. The first host is typically a small mammal like a mouse, vole, or other rodent that is used by the larvae. The second host may be a small mammal to large mammal or large ground nesting bird (e.g. wild turkey (*Meleagris gallopavo*)). In many instances the white-tailed deer (*Odocoileus virginianus*) is the host. Other hosts of ticks include small and medium sized mammals (mice, voles, chipmunks, and squirrels), turkey, geese, and migratory birds.

**II. DEER**

**Deer, ticks, tick-borne diseases**

White-tailed deer (*Odocoileus virginianus*) are found across Suffolk County’s natural areas but are also found in its residential communities. White-tailed deer are often reported as the primary host for several species of ticks, including the lone star tick (*Amblyomma americanum*) and the blacklegged tick (*Ixodes scapularis*). Hence, Long Island’s burgeoning populations of deer have greatly contributed to increased abundance and geographic distribution of ticks (Means & White, 1997; Wilson et al., 1990).

Studies have also documented that deer can serve as a reservoir for disease-causing agents. Specifically, white-tailed deer serve as a reservoir for *Ehrlichia chaffeensis* (Lockhart et al., 1997), the etiologic agent of human monocytic ehrlichiosis. Thus, deer provide a way of maintaining and spreading ehrlichiosis, a now relatively common disease, throughout Long Island. Deer apparently play no role in infecting the tick *I. scapularis* with
Borrelia burgdorferi (Lyme disease) or Babesia microti Franca (human babesiosis) (Piesman et al., 1979; Levine et al., 1985; Telford et al., 1988).

Deer Biology
Deer are prolific breeders. Each adult female (doe) can begin reproducing when they are less than one year old, giving birth to one to three fawns each year. Deer are also indiscriminate breeders. A single male, given the opportunity, will breed with all available females. On Long Island, deer rut (breeding) occurs twice a year – in the beginning of November and again 28 days later. If only male deer (bucks) are taken from the resident population, deer numbers will continue to grow. Unchecked, wild deer populations can double in size every two years. In order to control deer population numbers, female as well as male deer must be removed from the population. It is widely reported that about 40% of the adult does must be taken each year to keep deer numbers stable in most of southern and western New York. Conservatively, there are between 15 – 20,000 deer in Suffolk County. Approximately 3,000 deer are currently taken by recreational hunters each year in Suffolk County. Several thousand additional deer are taken through nuisance permits issued under the NY State Department of Environmental Conservation’s Deer Management Assistance Program. At the upper end of the population estimate, at least 8,000 deer per year must be taken to maintain a static population and a higher number must be taken to begin reducing the population. Certain communities on the eastern end of Suffolk County are being somewhat successful at population reductions through long term efforts. In order to make deer population management effective a good understanding of the number of deer in Suffolk County would be needed. There is no one method of estimating deer that is known to be highly accurate for determining population. More important is consistency of the methodology in order to compare numbers. Additionally, deer density is more important than deer population. Estimation of population or density could be achieved through an aerial assessment of the deer population using Forward Looking Infrared Radar (FLIR).

Several studies suggest that the size of the tick population is a function of the size or density of the white-tailed deer population, and that reducing deer densities could be a method of tick control (Wilson et al., 1990). Wilson et al. (1990) specifically stated that locally intensive removal of deer, deer fencing, or repellants could feasibly be used to reduce the number of vector ticks in suburban yards, parks and recreational sites, hence reducing the public’s risk of associated disease. Ginsburg and Zhioua (1999) suggest that simply lowering deer populations will only result in more ticks on fewer deer. Ticks have been nearly eliminated on Monhegan Island off the coast of Maine through elimination of the deer population (Rand, P.W. et al., 2004). Kilpatrick, et al, (2014) documented the reduction of ticks and lowering the incidence of Lyme disease in a Connecticut community through concerted reduction in the deer population to ~13 per sq. mi. resulted in a 76% reduction in tick abundance and an 80% reduction in resident-reported cases of Lyme disease. This would be a near impossible feat for Long Island and is neither desirable nor achievable. However, localized population reduction is possible. Growing data and evidence suggests that large scale reduction in deer populations to less than 10 per square mile over extended periods of time is likely necessary to effect significant tick reduction. However deer population management concurrent with localized tick management may be effective. Some form of management is needed to stabilize Long Island’s deer population.
Deer and vehicle accidents
It seems that car accidents with deer are becoming common in areas with large deer populations, although there is no clear link between deer population numbers and vehicle damage. According to the Department of Motor Vehicles (2002-2006), there have been approximately 10,000 deer-related accidents per year in New York where damage exceeds $1,000 or an accident resulted in serious injury or death. Since 1990, an average of three people died each year in New York due to deer-vehicle collisions (more than 54 people since 1990). One-third of the deaths were those on motorcycles. Accidents are more likely from mid-September to late November and a smaller spike occurs in May-June. Deer are most active during dawn and dusk and have predictable daily routines to and from feeding and bedding areas. The NYSDOT and some towns and counties keeps records of the carcasses collected.

Deer and ecosystem effects
Deer overpopulation harms natural ecosystems. Deer are selective browsers, targeting specific plant species to eat. In high deer density areas, deer browsing prevents the regeneration of forests as deer eat nearly all the tree seedlings, destroy forest understory plants, and reduce overall species richness. For example, studies have shown that the 2,039 acre-Mashomack Preserve on Shelter Island is changing from an oak-dominated forest to favoring more maples. In some natural areas, the understory of the forest is almost nonexistent due to over browse, negatively affecting birds and other animals that use that vegetation for food and cover. Several studies found that deer browsing significantly reduces songbird numbers by destroying their habitats.

Deer and agriculture
Growers on Long Island continue to be concerned with agricultural damage due to deer. According to a report by the Human Dimensions Research Unit, statewide agricultural damage by deer is estimated to be $58.8 million. The highest per acre damage estimate was documented on Long Island followed by Southeastern New York. According to the New York Farm Bureau, most damage takes place in late July to early September. To further illustrate the damage that can be caused, one deer can kick open 30 pumpkins in a single night (Kelder, 2006).

Hunting
Hunting is the primary component to deer management, even with recent modification to buffer areas around occupied buildings and other perceived safety issues. Hunting is limited to where this tool can be used. In addition, the number of hunters is steadily decreasing. For hunting to be an effective tool, several actions must be taken including: Increasing the available areas for hunting; Encouraging increased hunter participation; Extending or altering hunting seasons more so than currently exists (this would require changes to hunting regulations); reducing buffer areas for archery only hunts to 100 ft. or less around building; allow the use of crossbows; and use of specific baits to draw deer to areas where an effective shot may be taken.

Hunting is regulated by the NYSDEC with seasons and bag limits established on a Regional Basis. On Long Island the current hunting season is as follows:

- Archery – October 1 through December 31 (October 1-15 are for “Antlerless Only” hunting)

Hunters should check with the town where they want to hunt for specific requirements and regulations in that area.
The Towns of Brookhaven, East Hampton, Riverhead, Shelter Island, and Southold have waived the need for town permits for hunting on town property.

**Increasing available hunting areas**

Most lands currently available for hunting are owned by various levels of government. Large tracts of land either government or privately owned are not available for hunting and current limitations with regard to discharge of firearms (excluding archery which is 250 ft.) within 500ft of an occupied structure while having recently increased the available space for hunting, continue to eliminate a significant amount of area from hunting. Concerted effort to increase the available private and publicly available lands for hunting would significantly increase lands available for hunter access as would additional reduction in required offsets from occupied structures.

It is currently illegal to discharge a firearm or bow in New York State

- so that the load or arrow passes over any part of a public highway,
- within 500 feet (for firearm), 250 feet (for a crossbow), or 150 (for a longbow) of any school, playground, or an occupied factory or church,
- within 500 feet (for firearm), 250 feet (for a crossbow), or 150 (for a longbow) of a dwelling, farm building or structure in occupation or use unless you own it, lease it, are an immediate member of the family, an employee, or have the owner's consent.

In the highly urbanized areas of New York, these limitations severely restrict where hunters may hunt. To enhance ability to control deer populations, the State of Pennsylvania has reduced the minimum archery shooting distance from a residence to 50 ft. (Pennsylvania Game Commission Codes Title 34, Chapter 25, Sec. 2505). New York should consider modifying distance restrictions to 100ft or less from residences to increase areas accessible for hunter harvest.

**Increasing Hunter Participation**

With consistent reductions in the number of hunters across the nation, hunting as a tool for managing game populations is being greatly hindered. To combat this, various programs have been established such as special youth hunts, becoming an Outdoors Woman, among others. While these programs introduce hunting to new hunters, none of the programs seem to be effective at increasing the number of hunters by large numbers. A better understanding why hunting is declining and why people do not consider becoming hunters needs to be determined. Based on this information programs should be developed that specifically target new hunters and encourage life time hunters.

**Improve Meat Donation Programs**

In most states, including New York, programs called “Hunters for the Hungry” exist to provide a mechanism that allows hunters to donate deer and other wildlife to prisons, shelters and soup kitchens. These programs are supplemented by the state, but typically also result in an expense to the hunter of between $50 and $100 dollars. Many hunters would take additional deer for donation if there was an inexpensive mechanism allowing meat donation. Suffolk County has a butchering facility in Yaphank for training butcher trades. This facility currently does not have a dedicated portion that would allow butchering deer for donation purposes. Establishing such a facility for fee-free processing would allow deer taken through nuisance permits, and deer taken under routine hunting to be donated and put to beneficial use.
**Legal Sale of Meat**
New opportunities for exotic meats and exotic food restaurants are emerging. To support this market, highly regulated legalized sale of hunter harvested deer could facilitate population reductions. However, should this mechanism be established, it would require new regulations, both federal and state, for legal sale, quality control, and permits.

**Revised Hunting Seasons**
Deer are most easily hunted during the peak of the rutting season from November through early December. In Suffolk County deer hunting is restricted to archery only during this period. While this maximizes opportunities for bow hunters it may effectively reduce the number of animals taken. A revised shotgun season to coincide with the peak rutting period of Nov. 15 to Dec. 15 should be considered to increase potential harvest.

Bow season would therefore have to be modified to extend from Oct. 1 through Nov. 14 and would open again from Dec. 16 and could extend to the end of January. Additional season beyond Jan. 31 through February would result in additional take as well.

**Culling Deer**
Reducing the population of the deer herd in Suffolk County is a viable, although expensive option. Culling operations would need to be carried out by licensed individuals under contract to Suffolk County and/or various land managing agencies. Typically culling costs are between $150 and $300 per animal. If deer are to be beneficially used, many culling operations will also butcher and refrigerate the meat. This service adds approximately $100 to the cost per animal. Culling would necessarily target areas of high deer density and when possible focus on removal of does. This then requires having a solid understanding of the deer population and its distribution. Other issues related to culling are the same as those associated with hunting, i.e. discharge of firearms and archery equipment near structures, use of specified firearms, etc. These and other restrictions decrease the affective area for conducting culling operations.

**Fencing to Limit Range of Deer**
Fencing is an effective tool to prevent deer from either entering or leaving an area. This tool, although expensive, could be used to establish “deer free zones.” Without deer, the number of ticks present in an area would theoretically decline to manageable or tolerable levels. The biggest problem with this concept is the resulting displacement of large numbers of deer and the ability to remove all deer from a “deer free zone”.

Fencing as it is currently practiced has been implemented by individual land owners. Many east end farmers have installed deer fences that are 8-12’ in height to prevent deer from entering their farm fields and/or orchards. These fences seem to be fairly effective at preventing deer from accessing the agricultural areas. The key draw back to fencing is that it forces deer into smaller and smaller areas where their density then creates increased problems. Or, it forces deer into neighborhoods where they cause damage to horticultural and landscape plantings, thus becoming an increased nuisance to the home owner and are even more difficult to remove due to proximity to structures. Whether this higher density of deer has resulted in higher tick populations is unknown as is the potential ecological damage.
As currently used, the installation of fences is targeted more toward the preservation of property from deer damage than for tick population reduction and management.

**Contraceptives**

There are currently two options available for contraceptive control of wildlife; porcine zona pellucida (PZP) or gonadotropic hormones (GH or GonaCon™). Both are considered experimental and are not commercially available for use. The use of PZP has historically been labor intensive and costly. PZP treatment of deer requires a dual treatment the first year and re-treatment every year thereafter. This requirement results in added requirements for the identification of individuals and the need to trap individuals to apply some marking mechanism, typically ear tags. Once individuals are marked, they may be treated using dart rifles. The use of PZP has been shown to be effective in the western Fire Island communities on Long Island where special care has been taken to ensure all requirements are completed on an annual basis. One typical drawback to the use of PZP is the elimination of consumption of deer meat that may contain the contraceptive.

The use of gonadotropic hormones is a relatively new technique that has been tested over the past several years resulting in the development of a treatment called GonaCon™ which is currently seeking licensing through the FDA and EPA. GonaCon™ is a vaccine that stimulates antibodies that bind gonadotropic releasing hormone (GnRH). GnRH stimulates the production of sex hormones. When antibodies bind to GnRH the normal production of sex hormones is inhibited substantially reducing fertility. GonaCon™ can be used on both male and female deer effectively reducing fertility in both sexes and the population as a whole. However, use on males has been documented to cause negative health affects (Curtis, et al 2008). A single treatment is typically effective for 2-4 years making treatment necessary only two to three times during the life of a deer. Deer treated with GonaCon™ may be consumed. Drawback – GonaCon™ is not currently available for widespread use. (USDA-APHIS-WS-NWRC).

Should the commercial sale of GonaCon™ be approved, the cost of treatment would still be fairly high. A large portion of the deer population would have to be treated. With approximately 20,000 deer in Suffolk County, the treatment would require 10,000 or more individual deer to be treated. The cost of treating the deer population would likely be in the millions of dollars.

**Use of Predators**

There are currently no large predators on Long Island that can substantially control the white-tailed deer population. Historically, there were likely to have been mountain lion or cougar on Long Island but those were eradicated either prior to western man arriving or shortly thereafter. There are incidental observations that fox (red and grey) working in packs may take fawns. Observations at several dens at Brookhaven National Laboratory have indicated that fox bring in parts of deer. There has been no direct observation of fox taking deer.

Packs of wild dogs have likely taken deer on Long Island. Packs of dogs have been observed chasing deer, and several deer carcasses with evidence of heavy predation have been seen primarily at BNL on rare occasion. When dog packs have been removed, no additional deer carcasses with evidence of predation have been found.
The coyote (*Canis latrans*) does not currently exist on Long Island outside of Brooklyn and Queens. According to Audubon, the Smithsonian and other organizations, Long Island is the largest land mass in North America that does not have coyotes. Coyotes have been observed within NY City and they are present in Connecticut and Rhode Island. There is a fairly high likelihood that coyotes will eventually arrive on Long Island. Should this occur, the question becomes whether they would establish themselves at significant population levels to effectively reduce deer populations. The presence of coyotes would provide a medium sized predator to reduce deer populations, but the same predator would also attack domestic pets and feral animals.

### III. MICE AND OTHER SMALL MAMMALS

Small mammals like mice, voles, chipmunks and squirrels usually serve as the first host for larval ticks, and may be used as second and third hosts for the nymph and adult ticks. These hosts also serve as the reservoirs for *Borrelia burgdorferi* and other tick-borne infectious agents.

Managing these hosts usually involves managing the habitats around occupied structures. This includes keeping areas in and around households free of excess debris and managing landscapes to reduce habitats that serve as areas for breeding, feeding, and shelter. The State of Connecticut has published a document titled the *Tick Management Handbook* prepared by the Connecticut Agricultural Experiment Station in New Haven, CT (Appendix E). Available at: [http://www.ct.gov/caes/lib/caes/documents/special_features/TickHandbook.pdf](http://www.ct.gov/caes/lib/caes/documents/special_features/TickHandbook.pdf).

This handbook provides practical tips for the home owner to manage their landscapes in order to reduce tick populations on their property. The Handbook suggests the following approaches:

- Keep grass mowed
- Remove leaf litter, brush and weeds at the edge of the lawn
- Restrict the use of groundcover, such as pachysandra in areas frequented by family and roaming pets
- Remove brush and leaves around stonewalls and wood piles
- Discourage rodent activity. Cleanup and seal stonewalls and small openings around the home.
- Move firewood piles and bird feeders away from the house
- Manage pet activity; keep dogs and cats out of the woods to reduce ticks brought back into the home
- Use plantings that do not attract deer or exclude deer through various types of fencing
- Move children’s swings sets and sand boxes away from the woodland edge and place them on a wood chip or mulch foundation
- Trim tree branches and shrubs around the lawn edge to let in more sunlight
- Adopt hardscape and xeriscape (dryer or less water demanding) landscaping techniques with gravel pathways and mulches. Create a 3-foot or wider wood chip mulch, or gravel border between lawn and woods or stonewalls.
- Consider areas with decking, tile, gravel and border or container plantings in areas by the house or frequently traveled
- Widen woodland trails
- Consider host products to kill ticks on deer or rodent hosts
- Consider a pesticide application as a targeted barrier treatment

### IV. WILD TURKEY AND MIGRATORY BIRDS

The wild turkey (*Meleagris gallopavo*) is growing in number in Suffolk County. Reintroduced to Long Island in 1992, this large game bird’s population has steadily increased. There are now several thousand wild turkeys in the county. Because of their habit of roaming between forest and field, this bird may play a role in dispersal and
survival of ticks, especially the lone star tick. Observations of wild turkey poult's on Brookhaven National Laboratory suggest that poult's, and likely adults, may harbor hundreds of larval ticks during the late summer and early fall months (Green, personal observation). These larvae may then be spread to other areas as the turkeys roam from place to place. Turkeys have recently been shown to carry several *Borrelia* sp. (Scott et al., 2010). However, it is unknown if they are a source for the various tick-borne pathogens.

To reduce the likelihood of wild turkeys carrying ticks into an area, the area should be modified to reduce the chance of turkeys using it.

Migratory birds are known to provide mechanisms for the dispersal of ticks. While not considered a major host of ticks, migratory birds do harbor sufficient numbers of ticks to effectively disperse them from place to place. Therefore, if ticks are eradicated or greatly reduced in an area, migratory birds may be responsible for bringing ticks back into that area. Positioning bird feeders away from the house and frequented areas of yards will lessen the likelihood of ticks being introduced to the landscape.

**V. RECOMMENDATIONS**

Measures to reduce tick populations over a large geographic area are not currently practical or safe. Individual homeowners can use several measures to reduce tick numbers in the vicinity of their homes.

Discouraging hosts by practicing good sanitation, debris removal, and not feeding wildlife during the tick season can all help reduce hosts near homes. Fencing may also be used to discourage hosts. However, fencing that prevents deer from accessing a yard or garden area forces deer into smaller areas potentially resulting in other problems such as greater damage to the forest ecosystem or increase deer/vehicle accidents. Landscaping with deer resistant plants is a more effective mechanism at preventing deer from entering the area around homes. Homeowners interested in reducing ticks around their homes should reference the *Tick Management Handbook* prepared by the Connecticut Agricultural Experiment Station in New Haven, CT (Appendix E). Available at: [http://www.ct.gov/caes/lib/caes/documents/special_features/TickHandbook.pdf](http://www.ct.gov/caes/lib/caes/documents/special_features/TickHandbook.pdf)

On a countywide basis, Suffolk County should be working to:

- Establish a countywide deer management plan.
- Obtain a countywide estimate of deer population density.
- Work to change hunting regulations to allow the most efficient method of hunting at peak behavioral periods.
- Maximize the amount of County owned property open to hunting.
- Work with other local, state and federal landowners to open lands to hunting.
- Develop a location for donating deer for butchering and subsequent transfer to homeless shelters.
- Research tick and tick-borne disease relationships with wild turkey.
- Continue to review publications concerning host management research and tick reduction.
- Explore opportunities to use new technology for host management and tick reduction.
- Adopt or adapt Connecticut's *Tick Management Handbook* and encourage homeowners to manage their landscape to reduce the presence of ticks around their homes.
VI. REFERENCES


Chapter 3
Dan Gilrein and Joyce Rodler

TICK MANAGEMENT AND PERSONAL PROTECTION

Table of Contents

TICK MANAGEMENT AND PERSONAL PROTECTION

I. INTRODUCTION ......................................................................................................................... 25

II. HUMAN AND PET PROTECTION ............................................................................................. 26

III. WEBSITES WITH ADDITIONAL INFORMATION ................................................................. 30

IV. OUTDOOR BROADCAST SPRAYS ......................................................................................... 31

V. HOST-TARGETED TECHNOLOGIES ...................................................................................... 32

VI. REGISTERED PESTICIDE PRODUCTS .................................................................................. 37

VII. MINIMUM RISK PESTICIDES AND BIOPESTICIDES ..................................................... 38

VIII. LAWS, RULES, AND REGULATIONS ................................................................................ 40

IX. RECOMMENDATIONS ........................................................................................................... 40

X. REFERENCES .......................................................................................................................... 42

I. INTRODUCTION

This section updates information compiled and presented in the Final Report of the Suffolk County Tick Management Task Force (May 7, 2008), Section 3 Pesticide-Related Tick Management, co-authored by Vincent Palmer (lead author), then Regional Program Manager, New York State Department of Environmental Conservation (NYSDEC), Division of Materials Management/Bureau of Pest Management, and Amy Juchatz, Environmental Toxicologist, Suffolk County Department of Health Services. Much of text is drawn from the earlier report. The authors referenced a 1987 letter from the Regional Chief Scientist for the United States Department of the Interior, National Park Service, North Atlantic Region, requesting permission of the NYS Department of Environmental Conservation to apply DAMMINIX® Tick Tubes on Fire Island and stating in part, “Although we normally avoid pesticide use, the high incidence of Lyme disease among our employees and the families there makes such use necessary in selected areas for the safety of employees and visitors” (Soukup, 1987). If anything, the situation appears to have intensified and exists (as it did then) well beyond Fire Island. Blacklegged ticks (Ixodes scapularis) remain common in Suffolk County, with incidence and distribution of lone star (Amblyomma americanum) ticks expanding from eastern into central Suffolk County. The lone star tick is also an especially annoying biter, particularly when larvae are active during summer to early fall. Concerns for associated tick-borne disease remain high in Suffolk County. These factors undoubtedly contribute to the frequent use of broadcast sprays in and around residential landscapes to reduce tick levels.
The authors then noted tick populations high enough that Fire Island served as a testing site for several tick-management technologies. They recommended supporting funding for the ‘4-Poster’ Tick Management Technology Study and that arrangements be made for the Suffolk County Department of Public Works Division of Vector Control (SCDPW-DVC) and Suffolk County Department of Health Services Arthropod-Borne Disease Laboratory (SCDHS-ABDL) to contribute manpower and other resources to assist with the ‘4-Poster’ Tick Management Technology Study. Both objectives were met; Cornell Cooperative Extension of Suffolk County and Cornell University staff completed the study in 2011 (Curtis et al., 2011) with direct assistance from SCDPW-DVC and SCDHS-ABDL. (See Host-Targeted Technologies below).

The main tick species of concern to humans and companion animals in Suffolk County are the blacklegged (deer) tick, lone star tick, and American dog tick. Primarily outdoor pests, tick species are incidental invaders into homes and structures, gaining entry on pets and commensal rodents. Integrated Pest Management practices (IPM) such as sanitation, exclusion, and checking pets for ticks can reduce the incidence of ticks indoors. Furthermore, changes in human behavior and habitat modification play a direct role in reducing exposure to ticks.

The following discussion includes information on pesticides used in risk mitigation strategies primarily focused on personal protection and the use of insect repellents and contact pesticides in outdoor environments. Included in the recommendations is the proper handling of an individual’s clothing following field exposure. For example, placing clothes in a dryer on high heat for 1 hour is an effective measure to kill and prevent ticks from being introduced inadvertently indoors on clothing.

Currently, outdoor treatment strategies still rely heavily on broadcast spraying of pesticides on vegetation to manage tick populations. However, there are non-target species impacted by broadcast applications and other environmental impacts from drift and runoff. There is increasing interest in host-targeted systems such as the 4-Poster Deer Treatment Device, which targets blacklegged and lone star ticks, and DAMMINIX, which targets mainly blacklegged ticks.

II. HUMAN AND PET PROTECTION

Conventional and Biopesticide Repellents
Pesticide-related personal protection for people involves the use of a variety of repellents. These pesticide products can be effective at reducing insect and tick bites. However, their use is not without risk and it is especially important that they are used appropriately. Based on data reported to the national Poison Control Centers Toxic Exposure Surveillance System (TESS), insect repellents were ranked the fourth most frequently reported pesticide involved in poisonings (Litovitz et al., 1999). Similarly, in New York State, repellents are the fifth most frequently reported, representing 6.3 percent of the reported poisonings (NYSDOH, 1998).

The New York State Department of Health (NYSDOH) website Tick and Insect Repellents: Deciding on Their Use, is available in PDF format in both English and Spanish at www.health.ny.gov/publications2749/ (May 2015).
The NYSDOH website provides information on repellent products, reducing individuals' risk, frequently asked questions and a discussion on use of repellents on children and pregnant women. The NYSDOH points out that children may be at greater risk of adverse effects from the use of repellents. Listed on the website are the following recommendations:

- Use netting over strollers, playpens, etc. to reduce the need for repellents.
- Keep repellents out of the reach of children
- Do not allow children to apply repellents to themselves
- Use only small amounts of repellent on children
- Do not apply repellents to the hands of young children because it may wind up in their eyes or mouth
- As with chemical exposures in general, pregnant women should take care to avoid exposures to repellents when practical, as the developing baby may be vulnerable. Pregnant women should speak to their health care provider if they have questions.

The NYSDOH’s website www.health.ny.gov/diseases/communicable/lyme/, revised in October 2015, is a comprehensive resource for individuals seeking information on Lyme and other tick-borne diseases. Included in the website are PDFs in both English and Spanish covering topics of: How to dress to avoid ticks, diseases spread by ticks, the use and types of repellants, and even a video demonstrating how to safely remove a tick. The NYSDOH recognizes repellents are tools for protection against ticks; however, the NYSDOH emphasizes individuals’ need to recognize the location, duration, and likelihood of a “tick exposure.” Then, after assessing and evaluating the risk of an exposure, an individual can preventively dress, and choose the appropriate degree and type of repellent. Additional Tick and Repellent information can be found at the USEPA webpage http://ww2.epa.gov/insect-repellents.

Comparative efficacy information, simply presented, with periodically updated summaries of the various tick repellents available (including brand names) would help consumers decide when choosing among options. EPA has developed voluntary repellency awareness graphics for repellent product labels to enhance public health information for skin-applied insect repellent products by improving the prominence and clarity of product effectiveness claims on labels (see website list for link to the Guidance document). More awareness would help the public understand when and where repellents are most needed and what to expect from them. Websites provide some details but information on efficacy is generally lacking. Products labeled for adults, children and domestic animals (including large animals such as horses or other livestock) might also be distinguished with appropriate environmental, human health and veterinary warnings (e.g. avoid use of pyrethroids on cats). Some products are harder to obtain (e.g. permethrin-based materials are not generally found in many retail outlets where DEET-based materials are sold, but rather in sporting goods stores or through internet retailers). Information could be updated as new products are registered (or dropped) for use in New York State. The NYS Pesticide Product Ingredient and Manufacturer System (PIMS) is database designed to help the public search for pesticide products that are registered for sale, use and distribution in NYS. Information on PIMS is supplied to Cornell University’s Pesticide Management Education Program (PMEP) by the NYSDEC’s Pesticide Product Registration Section. PIMS is regularly updated and can be found at: http://pims.pszr.cornell.edu. The user can search for pesticides either by EPA registration number, product name, or by active ingredient. Specifically, the PIMS database can be used to identify currently registered repellent products containing specific active ingredients (n.b. minimum-risk pesticides and repellents are not included). Repellents now available in EPA-registered products and also
approved for use in NY State, include DEET, pyrethroids such as permethrin and deltamethrin, picaridin (KBR3023 = Bayrepel = 2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester), the biopesticide IR3535 (ethyl 3-[acetyl (butyl) amino] propanoate = 3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester), 2-undecanone, Morpel (MGK) 326, and minimum-risk products (i.e. specific materials except from requirements of EPA registration).

There is conflicting information concerning picaridin; the NC website below notes it is “not effective against ticks” but there are currently 24 products containing picaridin approved for use in NY State including some with uses as a tick repellent (e.g. Repel Tick Defense, EPA# 121-92-305; see PIMS website). Despite a May 2015 Consumer Reports article (http://www.consumerreports.org/cro/magazine/2015/05/what-really-works-against-bug-bites/index.htm) stating it is a "good alternative[s] to deet" for ticks, labels of products containing oil of lemon eucalyptus no longer include uses for repelling ticks, although products using para-menthane-3,8-diol (PMD), a synthetic version, do include uses as a tick repellent. The Centers for Disease Control and Prevention (CDC) has a comprehensive web site that provides tips on avoiding direct contact with ticks, and how to find and remove ticks. The CDC discusses the proper use of DEET- and permethrin-based repellents. Specifically, the CDC recommends using repellents that contain 20 – 30% DEET on exposed skin or clothing. Adults applying DEET to children are cautioned to avoid hands, eyes and mouth. Permethrin is only applied to clothing or equipment (boots, pants, socks, tents, and gear) and never directly to skin, in formulations containing 0.5% permethrin. According to the CDC, permethrin-treated clothing will retain repellent activity through multiple washes. Repellents used on skin can also be applied to clothing but provide shorter duration of protection (same duration as on skin) and must be reapplied after laundering. The CDC webpage Ticks is located at: http://www.cdc.gov/ticks/avoid/on_people.html.

**Tick-Repellent Devices and Other Alternatives**

There is limited information on tick-repellent devices and none were found in a December, 2014 PIMS (http://pims.psur.cornell.edu) search among products registered for use in New York (some metofluthrin-emitting devices are approved as mosquito repellents but not for ticks). An internet search conducted on 12/1/15, found two devices that claim to work as tick repellents. The first is an ultra-sound tick repellent device (TickLess Pet Ultrasonic Repellent – ‘not available to ship to California or Colorado’). The other device is “treated with a bio-energetic process and sealed in an electro-magnetic shielded envelope” that “when opened and placed on your pet, uses your pet’s own inherent energy to send out frequencies that repel pests. The process operates with quantum mechanic’s refined frequencies…” (Only Natural Pet EasyDefense Flea & Tick Tag).

A search (12/10/2014) of EPA’s website or the published literature (CAB Abstracts) found little information on tick-repellent devices. One report (Schein et al., 1988) stated “A flea collar which emitted ultrasonic waves (Bio-Protector) was tested under laboratory conditions on cats infested with *Ctenocephalides felis* and dogs infested with *Ixodes ricinus* and *Rhipicephalus sanguineus*. No effect was noted on infestation levels or individual ticks or fleas after 72 h or 14 days.” A second study (Brown & Lewis, 1991) examining the effect on ticks (*Rhipicephalus simus*) from two ultrasound generators reached a similar conclusion. The Connecticut Agriculture Experiment Station factsheet (Tick Bite Prevention & the Use of Insect Repellents) notes, “Ingested compounds like garlic and vitamin B1 and ultrasonic sound devices do not repel mosquitoes and probably do not repel ticks. Wrist-bands impregnated with either DEET or citronella provided no protection against mosquitoes and would not protect against ticks either. Protection is provided only around where the repellent is actually applied.”
Tick Repelling Clothing and Gear
Permethrin-treated articles of clothing and gear (ground cloths, tents, sleeping bags, etc.) repel ticks and other insects. Treated with permethrin and designed to protect the wearer from ticks, these are considered as formulations of pesticides that must be registered with the United States Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC). Examples of articles of clothing registered for distribution and use in New York State include the following products that contain permethrin as the active ingredient at a concentration of 0.52 percent:

- Insect + Shield insect repellent apparel (EPA Reg. No. 74843-2)
- Insect Blocker repellent apparel (EPA Reg. No. 74843-2)
- ShudderBug insect repellent clothing (EPA Reg. No. 74843-2)
- Insect + Shield repellent gear (EPA Reg. No. 74843-5)
- Perimeter Insect Guard Insect Repellent (EPA Reg. No. 82392-1)
- Skintex® MR III Insect Repellent Apparel (EPA Reg. No. 86110-2)

These articles of tick-repellent clothing and gear must be washed separately from other clothing, and cannot by dry-cleaned. Label directions for the first two products listed above indicate that the repellency remains effective for 70 washings, while the last three products indicate that their repellency remains effective for 25 washings.

The National Pesticide Information Center (NPIC) (http://npic.orst.edu) is a source of objective, science-based information about pesticides and pesticide-related topics that enable people to make informed decisions about pesticides and their use. NPIC is a cooperative agreement between Oregon State University and the USEPA. NPIC posts information about “Permethrin-Treated Clothes” as one of their “Hot Topics” at the following website: http://npic.orst.edu/hottopic/PermethrinTreatedClothes.pdf.

Companion Animal Protection
Companion animals are also susceptible to tick infestation and some tick-borne diseases. Ticks can also be introduced into homes on pets. Pesticide-related protection for companion animals (i.e. pets) involves the use of repellents, and tick-controlling substances that include flea and tick collars, shampoos, dusts, and dips. A significant amount of information from qualified government sources has been developed and posted on the websites listed in the outline below. Not all active ingredients for use on companion animals are effective or labeled for control of ticks and some formulations may contain other active ingredients. Available resources include fact sheets and safety data sheets for common tick-active ingredients used on animals, such as flumethrin, pyrethrins (derived from pyrethrum), permethrin, d-trans allethrin, phenothrin, deltamethrin, cyphenothrin, D-limonene, propoxur, amitraz, etofenprox (=ethofenprox), fipronil, coumaphos, tetrachlorvinphos (Gardona), and the synergists MGK 264 and piperonyl butoxide. These resources contain information about each of these pesticides and the risks they may pose.

As with personal repellents, the use of pet flea and tick products is not without risk. It is important that they are used only under guidance of a veterinarian and product instructions followed carefully. In July of 2003, the ASPCA Animal Poison Control Center received 3,100 cases of poisoning related to the use of flea and tick control products (ASPCA, 2004). Some products are labeled for dogs and should not be used on cats, and those that are labeled for adult cats or dogs should not be used on kittens or puppies. According to VCA Animal Hospitals (http://www.vcahospitals.com) “the use of pyrethrins/pyrethroids is very safe in dogs; however, cats and fish are
very sensitive to pyrethrins/pyrethroids.” Some are less tolerated than others; permethrin products in particular have caused toxicity in cats when products labeled for use on dogs are inadvertently used on cats. Permethrin “spot-on” products for dogs can contain between 45-65 percent permethrin. Even small amounts of these products can cause symptoms in cats (Richardson, 2000). Symptoms that are most often seen in cats from permethrin toxicosis include tremors, muscle twitching and seizures. These symptoms usually occur within hours to days following treatment and may last up to three days. It is also very important that certain flea and tick products not be used on very old or debilitated animals since they may also be more susceptible. In addition, there is potential for exposure to pet owners when flea and tick products are used on their pets and users should avoid exposing fish to residues or overspray.

III. WEBSITES WITH ADDITIONAL INFORMATION

- New York State Department of Health (NYSDOH) - Ticks and Lyme Disease
  https://www.health.ny.gov/diseases/communicable/lyme/

- United States Environmental Protection Agency (EPA), Insect Repellents - Reducing Insect Bites
  http://www2.epa.gov/insect-repellents

- United States Environmental Protection Agency (EPA) - DEET
  http://www2.epa.gov/insect-repellents/deet

- United States Environmental Protection Agency (EPA) - Repellency Awareness Guidance For Skin-Applied Insect Repellent Producers (2013)

- United States Environmental Protection Agency (EPA), Office of Pesticide Programs Regulatory Actions - Picaridin:

- United States Environmental Protection Agency (EPA), Office of Pesticide Programs Regulatory Actions - IR3535 (3-[N-Butyl-N-acetyl]aminopropionic acid, ethyl ester):

- United States Environmental Protection Agency (EPA), Office of Pesticide Programs Regulatory Actions - Methyl nonyl ketone or 2-undecanone:

- United States Environmental Protection Agency (EPA), Office of Pesticide Programs Regulatory Actions - p-Methane-3,8-diol or Oil of Lemon Eucalyptus:

- United States Environmental Protection Agency (EPA) - Pesticides Health and Safety Insect Repellents: Use and Effectiveness
  Includes information on hours of protection against ticks for specific repellents and products that contain the active ingredient of interest
  http://cfpub.epa.gov/oppref/insect/

- United States Environmental Protection Agency (EPA) - Repellent-Treated Clothing
  http://www2.epa.gov/insect-repellents/repellent-treated-clothing
IV. OUTDOOR BROADCAST SPRAYS

In Suffolk County, relatively few active ingredients are currently available in formulated products for outdoor broadcast sprays in landscape situations. Most are synthetic pyrethroid insecticides (permethrin, bifenthrin, lambda-cyhalothrin, gamma-cyhalothrin, fluvalinate, cyfluthrin, beta-cyfluthrin, etc.) but some include pyrethrins or carbaryl. The biopesticide (insect-killing fungus) *Metarhizium anisopliae* strain F52 (spores) is included in granular and liquid products mainly targeting blacklegged tick (efficacy against lone star ticks is limited). Several minimum-
risk products (often sold as “organic”) containing essential oils and other active ingredients from the FIFRA Section 25(b) list are available for controlling ticks (see Minimum Risk Pesticides and Biopesticides below).

When pesticides are applied to residential lawns and landscaping, exposure to humans, pets and wildlife can occur. Exposures may result during outdoor activities in treated areas. Less obvious are exposures that can also occur to the indoor environment when yards are treated. The pesticide registration process also takes these into account, which are often considered potentially more significant than outdoor exposures, according to Dr. Robert Lewis of the USEPA’s National Exposure Research Laboratory (Lewis, 2005) and occur when these chemicals are re-suspended by winds and are carried into houses through open windows or doors, or through cracks and crevices, or are tracked into houses on shoes, clothing, and pets (Nishioka, 2001). The likelihood and significance of such exposures will vary depending upon the pesticide product used, its environmental fate and persistence characteristics, and the application method used.

Infants and toddlers represent a particularly vulnerable population in terms of lawn and landscaping pesticide exposure, since they can have significant direct dermal contact with soils and dust, and may frequently engage in mouthing activities (involving contaminated hands, toys, furniture, etc.).

As with small children, pets are more likely to be exposed to pesticides and receive a higher dose since they are lower to the ground, can track pesticide residues indoors from outside, and their grooming habits can lead to oral ingestion of pesticide residues on their fur and paws. Note earlier comments concerning cats and sensitivity to pyrethroids/pyrethrins.

In addition to potential exposures to people and their pets, broadcast applications also have the potential to result in exposure to wildlife, such as grazing deer, and may result in environmental contamination. There is a growing body of evidence that sediments from agricultural and suburban areas may contain pyrethroids at concentrations that are toxic to aquatic organisms (Amweg et al., 2005 and Weston et al., 2005) and there are some concerns for drift or runoff from landscape-level applications. As noted above, fish are particularly sensitive to pyrethroids/pyrethrin insecticides.

A few products are also labeled for control of ticks indoors, but only as incidental pests (such as when brought indoors on clothing or pets). The primary tick species addressed here (blacklegged or deer tick, lone star tick, American dog tick) are not considered indoor pests and do not establish indoor populations. A few species, such as the brown dog tick (Rhipicephalus sanguineus), can breed and establish in indoor environments like dog kennels.

V. HOST-TARGETED TECHNOLOGIES

MAXFORCE Tick Management System (EPA Reg. No. 432-1248) noted in the 2008 report is no longer registered for use in New York State.
**DAMMINIX®.** DAMMINIX® Tick Tubes (6 to 24 tubes) (EPA Reg. No. 56783-1) was first registered for use in New York State on July 16, 1987. DAMMINIX® A TICK TOXICANT (96 tubes) (EPA Reg. No. 56783-1) was first registered for use in New York State on March 22, 1996. Both products remain currently registered as general-use pesticides (available to the general public and pest management professionals), marketed by EcoHealth, Inc., 33 Mount Vernon Street, Boston, Massachusetts 02108.

The manufacturer indicates that a mouse habitat measuring ¼ acre would involve the use of six tubes, a ½ acre habitat would involve the use of 24 tubes, and a two-acre habitat would involve the use of 96 tubes. This pesticide is registered for use only in outdoor areas inhabited by mice. Label directions instruct the user to apply DAMMINIX® Tick Tubes between April 01 and mid-September, and at least twice a year. Label directions also state that best results are obtained when DAMMINIX® Tick Tubes are applied immediately prior to the feeding activity periods for nymphal (May-June) and larval (August-September) blacklegged ticks. Tubes may also be replaced when nesting material is completely removed.

The product consists of a cardboard tube that contains cotton balls impregnated with 7.4 percent permethrin, a synthetic pyrethroid. The ends of these cylindrical tubes are open, allowing mice to remove cotton for use in building nests. Therefore, the effectiveness of this tick management strategy relies on mice using the cotton to line their nests; however, if there is an abundance of natural nest-building materials in the treatment zone mice may not use the cotton. It has also been reported that other small mammals such as shrews, voles and chipmunks may remove permethrin-treated cotton, and that birds may pick up cotton that mice remove from the tubes but do not bring to their nest. Ticks on the mice and in the nests are exposed to the permethrin on the cotton available in the DAMMINIX® Tick Tubes. This product is intended to aid in the control of ticks that infest mice and nests of mice found around yards, play areas, parks, brush, paths, and in woodlands. The Environmental Hazards section of both DAMMINIX® labels warns: “This product is extremely toxic to fish and other aquatic organisms. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark.” One important consideration is the fact that DAMMINIX® Tick Tubes (6 to 24 tubes) (EPA Reg. No. 56783-1) and DAMMINIX® A TICK TOXICANT (96 tubes) (EPA Reg. No. 56783-1) are only registered for the control of the blacklegged tick, and not the lone star tick which is a serious and increasing concern in Suffolk County. The manufacturer states the following on a “Frequently Asked Questions” section that is posted at their website: “DAMMINIX® Tick Tubes are targeted to the life cycle of disease-carrying black legged ticks (deer ticks) in the Eastern United States.” Further information can be found on the registered pesticide labels and the EcoHealth website at: [http://www.ticktubes.com/index.html](http://www.ticktubes.com/index.html).

Select TCS Tick Control System (EPA #85306-1) is a bait station for rodents to control ticks which may carry Lyme disease. First registered in NY in 2012, Select TCS is restricted-use in New York and labeled only to be used by pesticide management professionals and public health department personnel. Similar to the DAMMINIX® Tick Tubes, this technology does not directly target lone star tick. The active ingredient, fipronil (0.7% formulation) is applied to rodents visiting the bait stations.
**Y-TEX 4-Poster**

The 4-Poster, a host-targeted technology that applies a permethrin-based tickicide to deer as they feed at a specially designed bait station, was registered by NYSDEC on 1/9/12 for use in Nassau and Suffolk Counties under a Special Local Needs (SLN) registration and by permit only from NYSDEC. Deer are an important host for both lone star and blacklegged (deer) tick species. The study described in the 2008 report was undertaken, from late 2007 to 2011, to address outstanding questions towards informing a NY registration decision at NYSDEC. Areas on Long Island included in the study were Shelter Island, North Haven, and portions of Fire Island. The objectives of this study were to:

- assess human- and wildlife-associated risks due to changes in deer movement and behavior following placement of 4-Poster devices including documentation of potential impact on residential and natural vegetation, possible increases in deer-vehicle collisions, changes in contact between deer that enhance potential for disease transmission, effects upon deer mortality associated with feeding bait or reduced tick pressure, and non-target animal use at 4-Poster devices;
- address possible increased human exposure to permethrin from handling and consuming treated deer by quantifying permethrin residues in and on deer; and
- evaluate the efficacy of 4-Poster technology for control of blacklegged and lone star ticks in human-inhabited and –visited areas.

The Study confirmed efficacy of the technology for controlling both tick species, found no increased risk of deer-vehicle collisions, little to no effect on deer movement and range, and increased indirect but not direct contacts between deer. The NYS Department of Health addressed concerns about low-level permethrin residues detected in neck muscle samples concluding the human health risks from consumption are very low. Full final report text including data summaries, figures, and other findings can be found at: [http://wildlifecontrol.info/TickStudy/Pages/Study%20Reports%20and%20Posters.aspx](http://wildlifecontrol.info/TickStudy/Pages/Study%20Reports%20and%20Posters.aspx). The initial Y-Tex 4-Poster Tickicide (EPA reg. no. 39039-12) SLN label and NYSDEC registration letter including comments from the NYS Department of Health and NYS DEC Bureau of Wildlife can be found at [http://132.236.168.99/ppds/529708.pdf](http://132.236.168.99/ppds/529708.pdf). The current (2014) SLN label (SLN NY-120001) is at [http://132.236.168.99/ppds/538590.pdf](http://132.236.168.99/ppds/538590.pdf). 4-Posters have been deployed on Fire Island and Shelter Island since 2008 (Appendices F and G), Brookhaven National Laboratory since 2013, and Connetquot River State Park and North Haven in 2015.

Y-Tex Tickicide is a restricted-use pesticide. Applicators must carry a NYS-issued commercial pesticide applicator license in Category 8 – Public Health Pest Control. Use of the 4-Poster device requires a valid deer-feeding permit issued under 6 NYCRR Part 189 and additional restrictions and requirements apply. The device is not available for individual property owners to obtain and use on their own. Though effective for reducing blacklegged and especially lone star tick populations over time, use of the technology involves a significant expenditure of time and funds for maintenance, record-keeping and reporting.

Following is a discussion from the 2008 Report of the background preliminary to the Shelter Island and Fire Island 4-Poster Deer and Tick Study with a more detailed description of the 4-Poster technology. The Study involved considerable time, goodwill, and expense of many partners both in preparation and execution to successfully complete the work.

The ‘4-Poster’ system is the first topical self-treatment technology developed for deer. This system relies on an environmentally preferable host-targeted passive application process. The
technology is based on the fact that white-tailed deer serve as keystone hosts for the blacklegged tick and lone star tick, and the fact that control of ticks while they are on deer can limit the number of ticks on the entire landscape. The ‘4-Poster’ system is designed to attract deer to small gravity fed, corn-filled troughs. As the deer reach into the trough to obtain corn, their head, neck and ears come into contact with vertically stationed paint rollers that are treated with tickicide. The deer then act as ‘vacuums’ that collect ticks as they travel about their home range. The ticks that attach to the deer are then exposed to a lethal dose of tickicide. By killing those adult ticks, no eggs are laid, and the life cycle of the tick is interrupted. Eventually, this leads to a decline in the tick population in areas where the devices are deployed. Studies have demonstrated reductions in the population of free-living ticks as much as 91 to 100 percent (see discussion of studies that follows).

The ‘4-Poster’ system was developed at the Knipling-Bushland U.S. Livestock insects Research Laboratory (KBUSLIRL), and patented by the US Department of Agriculture’s Agricultural Research Service (USDA-ARS) in 1994 (Pound et al. 1994, 2000a). A field trial designed to evaluate efficacy against lone star ticks on white-tailed deer using an oily formulation of amitraz as the acaricide proved the technology to be highly efficacious against ticks feeding on deer (ca. 97 percent control) (Pound et al. 2000a). Efficacy after the third year of treatment was 91.9 and 93.7 percent against free-living nymphs and adults, respectively (Pound, et al. 2000b). This was quite similar to efficacy demonstrated in the previous and similar three-year trial of systemic ivermectin-medicated bait technology (Pound et al. 1996).

From 1997 to 2004, the USDA Northeast Area-wide Tick Control Project (NEATCP) conducted a major field trial of >4-Poster= Deer Treatment Bait Stations in two square mile test plots each at seven research sites in five northeastern states (CT, MD, NJ, NY, and RI) to control ticks feeding on white-tailed deer (Pound et al. 2008a, 2008b). These two manuscripts have been peer reviewed, edited, and submitted to the journal entitled Vector-Borne and Zoonotic Diseases. The objective was to reduce free-living blacklegged and lone star tick populations throughout the plots, thereby reducing the risk of tick-borne disease. Data were collected and compiled and deployment, operational, and maintenance procedures were compared among the sites. Subsequently, major factors that influenced efficacy were extrapolated to better understand and improve the technology. Treatments utilized a 2 percent oily formulation of the acaricide amitraz and resulted in significant reductions in free-living populations of nymphal blacklegged ticks at all seven sites and lone star ticks at the three sites where these ticks also were present. Maximal efficacy against nymphal blacklegged and lone star ticks was 81.7 and 99.5 percent, respectively. Although the technology is labor intensive and requires two or more years to show efficacy, it was considerably more economical and environmentally friendly than spraying residential vegetation to control ticks. The major environmental factor that interfered with treatment was the sporadic occurrence of heavy acorn masts. These alternative food sources minimized the use of treatment devices by deer and reduced the control of ticks feeding on them. The NEATCP demonstrated that if properly deployed and maintained, the >4-Poster= technology is an efficacious, economical, safe, and environmentally friendly alternative to area-wide spraying to reduce the risk of transmitting the agents causing Lyme disease, human ehrlichiosis, southern tick-associated rash illness (STARI), and other tick-borne diseases to humans, livestock, pets and wildlife (Pound et al. 2008b).

A second major field trial of the 4-Poster technology sought to reduce tick abundance at the Goddard Space Flight Center at Greenbelt, Maryland. This trial used four, 4-Poster= devices in an area of over 600 acres and treated with an oily 10 percent formulation of permethrin. In this study the “treatment resulted in elimination of adult I. scapularis on sampled deer (100% control) by the 2nd year of treatment and reductions of immature tick stages on mice. During the 3rd year of treatment, adult, nymphal, and larval questing ticks were reduced by 91-100% from sampled plots, and nymphal and larval ticks were reduced by 70-95% on sampled mice” (Solberg et al. 2003). The ‘4-Poster’ Tickicide is a similar, oily 10% formulation of permethrin that was labeled in 2003 by the EPA for use only on ‘4-Poster’ Deer Treatment Bait Stations.

In a letter dated March 18, 2006, former NYS Governor Hugh L. Carey asked then NYS Governor George E. Pataki to endorse a pilot program to establish the 4-Poster tick management system on Shelter Island. In a letter of reply dated July 19, 2006, Governor Pataki informed Governor Carey.
that the NYSDEC would undertake a comprehensive scientific study to address the currently unanswered questions about the efficacy of the 4-Poster Tickicide system in reducing human incidence of Lyme disease and other tick-borne diseases . . . and document impacts on deer populations and behavior.

This exchange of letters is reflective of the growing concern about this public health threat by a concern that finds New York State lawmakers and other elected officials, activists, the health care and medical communities, public interest and environmental organizations, academia, and others joining forces to combat this problem. The Suffolk County Tick Management Task Force is one example of that widespread attention to this public health problem.

The NYSDEC facilitated the preparation and submission of application for the necessary registration and permit that would be needed to conduct the research. The application was required to be accompanied by a scope of study design to answer outstanding technical concerns expressed by the NYSDEC’s Division of Solid and Hazardous Materials (DS&HM), and Division of Fish, Wildlife, and Marine Resources (DFW&MR), as well as the New York State Department of Health. This required the coordination of a unified approach to the problem by focusing the energies, expertise and financial support of a diverse group of stakeholders on the goal of designing a study that would address outstanding technical concerns of the NYSDEC and NYSDOH relative to a promising tick control technology that is registered in 48 other states. The technology consists of a 4-Poster Deer Treatment Device charged with Y-TEX’ 4-Poster’ Tickicide (EPA Reg. No. 39039-12). The tickicide and technology associated with this tick control system offers a potential dramatic reduction in ticks, the human incidence of diseases they transmit, and the amount of pesticides presently used to control ticks by broadcast spraying large outdoor areas.

To address the technical concerns through a comprehensive study, the NYSDEC organized a consortium of federal [United States Department of Agriculture, Agricultural Research Service (USDA-ARS), United States Department of the Interior, National Park Service, Fire Island National Seashore (USDI-NPS-FINS), United States Geological Services (USGS), and United States Public Health Service (USPHS)], New York State [NYSDEC, New York State Department of Health (NYSDOH), and New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP)], local agencies (Towns of Islip and Shelter Island, Incorporated Villages of Dering Harbor, North Haven, and Saltaire, and the Fire Island communities of Kismet, Fair Harbor, Dunewood, and Atlantic Beach), academia (Cornell University and Yale University), and private interests (Fire Island Wildlife Foundation, Shelter Island Deer and Tick Committee/Deer Management Foundation, Fire Island Association, Inc., and The Humane Society of the United States).

A study was needed to address technical concerns associated with the proposed use of this system. One technical concern related to the effectiveness of 4-Poster tick management technology in reducing tick densities and the associated human incidence of such tick-borne diseases as Lyme disease, babesiosis, human granulocytic anaplasmosis, human monocytic ehrlichiosis, tularemia, Rocky Mountain spotted fever, tick paralysis, and southern tick-associated rash illness (STARI). Another technical concern related to the influence 4-Poster deer treatment devices would have on the population and behavior of white-tailed deer, and any impact tickicide residue on deer hides and in deer flesh could have on hunters and others handling deer and eating venison.

The study required that two essential authorizations be issued by the NYSDEC to a Special Local Need (SLN) registration to allow the commercial application of Y-TEX 4-Poster Tickicide (EPA Reg. No. 39039-12/SLN No. NY-070005) to roller posts on deer treatment devices, and a Special License to Collect and Possess to allow the feeding and taking of deer in connection with the study. The process required a comprehensive review, analysis, and arranged compliance with an array of federal and State regulatory concerns that included freshwater and tidal wetland permit requirements; the provisions of the State Environmental Quality Review Act (SEQRA); commercial pesticide applicator certification and pesticide business registration requirements; riparian property owner consent; Special Local Need pesticide product registration; and Special License to Collect and Possess.
A kick-off meeting at NYSDEC Region One Headquarters (Stony Brook University) during October 2006 started the collaborative effort that led to the fall 2007 start of the study. That initial meeting was attended by 52 key potential participants. That meeting was then followed by many other meetings and communications that led, one year later, to the issuance of both the SLN registration and Special License. A copy of the SLN can be found at the following website under ’Special Registrations’: http://pims.psur.cornell.edu/.

On October 22, 2007, the first corn-filled, tickicide-charged deer treatment devices were deployed.

VI. REGISTERED PESTICIDE PRODUCTS

In part, Section 2(u) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and Section 33-0101(35) of the Environmental Conservation Law of New York State (ECL) define a “pesticide” as any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, such as a tick. Except in very limited circumstances, any substance falling within this definition of a pesticide must be registered by US EPA and the NYSDEC before it can be legally offered for sale, sold, distributed, or used in New York State. One such exception to the registration requirement pertains to those pesticides that the US EPA, under Section 25(b) of FIFRA, has determined “to be of a character which is unnecessary to be subject to this Act,” such as minimum-risk pesticides discussed below.

The New York State registration status of a pesticide product can be checked by searching the New York State Pesticide Product, Ingredient, and Manufacturer System (PIMS) computer database at http://pims.psur.cornell.edu. Products can be searched by entering a product EPA Registration Number, a product label name, trade name, brand name or a portion thereof. They can also be found by entering an active ingredient, or a company or distributor name. Custom searches are also available, as are searches of special and pending registrations.

Many active ingredients on the extensive list of registered pesticides in the 2008 report are no longer available or have no corresponding extant commercial products (or products are in ‘discontinued’ status) in New York State with labeling for controlling or repelling ticks, such as dimethoate, dicofol, calcium polysulfide, cube resins other than rotenone, ethion, rotenone, milbemectin, 2-myclobutanil, etc. Since 2008 at least one new active ingredient has since been introduced, Metarhizium anisopliae Strain F52 (spores of an entomopathogen i.e. insect-killing fungus) and the 4-Poster technology was approved in Nassau and Suffolk Counties. As noted earlier, most products registered in NY and labeled for control of ticks in landscapes contain active ingredients such as a synthetic pyrethroids (permethrin, bifenthrin, lambda-cyhalothrin, gamma-cyhalothrin, fluvalinate, cyfluthrin, beta-cyfluthrin, etofenprox), pyrethrins (derived from pyrethrum), or carbaryl. Those for use on companion animals contain a synthetic pyrethroid (flumethrin, permethrin, d-trans allethrin, phenothrin, deltamethrin, cyphenothrin), pyrethrins, D-limonene, propoxur, amitraz, ethofenprox (=etofenprox), fipronil, coumaphos, or tetrachlorvinphos (Gardona), sometimes with the synergists MGK 264 and piperonyl butoxide, Active ingredients in repellents include DEET, pyrethroids such as permethrin and deltamethrin, picaridin, IR3535, 2-undecanone, Morpel (MGK) 326, and possibly some minimum-risk materials. It would be helpful for users – homeowners, landscape professionals, physicians, veterinarians - to have more details on comparative efficacy of different materials for important tick species such as products for organic use, landscape applications, pet collars, topical animal treatments, and personal repellents. Some of these uses are restricted to licensed commercial applicators but others are available.
as general-use products that homeowners can purchase. Particularly when speaking with consumers and other non-professionals, communication is greatly improved when referencing brand names rather than active ingredients alone.

VII. MINIMUM RISK PESTICIDES AND BIOPESTICIDES

Minimum-risk pesticides (FIFRA 25(b), 40 CFR 152.25(f))
Minimum risk pesticides are exempt from federal and New York State pesticide registration requirements and therefore labels bear no EPA registration numbers. They must meet specific labeling and composition criteria to be eligible for registration exemption. The US EPA regards these products as posing little or no risk to the public. At the present time nearly all insecticides offered as ‘organic’ landscape broadcast sprays for control of ticks are minimum-risk pesticides. Lacking state or federal registration, identifying actual products that can be used for ticks can be difficult, although several have been widely used around eastern Suffolk County. Minimum-risk pesticides currently available include EcoVia (thyme & rosemary oils, 2-phenethyl propionate), Essentria IC3 (rosemary & peppermint oils, geraniol), Essentria All-Purpose (rosemary & peppermint oils), Tick Killz (cedar oil, 2-phenethyl propionate, peppermint oil). A few minimum-risk repellents are also sold.

The US EPA’s website, Minimum Risk Pesticides Exempted from FIFRA Registration, posted January 2015, can be found at: [http://www2.epa.gov/minimum-risk-pesticides](http://www2.epa.gov/minimum-risk-pesticides). Neither the US EPA, nor the NYSDEC, reviews or issues notices of exemption for products which meet the conditions for exemption. Five conditions below [listed in CFR 152.25 (f)(1) through CFR 152.25(f) (3)(iii)] must be met in order for a pesticide to qualify as minimum-risk under federal law. New York State also requires such products to display pesticide use directions [6 NYCRR Part 325.2(b)]. Products failing to meet all exemption criteria are not exempt from federal and New York State pesticide product registration; offer for sale, sale, distribution, or use would constitute a violation if not registered.

Condition 1- Active ingredients are those ingredients specifically responsible for killing and repelling the target pest. Each active ingredient in the pesticide product must be listed in Part 152.25(f) of Title 40 of the Code of Federal Regulations (40 CFR) (amended Dec. 28, 2015 and published in Vol. 80 of the Federal Register page 80660). A link to the most recently (Dec. 2015) updated list can also be found at [http://www.epa.gov/minimum-risk-pesticides/active-ingredients-eligible-minimum-risk-pesticide-products](http://www.epa.gov/minimum-risk-pesticides/active-ingredients-eligible-minimum-risk-pesticide-products). Currently, this list contains more than 30 active ingredients. [Products intended for use on food-use sites (i.e., used on food, food crops, food-contact surfaces, or animal feed commodities) can only include active ingredients with applicable tolerances or tolerance exemptions in 40 CFR 180.]

Condition 2 - Inert ingredients are all other ingredients found in a minimum-risk pesticide that are not the active ingredients. 40 CFR 152.25(f)(2) provides that these pesticide products may only contain minimal risk inert ingredients either listed in the most current List 4A; are a commonly consumed food commodity, animal feed item, or edible fat and oil as specified in 40 CFR 180.950(a), (b), or (c), respectively; or are certain chemical substances listed under 40 CFR 180.950(e). A current list of inert ingredients approved for use in minimum-risk pesticide products can be found at [http://www2.epa.gov/minimum-risk-pesticides/inert-ingredients-approved-use-minimum-risk-pesticide-products](http://www2.epa.gov/minimum-risk-pesticides/inert-ingredients-approved-use-minimum-risk-pesticide-products).
Condition 3 – All active ingredients must be listed by name and percentage (by weight) and all inert ingredients must be listed by name.

Condition 4 – States the label cannot make any false or misleading statements as described in 40 CFR 156.10(a)(5)(i) through (viii).

Condition 5 – The label cannot state or imply that the product can or will control or reduce organisms that pose a threat to human health, or insects or rodents carrying specific diseases. For example a label cannot advertise that the pesticide “controls ticks that carry Lyme disease”. The label must simply say, “Controls ticks.”

Condition 5 stems from a petition filed by the Consumer Specialty Products Association in request that the USEPA exclude from the minimum risk pesticide exemption under FIFRA 25(b) those pesticides that claim to control pests of significant public health importance, and that the USEPA require an abbreviated registration for minimum risk pesticide products intended to be used for the control of public health pests. “EPA is now looking at options to ensure that minimum risk public health pesticides that are otherwise exempted from regulation are effective” (http://www.epa.gov/pesticides/health/public.html). Labeling of some of these products for ticks appears to rest, in some cases, only upon laboratory tests. Actual field performance data from replicated, controlled studies with any of these materials for important ticks in Suffolk County is limited or lacking. Any minimum risk pesticide considered for use should be carefully evaluated prior to, and during use to determine its effectiveness.

Biopesticides
Biopesticides are naturally derived from animals, plants, bacteria, and certain minerals and include biochemical pesticides (naturally occurring substances), microbial pesticides (bacteria, fungi, viruses, protozoa), and plant-incorporated protectants (pesticidal substances plants produce from genetic material added to the plant). Where tick management is concerned, only biochemical and microbial agents are considered; plant-incorporated protectants play no role in this area of public health pest control. [Other than a microbial pesticide, we know of no effective commercial biological control/natural enemy (e.g. parasitoid or predator) for ticks.]

Advantages of many biopesticides include inherently lower toxicity than most older conventional pesticides (some new pesticides have very low toxicity to humans and most non-target species, however). Some biopesticides are more specific to the target pest and closely related organisms, in contrast to some broad-spectrum, conventional pesticides (e.g. pyrethroids) that may affect many organisms. They often are used in very small quantities and decompose quickly, thereby resulting in lower exposures and largely avoiding the negative impact to environmental resources sometimes caused by some conventional pesticides. Disadvantages include (often) higher cost, lower efficacy, and shorter residual activity against target pests. However, biopesticides as a component of an Integrated Pest Management (IPM) program generally allow existing or augmented natural enemies to contribute with the potential to greatly decrease the use of conventional pesticides. There is increased interest in biopesticides particularly in populated and environmentally sensitive areas like Suffolk County and EPA is encouraging their development and use. An active applied research program, as Cornell maintains for agriculture and landscape
situations, could contribute to a better understanding and more rapid registration and adoption of biopesticides over time.

Three biopesticide active ingredients are currently listed among NYSDEC-registered pesticides for tick management. The biochemical pesticide oil of lemon eucalyptus (OLE) or the synthetic version of its main active ingredient, para-menthane-3,8-diol (PMD), are in several personal repellent products including at least one for horses. Use as a tick repellent was dropped from two OLE repellent labels (including one named in the Consumer Reports article referenced above) since 2008 though PMD products continue to include uses against ticks, some noting activity for 2 hours. IR3535 (3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester = ethyl butylacetylaminopropionate) is a biochemical pesticide in many personal repellents for people. Met-52 is a microbial pesticide formulation of insect-killing fungal spores (Metarhizium anisopliae) labeled for control of blacklegged (deer) ticks. So far tests have not shown a high level of efficacy against lone star ticks.

For more information on biopesticides, see http://www2.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides

VIII. LAWS, RULES, AND REGULATIONS

Since the 2008 report EPA now requires supporting efficacy data (see Section V) for minimum-risk pesticides. Even prior to 2008 Suffolk County opted into the Neighbor Notification law, formally Chapter 285 of the Laws of 2000, added Sections 33-1004 and 33-1005 to the NYS Environmental Conservation Law, requiring 48-hr prior written notification of neighbors by professional applicators for commercial lawn (landscape) applications of pesticides. Excluded from notification requirements are biopesticides, reduced-risk pesticides, minimum-risk pesticides, granular pesticides and certain other kinds of treatments unlikely to pose risk of drift (spelled out here: http://tinyurl.com/oj8i2k). Suffolk County Code Chapter 380-5 established the Pest Management Program for Suffolk County Properties Community Advisory Committee (CAC) which phased out pesticide use on County properties. Local Law No. 34-1999 now requires all County-owned properties to be managed organically. The CAC seeks alternative solutions to pesticide use, reviews emergency waivers and exemptions from the law, conducts research projects and collaborates on an inventory of pesticides for the County.

For any questions or concerns regarding information on NYS Environmental Conservation Law in reference to pesticide sales, use, distribution, and registration, feel free to contact the NYSDEC Region 1 Bureau of Pest Management. Staff is available Monday through Friday, 8:30am - 4:30pm. Phone number: 631-444-0340. Public email: mailto:R1Pesticides@dec.ny.gov

IX. RECOMMENDATIONS

Following are some suggestions that may enhance our understanding of and ability to address management of ticks and tick-borne diseases.
Landscape tick control: Landscape professionals and homeowners would benefit from more specific information on comparative efficacy of both chemical (including biopesticides) and non-chemical management strategies. This could also include a regularly updated list of options, including minimum-risk, biopesticide and ‘conventional’ treatments for both homeowners and landscape professionals.

Repellents: Clearer information on comparative efficacy and use of repellents including products for animals (collars vs topical treatments, how different active ingredients perform for various ticks), clothing, topical treatments. Information should also be directed to physicians and veterinarians, as well as those who work in tick-infested areas and homeowners.

Clarify pesticide products or formulations that are “safe” for the use on children to protect against ticks and mosquitos. For example, the FDA (http://www.fda.gov/Drugs/EmergencyPreparedness/ucm085277.htm - updated December 9, 2014) very specifically lists insect repellents containing DEET should not be used on children under two (2) months old. Oil of lemon eucalyptus should not be used on children under 3 years old. The NYSDOH provides only “general” warnings of using only small amounts of repellants on children and not to apply repellants to children's hands. A suggestion would be to provide a medically sound guidance document parents and care providers can refer to.

Information is needed on the degree to which landscape controls and repellents actually provide protection from disease – what is known?

Selecting a landscape professional for managing ticks in residential landscapes – include with web-based or other information. Include the New York State Pesticide Administration Database (NYSPAD) located at: http://www.dec.ny.gov/nyspad/?0, a new NYSDEC search engine designed to help the public locate NYSDEC commercially certified applicators and registered pesticide businesses.

Public Education needs to go electronic (e.g. Facebook, QR codes, YouTube). For example, Cornell Coop. Extension of Suffolk County has a Tick Click app for identifying ticks. A review of existing public information on tick management and personal protection, including products adapted for electronic media (smartphones, e.g.) would help to assess specific needs in this area. Information presented more seasonally may help improve understanding of risks at different times of the year (much may already be available). This and other information noted above might be made available on an existing County website (e.g. Dept. of Health Services). Include DEC Bureau of Pest Management contact information assistance: 8:30am - 4:30pm Monday through Friday. Phone 631-444-0340, email: R1pesticides@dec.ny.gov.state.

Cooperation of agencies and municipalities. Involve town, county, and state agencies to share in collaborating efforts to provide tick awareness to their constituents. Outreach can include universities, school districts and library districts, employee unions, Public Service Announcements (PSA) to radio and television, websites (e.g. Suffolk County Employee home page) among others.
Suffolk County Division of Vector Control should regularly develop plans to aid in the reduction of tick-borne illnesses in Suffolk County, which should be included in the yearly Vector Control Plan of Work: now in process (Appendices H and I). SCDPW-Vector Control and SCDHS have already begun survey and other work to better understand seasonality of ticks and associated pathogens in Suffolk County, which can inform public messages and a better understanding of risks.

**X. REFERENCES**


I. INTRODUCTION

Tick-borne pathogens and associated diseases have a significant impact on the public health and the well-being of individuals infected with tick-borne pathogens. These diseases are endemic to Suffolk County and everyone (e.g. medical professionals, residents, visitors) should be aware of the potential risks of acquiring tick-borne pathogens and the clinical signs for each disease.

II. REPORTABLE AND NOTIFIABLE CONDITIONS

New York State Reportable Diseases
New York State requires that certain communicable diseases be reported to local health departments (New York State Sanitary Code (10NYCRR 2.10, 2.14)). Reportable tick-borne diseases include:

- Anaplasmosis
- Arboviral infection, including Powassan virus*
- Babesiosis
- Ehrlichiosis
- Lyme Disease
- Rocky Mountain Spotted Fever
- Tularemia*

*Powassan virus and Tularemia warrant prompt action and should be reported immediately to local health departments by phone followed by submission of the confidential case report form (DOH-389).

Please see Appendix J for more information on NYSDOH reportable diseases.

For further information on NYSDOH reportable diseases:

https://www.health.ny.gov/professionals/diseases/reporting/communicable/

Suffolk County Department of Health Bureau of Epidemiology and Disease Control:

http://www.suffolkcountyny.gov/Departments/HealthServices/PublicHealth/EpidemiologyandDiseaseControl.aspx

**Nationally Notifiable Conditions**

The CDC requests that certain communicable diseases be reported on a voluntary basis. Notifiable tick-borne diseases include:

- Anaplasmosis
- Arbovirus, including Powassan virus
- Babesiosis
- Ehrlichiosis
- Lyme Diseases
- Spotted Fever Rickettsiosis
- Tularemia

The above diseases can be reported through the National Notifiable Disease Surveillance System:

http://wwwn.cdc.gov/nndss

**Incidence Data**

The human case data for this chapter was obtained from the New York State Department of Health's CDESS (Communicable Disease Electronic Surveillance System – Oracle) and Communicable Disease Queries online systems. The human case data by zip code included in the incidence maps was obtained through CDESS. CDESS includes confirmed, probable, suspect and revoked cases. The human case data included in the incidence tables was obtained through the Communicable Disease Queries system. Currently, for the reportable diseases discussed here, Communicable Disease Queries includes confirmed and probable cases, aside from malaria which includes confirmed cases only. However, reporting criteria may have changed over the years, so what was reported in the past may not be the same as what is reported today. For example, prior to 2008 only confirmed cases of Lyme disease were reported. In 2008, the case definition was changed to include probable cases as well. Past reporting criteria for comparison to present day criteria are not readily available.
Table 1: Suffolk County Human Tick-Borne Disease Cases by Year. Data obtained from NYS DOH Communicable Disease Queries

<table>
<thead>
<tr>
<th>Year</th>
<th>Ehrlichiosis Total</th>
<th>Anaplasmosis</th>
<th>Babesiosis</th>
<th>Lyme Disease</th>
<th>Rocky Mtn. Spotted Fever</th>
<th>Tularemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>0</td>
<td>30</td>
<td>654</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>0</td>
<td>24</td>
<td>1107</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1994</td>
<td>0</td>
<td>26</td>
<td>1775</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>0</td>
<td>19</td>
<td>1343</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>2</td>
<td>22</td>
<td>1245</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>14</td>
<td>11</td>
<td>842</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>24</td>
<td>80</td>
<td>916</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>15</td>
<td>47</td>
<td>847</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>29</td>
<td>53</td>
<td>581</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>10</td>
<td>69</td>
<td>417</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>10</td>
<td>66</td>
<td>513</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>12</td>
<td>42</td>
<td>288</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>13</td>
<td>59</td>
<td>561</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>42</td>
<td>109</td>
<td>542</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>41</td>
<td>103</td>
<td>190</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>46</td>
<td>93</td>
<td>124</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>45</td>
<td>95</td>
<td>542</td>
<td>30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>31</td>
<td>123</td>
<td>216</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2010</td>
<td>32</td>
<td>18</td>
<td>13</td>
<td>124</td>
<td>297</td>
<td>3</td>
</tr>
<tr>
<td>2011</td>
<td>49</td>
<td>29</td>
<td>20</td>
<td>206</td>
<td>334</td>
<td>2</td>
</tr>
<tr>
<td>2012</td>
<td>56</td>
<td>25</td>
<td>30</td>
<td>139</td>
<td>241</td>
<td>14</td>
</tr>
<tr>
<td>2013</td>
<td>80</td>
<td>34</td>
<td>46</td>
<td>193</td>
<td>201</td>
<td>8</td>
</tr>
<tr>
<td>2014</td>
<td>114</td>
<td>46</td>
<td>67</td>
<td>197</td>
<td>231</td>
<td>8</td>
</tr>
</tbody>
</table>

*In 2010, ehrlichiosis was split into two separate diseases; ehrlichiosis and anaplasmosis.

References

New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Electronic Surveillance System (CDESS). Data. Available by permission from [https://commerce.health.state.ny.us/hin/](https://commerce.health.state.ny.us/hin/)

New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Queries. Data. Available by permission from [https://commerce.health.state.ny.us/hin/](https://commerce.health.state.ny.us/hin/)

III. DIAGNOSIS AND PREVENTION

Many tick-borne diseases have similar symptoms. Health care providers should use clinical symptoms and test results to make the best possible diagnosis. People who live in areas with high tick populations, spend time outdoors, and those who have been bitten by a tick should be aware that the following symptoms may indicate the presence of a tick-borne disease:

- Fever or Chills
- Aches and pains, including headache, joint pain, and muscle aches
- Fatigue
- Rash
Since most tick-borne diseases do not have a vaccine, and some have no specific treatment, it is recommended that people living in or visiting areas with ticks take steps to prevent tick bites.

- Stay on trails while in the woods
- Apply insect repellent during outdoor activity
- Apply permethrin to clothing during outdoor activity
- Wear socks, pants, and long sleeved shirts during outdoor activity
- Wear light colored clothing during outdoor activity
- Check for ticks, shower, and put clothes in the dryer after outdoor activity
- Check pets for ticks
- Remove ticks promptly with a tweezers, not with heat, nail polish, or petroleum jelly

For more information on tick repellent and tick bite prevention, see Chapter 3.

**References and Further Information**


**IV. ANAPLASMOSIS**

**Pathogen and Transmission**

Anaplasmosis (previously grouped with human granulocytic ehrlichiosis) is a disease caused by the bacterium *Anaplasma phagocytophilum* (previously called *Ehrlichia phagocytophilum*). In 2010, the classification was changed from *Ehrlichia* to *Anaplasma*. This pathogen is transmitted to humans by the bite of an infected blacklegged (deer) tick (*Ixodes scapularis*). It is not spread from person to person, though there is a risk of transmission through blood or organ transplants. Cases in New York State have been concentrated on Long Island and in the Hudson Valley. See Figures 1 and 4 for numbers and locations of Suffolk County anaplasmosis cases.

**Symptoms**

Symptoms typically begin within 1 to 3 weeks after being bitten by an infected tick.

- Fever
- Headache
- Muscle/joint Pain
- Weakness
- Malaise
- Chills
- Nausea
- Abdominal Pain
- Cough
- Confusion
- Rash (rare)
- In severe cases: difficulty breathing, hemorrhage, renal failure, neurological problems

(CDC 2013, NYSDOH 2012)
Diagnosis
Symptoms of anaplasmosis can vary from patient to patient and often resemble other tick-borne diseases such as Rocky Mountain spotted fever and ehrlichiosis. Some patients have no memory of being bitten by a tick. In order to provide prompt treatment, healthcare providers should begin treatment based on clinical signs and symptoms. According to the CDC, “Treatment [of anaplasmosis] should never be delayed pending the receipt of laboratory test results, or be withheld on the basis of an initial negative laboratory result.” Diagnostic lab tests usually are negative in the first 7 to 10 days. Several different laboratory tests are effective in detecting anaplasmosis. The CDC details when and how each one is most useful:

During the acute phase of illness, a sample of whole blood can be tested by polymerase chain reaction (PCR) assay to determine if a patient has anaplasmosis. This method is most sensitive in the first week of illness, and rapidly decreases in sensitivity following the administration of appropriate antibiotics. Although a positive PCR result is helpful, a negative result does not completely rule out the diagnosis, and treatment should not be withheld due to a negative result.

During the first week of illness a microscopic examination of blood smears (known as a peripheral blood smear) may reveal morulae (microcolonies of Anaplasma) in the cytoplasm of white blood cells in up to 20% of patients. During A. phagocytophilum infection, morulae are most frequently observed in granulocytes. However, the observance of morulae in a particular cell type cannot conclusively identify the infecting species. Culture isolation of A. phagocytophilum is only available at specialized laboratories; routine hospital blood cultures cannot detect the organism.

The gold standard serologic test for diagnosis of anaplasmosis is the indirect immunofluorescence assay (IFA) using A. phagocytophilum antigen, performed on paired serum samples to demonstrate a significant (four-fold) rise in antibody titers. The first sample should be taken as early in the disease as possible, preferably in the first week of symptoms, and the second sample should be taken 2 to 4 weeks later. In most cases of anaplasmosis, the first IgG IFA titer is typically low, or “negative,” and the second typically shows a significant (four-fold) increase in IgG antibody levels. IgM antibodies usually rise at the same time as IgG near the end of the first week of illness and remain elevated for months or longer. Also, IgM antibodies are less specific than IgG antibodies and more likely to result in a false positive. For these reasons, physicians requesting IgM serologic titers should also request a concurrent IgG titer.

Serologic tests based on enzyme immunoassay (EIA) technology are available from some commercial laboratories. However, EIA tests are qualitative rather than quantitative, meaning they only provide a positive/negative result, and are less useful to measure changes in antibody titers between paired specimens. Furthermore, some EIA assays rely on the evaluation of IgM antibody alone, which may have a higher frequency of false positive results.

Antibodies to A. phagocytophilum may remain elevated for months or longer after the disease has resolved, or may be detected in persons who were previously exposed to antigenically related organisms. Between 5-10% of currently healthy people in some areas may have elevated antibody titers due to past exposure to A. phagocytophilum or similar organisms. Therefore, if only one sample is tested it can be difficult to interpret, while paired samples taken weeks apart demonstrating a significant (four-fold) rise in antibody titer provides the best evidence for a correct diagnosis of anaplasmosis. (CDC 2013)

Treatment and Prognosis
Patients treated correctly and promptly typically recover quickly. If incorrectly treated or treated too late, it can be life-threatening or fatal even to people who were healthy before infection. An estimated 1% of cases are fatal. The CDC recommends doxycycline to treat anaplasmosis:

Use of antibiotics other than doxycycline or other tetracyclines has been associated with a higher risk of fatal outcome for some rickettsial infections. Doxycycline is most effective at preventing severe complications from developing if it is started early in the course of disease. Therefore,
treatment must be based on clinical suspicion alone and should always begin before laboratory results return.

If the patient is treated within the first 5 days of the disease, fever generally subsides within 24-72 hours. In fact, failure to respond to doxycycline suggests that the patient’s condition might not be due to anaplasmosis. Severely ill patients may require longer periods before their fever resolves. Resistance to doxycycline or relapses in symptoms after the completion of the recommended course have not been documented.

Recommended Dosage: Doxycycline is the first line treatment for adults and children of all ages:
- Adults: 100 mg every 12 hours
- Children under 45 kg (100 lbs.): 2.2 mg/kg body weight given twice a day

Patients should be treated for at least 3 days after the fever subsides and until there is evidence of clinical improvement. Standard duration of treatment is 7 to 14 days. Some patients may continue to experience headache, weakness and malaise for weeks after adequate treatment. (CDC 2013)

There is no evidence that doxycycline (unlike older tetracyclines) causes staining of permanent teeth in children; doxycycline can therefore be safely used according to the specified dosage. Occasionally, however, allergies or pregnancy may require physicians to:

consider alternate antibiotics. Although recommended as a second-line therapeutic alternative to treat Rocky Mountain Spotted Fever, chloramphenicol is not recommended for the treatment of anaplasmosis, as studies have shown a lack of efficacy. Rifampin has been used successfully in several pregnant women with anaplasmosis, and studies suggest that this drug appears effective against Anaplasma species. However, rifampin is not effective in treating RMSF, a disease that may be confused with anaplasmosis. Healthcare providers should be cautious when exploring treatments other than doxycycline, which is highly effective in treating both. Other antibiotics, including broad spectrum antibiotics are not considered highly effective against A. phagocytophilum, and the use of sulfa drugs during acute illness may worsen the severity of infection. Antibiotic treatment following a tick bite is not recommended as a means to prevent anaplasmosis. There is no evidence this practice is effective, and this may simply delay onset of disease. (CDC 2013)

**Case Statistics for the United States, New York, and Suffolk County**

Until 2010, anaplasmosis was reported as ehrlichiosis. For annual data, and ehrlichiosis/anaplasmosis data before 2010, see [Case Statistics for Ehrlichiosis and Anaplasmosis](https://www.cdc.gov/parasites/anaplasmosis/statistics.html) (page 58).
References and Further Information
New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Electronic Surveillance System (CDESS). Data file. Available by permission from https://commerce.health.state.ny.us/hin/
V. BABESIOSIS

Pathogen and Transmission
Babesiosis is caused by microscopic protozoan parasites in the genus *Babesia* that infect red blood cells. *Babesia microti*—which usually infects small mammals such as the white-footed mouse (*Peromyscus leucopus*), but not deer—is the main species found to infect people in the United States. It is usually spread to humans by infected blacklegged (deer) ticks (*Ixodes scapularis*) in the nymph stage. It can also be transmitted through contaminated blood transfusions or from an infected mother to her fetus, but is not otherwise spread from person to person. Geographically, it is concentrated in the upper Midwest and Northeastern United States. In 2011, 37.2% of babesiosis cases were from New York. See Figures 2-4 for numbers and locations of Suffolk County babesiosis cases (CDC February 2014, NYSDOH 2013).

Symptoms
Babesiosis symptoms can range in severity from asymptomatic to life threatening. The symptoms listed below, when they occur, can start anywhere from a week to several months after being infected with the pathogen during a tick bite, and can continue from days to months after onset.

- Fever
- Chills
- Sweats
- Headache
- Body aches
- Loss of appetite
- Nausea
- Fatigue
- Hemolytic anemia

(CDC February 2014, NYSDOH 2013)

Diagnosis
Clinical signs and symptoms of babesiosis are often non-specific. The CDC recommends several options for laboratory diagnosis:

Antibody Detection
Diagnosis of *Babesia* infection should be made by detection of parasites in patients' blood smears. However, antibody detection tests are useful for detecting infected individuals with very low levels of parasitemia (such as asymptomatic blood donors in transfusion-associated cases), for diagnosis after infection is cleared by therapy, and for discrimination between *Plasmodium falciparum* and *Babesia* infection in patients whose blood smear examinations are inconclusive and whose travel histories cannot exclude either parasite.

The indirect fluorescent antibody test (IFA) using *B. microti* parasites as antigen detects antibodies in 88-96% of patients with *B. microti* infection. IFA antigen slides are prepared using washed, parasitized erythrocytes produced in hamsters. Patients' titers generally rise to ≥1:1024 during the first weeks of illness and decline gradually over 6 months to titers of 1:16 to 1:256 but may remain detectable at low levels for a year or more. Specificity is 100% in patients with other tick-borne diseases or persons not exposed to the parasite. Cross-reactions may occur in serum specimens from patients with malaria infections, but generally titers are highest with the homologous antigen.

The extent of cross-reactivity between *Babesia* species is variable. A negative result with *B. microti* antigen for a patient exposed on the West Coast may be a false-negative reaction for *Babesia* infection. Individuals whose exposure could have occurred on the West Coast should be tested also for antibodies to the *Babesia duncani*, because of the lack of cross-reactivity with *B. microti*.
Molecular diagnosis

In some infections with intraerythrocytic parasites, the morphologic characteristics observed on microscopic examination of blood smears do not allow an unambiguous differentiation between *Babesia* and *Plasmodium*. Moreover, potential blood donors may have subclinical symptoms and very low parasitemia, undetectable in blood smears. In such cases, the diagnosis can be derived from molecular techniques, such as PCR using the appropriate primers and single-step, or the more sensitive nested PCR technique. In addition, molecular approaches are very valuable in investigations of new *Babesia* variants (or species) observed in recent human infections in the US and in Europe. (CDC 2013)

Prognosis and Treatment

Not every case of babesiosis requires treatment, as the manifestations can range from asymptomatic to life-threatening. Babesiosis can be life threatening for individuals who:

- do not have a spleen
- have a weak/compromised immune system
- have other serious health conditions (i.e. liver or kidney disease)
- are elderly

In cases where there are clinical manifestations, the CDC notes that “treatment decisions should be individualized, especially for patients who have (or are at risk for) severe or relapsing infection,” and recommends the following options:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Adult dosage (usually treat for at least 7-10 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atovaquone</td>
<td>750 mg orally twice a day</td>
</tr>
<tr>
<td>along with</td>
<td></td>
</tr>
<tr>
<td>Azithromycin</td>
<td>on the first day, give a total dose in the range of 500-1000 mg orally; on subsequent days, give a total daily dose in the range of 250-1000 mg</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>Clindamycin</td>
<td>600 mg orally 3 times a day</td>
</tr>
<tr>
<td>or</td>
<td>300-600 mg intravenously 4 times a day</td>
</tr>
<tr>
<td>along with</td>
<td></td>
</tr>
<tr>
<td>Quinine</td>
<td>650 mg orally 3 times a day</td>
</tr>
</tbody>
</table>

Some patients—including those with severe illness—might require or benefit from supportive care, such as:

- antipyretics;
- vasopressors (if the blood pressure is low and unstable);
- blood transfusions;
- exchange transfusions (in which portions of a patient’s blood or blood cells are replaced with transfused blood components);
- mechanical ventilation; or
- dialysis

Currently there is no babesiosis vaccine available for humans (CDC 2013).
Case Statistics for Babesiosis

**Figure 2.** Suffolk County Babesiosis Cases 1992-2014. Data obtained from NYSDOH Communicable Disease Queries

**Figure 3.** Suffolk County Babesiosis Cases 2005-2009. Data obtained from NYSDOH CDESS
References and Further Information


New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Electronic Surveillance System (CDESS). Data file. Available by permission from https://commerce.health.state.ny.us/hin/

New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Queries. Data file. Available by permission from https://commerce.health.state.ny.us/hin/

VI. EHRlichiosis

Pathogen and Transmission

Ehrlichiosis is a tick-borne disease that is caused by the bacteria *Ehrlichia chaffeensis* or *Ehrlichia ewingii*, which are transmitted by the lone star tick (*Amblyomma americanum*). Cases in New York State have been concentrated on Long Island and in the Hudson Valley. Ehrlichiosis cannot be spread through person to person contact, but there is a risk of transmission through blood transfusions. See Figures 4-6 for numbers and locations of Suffolk County ehrlichiosis cases (CDC 2013, NYSDOH 2012).

Symptoms

Symptoms usually develop 1-3 weeks after the bite of an infected tick, and can range from mild to life-threatening.

- Fever
- Headache
- Chills
- Malaise
- Muscle/joint pain
- Nausea / Vomiting / Diarrhea
- Confusion
- Conjunctival injection (red eyes)
- Rash (in up to 60% of children, less than 30% of adults)
- In severe cases: difficulty breathing, bleeding disorders

(CDC 2013, NYSDOH 2012)

Diagnosis

Preliminary diagnosis of ehrlichiosis, for the purpose of prompt treatment, is based on the symptoms above and the possibility of exposure to ticks. The CDC (2013) gives the following recommendations for physician and laboratory diagnosis.

There are several aspects of ehrlichiosis that make it challenging for healthcare providers to diagnose and treat. The symptoms vary from patient to patient and can be difficult to distinguish from other diseases. Treatment is more likely to be effective if started early in the course of disease. Diagnostic tests based on the detection of antibodies will frequently be negative in the first 7-10 days of illness.

For this reason, healthcare providers must use their judgment to treat patients based on clinical suspicion alone. Healthcare providers may find important information in the patient’s history and physical examination that may aid clinical suspicion. Information such as recent tick bites, exposure to areas where ticks are likely to be found, or history of recent travel to areas where ehrlichiosis is endemic can be helpful in making the diagnosis. The healthcare provider should also look at routine blood tests, such as a complete blood cell count or a chemistry panel. Clues such as a low platelet count (thrombocytopenia), low white blood cell count (leukopenia), or elevated liver enzyme levels are helpful predictors of ehrlichiosis, but may not be present in all patients depending on the course of the disease. After a suspect diagnosis is made on clinical suspicion and treatment has begun, specialized laboratory testing should be used to confirm the diagnosis of ehrlichiosis.

During the acute phase of illness, a sample of whole blood can be tested by polymerase chain reaction (PCR) assay to determine if a patient has ehrlichiosis. This method is most sensitive in the first week of illness, and quickly decreases in sensitivity following the administration of appropriate antibiotics. Although a positive PCR result is helpful, a negative result does not completely rule out the diagnosis.
During the first week of illness a microscopic examination of blood smears (known as a peripheral blood smear) may reveal morulae (microcolonies of ehrlichiae) in the cytoplasm of white blood cells in up to 20% of patients.

The type of blood cell in which morulae are observed may provide insight into the infecting species: *E. chaffeensis* most commonly infects monocytes, whereas *E. ewingii* more commonly infect granulocytes. However, the observance of morulae in a particular cell type cannot conclusively identify the infecting species. Culture isolation of *Ehrlichia* is only available at specialized laboratories; routine hospital blood cultures cannot detect *Ehrlichia*.

When a person develops ehrlichiosis, their immune system produces antibodies to the *Ehrlichia*, with detectable antibody titers usually observed by 7-10 days after illness onset. It is important to note that antibodies are not detectable in the first week of illness in 85% of patients, and a negative test during this time does not rule out ehrlichiosis as a cause of illness.

The gold standard serologic test for diagnosis of ehrlichiosis is the indirect immunofluorescence assay (IFA) using *E. chaffeensis* antigen, performed on paired serum samples to demonstrate a significant (four-fold) rise in antibody titers. The first sample should be taken as early in the disease as possible, preferably in the first week of symptoms, and the second sample should be taken 2 to 4 weeks later. In most cases of ehrlichiosis, the first IgG IFA titer is typically low, or "negative," and the second typically shows a significant (four-fold) increase in IgG antibody levels. IgM antibodies usually rise at the same time as IgG near the end of the first week of illness and remain elevated for months or longer. Also, IgM antibodies are less specific than IgG antibodies and more likely to result in a false positive. For these reasons, physicians requesting IgM serologic titers should also request a concurrent IgG titer.

Serologic tests based on enzyme immunoassay (EIA) technology are available from some commercial laboratories. However, EIA tests are qualitative rather than quantitative, meaning they only provide a positive/negative result, and are less useful to measure changes in antibody titers between paired specimens. Furthermore, some EIA assays rely on the evaluation of IgM antibody alone, which may have a higher frequency of false positive results.

Antibodies to *E. chaffeensis* may remain elevated for months or longer after the disease has resolved, or may be detected in persons who were previously exposed to antigenically related organisms. Up to 12% of currently healthy people in some areas may have elevated antibody titers due to past exposure to *Ehrlichia* species or similar organisms. Therefore, if only one sample is tested it can be difficult to interpret, while paired samples taken weeks apart demonstrating a significant (four-fold) rise in antibody titer provides the best evidence for a correct diagnosis of ehrlichiosis (CDC 2013).

**Prognosis and Treatment**

The CDC (2013) recommends doxycycline as “the first line treatment for adults and children of all ages [which] should be initiated immediately whenever anaplasmosis is suspected.

If the patient is treated within the first 5 days of the disease, fever generally subsides within 24-72 hours. In fact, failure to respond to doxycycline suggests that the patient’s condition might not be due to ehrlichiosis. Severely ill patients may require longer periods before their fever resolves. Resistance to doxycycline or relapses in symptoms after the completion of the recommended course have not been documented.

**Recommended Dosage:** Doxycycline is the first line treatment for adults and children of all ages:

- Adults: 100 mg every 12 hours
- Children under 45 kg (100 lbs.): 2.2 mg/kg body weight given twice a day

Patients should be treated for at least 3 days after the fever subsides and until there is evidence of clinical improvement. Standard duration of treatment is 7 to 14 days. Some patients may continue to experience headache, weakness and malaise for weeks after adequate treatment.
Other Treatments

In cases of life threatening allergies to doxycycline and in some pregnant patients for whom the clinical course of ehrlichiosis appears mild, physicians may need to consider alternate antibiotics. Although recommended as a second-line therapeutic alternative to treat Rocky Mountain spotted fever (RMSF), chloramphenicol is not recommended for the treatment of either ehrlichiosis or anaplasmosis, as studies have shown a lack of efficacy. Rifampin appears effective against *Ehrlichia* in laboratory settings. However, rifampin is not effective in treating RMSF, a disease that may be confused with ehrlichiosis. Healthcare providers should be cautious when exploring treatments other than doxycycline, which is highly effective in treating both. Other antibiotics, including broad spectrum antibiotics are not considered highly effective against ehrlichiosis, and the use of sulfa drugs during acute illness may worsen the severity of infection.

Prophylaxis (Preventive Treatment)

Antibiotic treatment following a tick bite is not recommended as a means to prevent ehrlichiosis. There is no evidence this practice is effective, and this may simply delay onset of disease. Instead, persons who experience a tick bite should be alert for symptoms suggestive of tick-borne illness and consult a physician if fever, rash, or other symptoms of concern develop.

There is no ehrlichiosis vaccine available for humans (CDC 2013).

Case Statistics for Ehrlichiosis and Anaplasmosis

![Case Statistics for Ehrlichiosis and Anaplasmosis](image)

**Figure 4.** Confirmed and Probable Anaplasmosis, Ehrlichiosis, and Ehrlichiosis Total Cases 1992-2014. Data obtained from NYSDOH Communicable Disease Queries.
Figure 5. Suffolk County Ehrlichiosis Total Cases 2005-2009. Data obtained from NYSDOH CDESS.

Figure 6. Suffolk County Ehrlichiosis Cases 2010-2014. Data obtained from NYSDOH CDESS.
VII. LYME DISEASE

Pathogen and Transmission
Lyme disease is caused by the spirochetal bacterium *Borrelia burgdorferi* and transmitted by the blacklegged (deer) tick (*Ixodes scapularis*). A tick must be attached to a human for approximately 36 to 48 hours in order to transmit the disease. Although both nymph and adult ticks are capable of transmitting Lyme disease, adult ticks, due to their larger size, are more likely to be found and removed before the disease is transmitted. Adult blacklegged ticks are active in fall, winter, and spring, while nymphs are most active in the summer. Since 1984 when Lyme disease was first reported, New York State alone has seen over 95,000 cases of Lyme disease. See Figures 8-10 for numbers and locations of Suffolk County Lyme disease cases (CDC August 2015, NYSDOH 2011).

Symptoms
Initial symptoms usually develop 3-30 days after receiving a bite from an infected tick.

- Fever
- Chills
- Headache
- Fatigue
- Muscle and joint aches
- Swollen lymph nodes
- Erythema migraines (EM) rash

The rash, which begins at the site of the tick bite and expands and spreads, occurs in seventy to eighty percent of infected patients. It can reach up to 12 inches across, sometimes clearing in the center to create a “bull’s-eye.” Lack of a rash does not rule out Lyme disease. Brief redness and irritation at the site should not be mistaken for a rash (CDC 2015, NYSDOH 2011).

If Lyme disease is untreated, more severe symptoms may develop days to months later.

- Severe headaches
- Additional EM rashes across the body
- Arthritis
- Bell’s palsy
- Pain in tendons, muscles, joints, and bones
- Heart palpitations
- Intermittent dizziness
- Intermittent shortness of breath
- Meningitis/Encephalitis
- Nerve pain
- Pain, numbness, or tingling in the hands and feet
- Short term memory problems (CDC 2015, CDC July 2015, NYSDOH 2011)

**Diagnosis**

Diagnosis of Lyme disease is based on evaluation of symptoms and exposure to ticks, and supplemented by a two-step blood test (Figure 7):

The Two-tier Testing Decision Tree describes the steps required to properly test for Lyme disease. The first required test is the Enzyme Immunoassay (EIA) or Immunofluorescence Assay (IFA). If this test yields negative results, the provider should consider an alternative diagnosis. Or in cases where the patient has had symptoms for less than or equal to 30 days, the provider may treat the patient and follow up with a convalescent serum. If the first test yields positive or equivocal results, two options are available: 1) if the patient has had symptoms for less than or equal to 30 days, an IgM Western Blot is performed; 2) if the patient has had symptoms for more than 30 days, the IgG Western Blot is performed. The IgM should not be used if the patient has been ill for more than 30 days (CDC March 2015).

![Two-Tiered Testing for Lyme Disease](image)

**Two-Tiered Testing for Lyme Disease**

**First Test**
- Enzyme Immunoassay (EIA)  
  OR  
- Immunofluorescence Assay (IFA)

**Second Test**
- IgM and IgG Western Blot
- IgG Western Blot ONLY

Or in cases where the patient has had symptoms for less than or equal to 30 days, the provider may treat the patient and follow up with a convalescent serum. If the first test yields positive or equivocal results, two options are available: 1) if the patient has had symptoms for less than or equal to 30 days, an IgM Western Blot is performed; 2) if the patient has had symptoms for more than 30 days, the IgG Western Blot is performed. The IgM should not be used if the patient has been ill for more than 30 days (CDC March 2015).

**Treatment and Prognosis**

Early treatment with antibiotics such as doxycycline or amoxicillin is generally effective, and patients typically recover within a few weeks. Delayed treatment lessens the chance of a complete cure, and if neurological or
cardiac symptoms develop, intravenous antibiotic treatment may be necessary. Prophylaxis with antibiotics administered within three days of the bite is considered appropriate only if there is significant likelihood that Lyme disease was transmitted. (CDC August 2015, NYSDOH 2011). Though most patients recover after 2 to 4 weeks of antibiotics, a small percentage of cases’ symptoms continue for more than 6 months, called Post-Treatment Lyme Disease. Possible causes include damage to tissues and the immune system or continued infection with *B. burgdorferi*. Research is ongoing. Continued antibiotic treatment is typically not recommended; after several months, the symptoms generally fade. (CDC July 2015). A human Lyme disease recombinant vaccine, LYMErix™ (GlaxoSmithKline), was approved in December 1998. However, the manufacturer took the vaccine off the market in February 2002 because of declining sales. According to the CDC, protection provided by this vaccine diminishes over time. Therefore, Lyme disease vaccine given before 2002 is most likely no longer protective against Lyme disease. A new chimeric vaccine that targets all North American strains of *Borrelia burgdorferi* is currently undergoing trials in Europe (CDC November 2015, Wressnigg et al., 2013).

**Case Statistics for Lyme Disease in Suffolk County**

![Lyme Disease Suffolk County Cases per Year](image)

Figure 8. **Suffolk County Lyme Disease Cases 1992-2014.** Data obtained from NYSDOH Communicable Disease Queries
Recent evidence suggests that Lyme disease may be drastically underreported. While approximately 30,000 cases of Lyme disease are reported to the CDC each year, some researchers suggest the true number is closer to 300,000 (Nelson et al., 2015).
VIII. ROCKY MOUNTAIN SPOTTED FEVER

Pathogen and Transmission
Rock Mountain spotted fever (RMSF) is caused by the bacterium *Rickettsia rickettsii* and transmitted by the bite of an infected tick. In New York, the American dog tick (*Dermacentor variabilis*) is the primary vector, and children are most commonly infected, though fewer than 80 cases are reported per year. RMSF is the most common disease in the category Spotted Fever rickettsiosis, which includes similar disease not caused specifically by *R. rickettsii*.

See Figures 11-13 for numbers and locations of Suffolk County Rocky Mountain spotted fever cases (CDC 2013, NYSDOH 2011).

Symptoms
Symptoms usually develop two to fourteen days after being bitten by an infected tick. Early symptoms are often non-specific. Only approximately 90% of individuals develop a rash and some develop a rash later in the course of
illness or after antibiotic treatment has begun. Therefore, initiation of treatment should not be based solely on the presence or absence of a rash.

- Fever
- Rash (occurs 2-5 days after fever, may be absent in some cases; more common in children)
- Headache
- Nausea
- Vomiting
- Abdominal pain (may mimic appendicitis or other causes of acute abdominal pain)
- Muscle pain
- Lack of appetite
- Conjunctival injection (red eyes) (CDC 2013, NYSDOH 2011).

**Diagnosis**

Symptoms of RMSF can vary from patient to patient, and often resemble more common diseases. Diagnostic lab tests usually are negative in the first 7 to 10 days. In order to provide prompt treatment, healthcare providers should make a preliminary diagnosis and begin treatment immediately. Presenting symptoms, recent exposure to ticks, and an examination of routine blood test results for thrombocytopenia, hyponatremia, or elevated liver enzyme levels can be part of a diagnosis. The CDC states that “treatment should never be delayed pending the receipt of laboratory test results, or be withheld on the basis of an initial negative finding for *R. rickettsii*.”

*R. rickettsii* infects the endothelial cells that line blood vessels, and does not circulate in large numbers in the blood unless the patient has progressed to a very severe phase of infection. For this reason, blood specimens (whole blood, serum) are not always useful for detection of the organism through polymerase chain reaction (PCR) or culture. If the patient has a rash, PCR or immunohistochemical (IHC) staining can be performed on a skin biopsy taken from the rash site. This test can often deliver a rapid result. These tests have good sensitivity (70%) when applied to tissue specimens collected during the acute phase of illness and before antibiotic treatment has been started, but a negative result should not be used to guide treatment decisions. PCR, culture, and IHC can also be applied to autopsy specimens (liver, spleen, kidney, etc.) collected after a patient dies. Culture of *R. rickettsii* is only available at specialized laboratories; routine hospital blood cultures cannot detect *R. rickettsii*.

During RMSF infection, a patient’s immune system develops antibodies to *R. rickettsii*, with detectable antibody titers usually observed by 7-10 days after illness onset. It is important to note that antibodies are not detectable in the first week of illness in 85% of patients, and a negative test during this time does not rule out RMSF as a cause of illness.

The gold standard serologic test for diagnosis of RMSF is the indirect immunofluorescence assay (IFA) with *R. rickettsii* antigen, performed on two paired serum samples to demonstrate a significant (four-fold) rise in antibody titers. The first sample should be taken as early in the disease as possible, preferably in the first week of symptoms, and the second sample should be taken 2 to 4 weeks later. In most RMSF cases, the first IgG IFA titer is typically low or negative, and the second typically shows a significant (fourfold) increase in IgG antibody levels. IgM antibodies usually rise at the same time as IgG near the end of the first week of illness and remain elevated for months or even years. Also, IgM antibodies are less specific than IgG antibodies and more likely to result in a false positive. For these reasons, physicians requesting IgM serologic titers should also request a concurrent IgG titer.

Both IgM and IgG levels may remain elevated for months or longer after the disease has resolved, or may be detected in persons who were previously exposed to antigenically related organisms. Up to 10% of currently healthy people in some areas may have elevated antibody titers due to past exposure to *R. rickettsii* or similar organisms. Therefore, if only one sample is tested it can be difficult to interpret, whereas two paired samples taken weeks apart demonstrating a significant (four-fold) rise in antibody titer provide the best evidence for a correct diagnosis of RMSF (CDC 2013).
**Prognosis and Treatment**

The CDC recommends doxycycline as treatment for RMSF for children and adults.

If the patient is treated within the first 5 days of the disease, fever generally subsides within 24-72 hours. In fact, failure to respond to doxycycline suggests that the patient’s condition might not be RMSF. Severely ill patients may require longer periods before their fever resolves, especially if they have experienced damage to multiple organ systems. Resistance to doxycycline or relapses in symptoms after the completion of the recommended course of treatment have not been documented. Recommended Dosage: Doxycycline is the first line treatment for adults and children of all ages:

- Adults: 100 mg every 12 hours
- Children under 45 kg (100 lbs.): 2.2 mg/kg body weight given twice a day

Patients should be treated for at least 3 days after the fever subsides and until there is evidence of clinical improvement. Standard duration of treatment is 7-14 days.

**Other Treatments**

In cases of life threatening allergies to doxycycline and in some pregnant patients for whom the clinical course of RMSF appears mild, chloramphenicol may be considered as an alternative antibiotic. Oral formulations of chloramphenicol are not available in the United States, and use of this drug carries the potential for other adverse risks, such as aplastic anemia and grey baby syndrome. Furthermore, the risk for fatal outcome is elevated in patients who are treated with chloramphenicol compared to those treated with doxycycline. Other antibiotics, including broad spectrum antibiotics are not effective against *R. rickettsii*, and the use of sulfa drugs may worsen infection.

**Prophylaxis (Preventive Treatment)**

Antibiotic treatment following a tick bite is not recommended as a means to prevent RMSF. There is no evidence this practice is effective, and may simply delay onset of disease. Instead, persons who experience a tick bite should be alert for symptoms suggestive of tick-borne illness and consult a physician if fever, rash, or other symptoms of concern develop. (CDC September 2013)

Currently there is no Rocky Mountain spotted fever vaccine available for humans (CDC 2013).
Case Statistics for Rocky Mountain Spotted Fever

Rocky Mountain Spotted Fever
Suffolk County Cases per Year

Figure 11. Suffolk County Rocky Mountain Spotted Fever Cases 1992-2014. Data obtained from NYSDOH Communicable Disease Queries.

Suffolk County Rocky Mountain Spotted Fever Cases 2005-2009

Figure 12. Suffolk County Rocky Mountain Spotted Fever Cases 2005-2009. Data obtained from NYSDOH CDESS.
IX. TULAREMIA

Pathogen and Transmission
Tularemia is caused by the bacterium *Francisella tularensis*. The bacterium can infect a human through the skin, eyes, mouth, throat, or lungs. It is often transmitted to humans and animals by the American dog tick (*Dermacentor variabilis*), the wood tick (*Dermacentor andersoni*), and the lone star tick (*Amblyomma americanum*), as well as by the deer fly (*Chrysops spp*). It can also be transmitted by contact with an infected animal, contaminated water,
contaminated dust, or through exposure in a laboratory. It is not transmitted from person to person. See Figures 14-16 for numbers and locations of Suffolk County tularemia cases (CDC October 2015).

**Symptoms**
Symptoms of tularemia vary depending on the way the patient was infected. A fever of up to 104°F is present in all cases.

- Ulceroglandular: ulcer at site of bite or contact, swelling of regional lymph glands
- Glandular: Swelling of regional lymph glands, without an ulcer
  (Ulceroglandular and glandular symptoms occur as a result of animal bites or skin contact)
- Oculoglandular: inflammation/irritation of the eye, swelling of lymph glands in front of the ear
  (Oculoglandular symptoms occur as a result of contamination through the eye)
- Oropharyngeal: sore throat, mouth ulcers, tonsillitis, swelling of lymph glands in the neck
  (Oropharyngeal symptoms occur as a result of consumption of contaminated food or water)
- Pneumonic: cough, chest pain, difficulty breathing
  (Pneumonic symptoms occur as a result of breathing contaminated dusts or aerosols, or of untreated lesser forms spreading through the bloodstream. Pneumonic tularemia is the most severe form.)
- Typhoidal: a combination of general symptoms. (CDC October 2015, CDC July 2015)

**Diagnosis**
Tularemia is rare and can be difficult to diagnose. The symptoms can be mistaken for other illnesses so it is important to identify possible exposure such as arthropod bites (e.g. ticks, deer flies) or contact with animals (e.g. sick/dead animals, pets, hunted game). The CDC provides the following recommendations for diagnostic testing:

Physicians who suspect tularemia should promptly collect appropriate specimens (see below) and alert the laboratory to the need for special diagnostic and safety procedures. Rapid diagnostic testing for tularemia is not widely available.

Growth of *F. tularensis* in culture is the definitive means of confirming the diagnosis of tularemia. Appropriate specimens include swabs or scrapping of skin lesions, lymph node aspirates or biopsies, pharyngeal washings, sputum specimens, or gastric aspirates, depending on the form of illness. Paradoxically, blood cultures are often negative.

A presumptive diagnosis of tularemia may be made through testing of specimens using direct fluorescent antibody, immunohistochemical staining, or PCR.

The diagnosis of tularemia can also be established serologically by demonstrating a 4-fold change in specific antibody titers between acute and convalescent sera. Convalescent sera are best drawn at least 4 weeks after illness onset; hence this method is not useful for clinical management. (July 2015)

**Treatment/Prognosis**
According to the CDC:

Tularemia can be fatal, but is generally treated successfully with antibiotics. Streptomycin is the drug of choice based on experience, efficacy and FDA approval. Gentamicin is considered an acceptable alternative, but some series have reported a lower primary success rate. Treatment with aminoglycosides should be continued for 10 days.

Tetracyclines may be a suitable alternative to aminoglycosides for patients who are less severely ill. Tetracyclines are static agents and should be given for at least 14 days to avoid relapse.

Ciprofloxacin and other fluoroquinolones are not FDA-approved for treatment of tularemia but have shown good efficacy in vitro, in animals, and in humans.
A tularemia vaccine had been available for use by laboratory workers routinely working with *Francisella tularenisis*. However, it is under review by the US Food and Drug Administration (FDA) and is not currently available (CDC July 2015).

**Prevention**
- Avoid tick bites
- Avoid bare-hand contact with sick or dead animals, both wild and domestic
- Avoid mowing over dead animals
- Avoid undercooked meat, especially game meat
- Do not drink untreated water
- Hospitals and morgues should abide by standard procedures when handling the bodies of those who died of tularemia. Isolation of tularemia patients is unnecessary.
- In addition, laboratories working with *F. tularenisis* should take the following precautions recommended by the CDC:
  - Laboratory personnel should be alerted when tularemia is suspected. Diagnostic procedures with clinical materials can be performed in biosafety level 2 conditions. All work with suspect cultures of *F. tularenisis* should be done in a biological safety cabinet. Manipulation of cultures and other procedures that might produce aerosols or droplets (e.g., grinding, centrifuging, vigorous shaking, animal studies) should be conducted under biosafety level 3 conditions (CDC October 2015).

**Case Statistics for Tularemia**

![Tularemia Suffolk County Cases per Year](image)

Figure 14. Suffolk County Tularemia Cases 1992-2014. Data obtained from NYSDOH Communicable Disease Queries.
Figure 15. Suffolk County Tularemia Cases 2005-2009. Data obtained from NYSDOH CDESS.

Figure 16. Suffolk County Tularemia Cases 2010-2014. Data obtained from NYSDOH CDESS.
X. EMERGING DISEASES

Summary
The CDC defines emerging diseases as “infectious diseases whose incidence in humans has increased in the past 2 decades or threatens to increase in the near future,” including:

- New infections resulting from changes or evolution of existing organisms
- Known infections spreading to new geographic areas or populations
- Previously unrecognized infections appearing in areas undergoing ecologic transformation
- Old infections reemerging as a result of antimicrobial resistance in known agents or breakdowns in public health measures.

(Rhttp://wwwnc.cdc.gov/eid/page/background-goals)

*Rickettsia amblyommii*

Pathogen and Transmission
*Rickettsia amblyommii* is a member of the spotted fever group *Rickettsia*. It is transmitted to humans by the lone star tick (*Amblyomma americanum*). Its pathogenicity is unknown, but it is speculated that it could be responsible for the rise in apparent incidence of Rocky Mountain spotted fever (caused by *Rickettsia rickettsii*) that coincided with a drop in mortality rates. The areas where this increase in RMSF has occurred correlate with the spread of the lone star tick. It is hypothesized that “less pathogenic rickettsiae [spread by the lone star tick] are causing more human infections,” accounting for the higher incidence of less severe rickettsial infection (Dahlgren et al., 2015).

Symptoms
- Mild fever (Mixon et al., 2006)

Diagnosis
Accurate diagnosis of rickettsial infection is difficult. An IFA test often leads to a diagnosis of RMSF; IgG tests give more specificity and can distinguish between different rickettsial infections (Apperson et al., 2008).
Treatment and Prognosis
Current research suggests that *Rickettsia amblyommii* is less severe than RMSF; some studies suggest that infection with *R. amblyommii* gives immunity against *Rickettsia rickettsii* (Blanton et al., 2014).

Case Statistics
*R. amblyommii* is not a reportable disease.

References

**STARI (Southern Tick-Associated Rash Illness)**

Pathogen and Transmission
STARI (Southern Tick-Associated Rash Illness) is believed to be spread by the bite of a lone star tick. The cause of the illness is unknown.

Symptoms
- Red, expanding bull’s-eye lesion at site of bite. Rash appears within 7 days and expands to 8 or more centimeters, distinguishing it from normal irritation at the site of a tick bite.
- Fatigue
- Headache
- Fever
- Muscle and joint pain

The rash appears within 7 days (faster than in cases of Lyme disease), and in some cases, that is the only symptom. The diameter of the lesions is lesser in STARI than in Lyme disease, and symptoms are less severe. (Wormser et al., 2005a, Wormser et al., 2005b)

Diagnosis
No diagnostic test exists for STARI. Diagnosis is based on a combination of symptoms and risk or history of a tick bite.
Treatment and Prognosis
STARI is often treated with doxycycline; it has been seen to clear without treatment.

Case Statistics
STARI is not a reportable disease

References


Borrelia miyamotoi

Pathogen and Transmission
Borrelia miyamotoi infection is caused by a species of spirochete, a spiral shaped bacteria related to the bacterium which causes tick-borne relapsing fever and Lyme disease, and is transmitted by the blacklegged tick (Ixodes scapularis). It was first noted in Japan, and confirmed as a human pathogen in Russia in 2011 (Platonov et al., 2011). The first recognized cases in North America were reported in 2013 (Molloy et al., 2015). Fewer than 60 human cases have been reported in the US, but efficient and effective diagnosis of Borrelia miyamotoi still needs to be improved to gain an accurate understanding of its scope.

Symptoms
- Fever
- Chills
- Headache
- Myalgia
- Arthralgia
- Fatigue
- Nausea
- Meningoencephalitis (in severe cases) (Planotov et al., 2011)
Diagnosis
Symptoms are non-specific and should be supported with laboratory testing. A test for Lyme disease is not helpful in diagnosing *B. miyamotoi* infection. Blood smear examination, PCR, antibody assay, in vitro cultivation, and/or isolation by animal inoculation can be used to diagnose *B. miyamotoi* infection (Krause et al., 2015).

Treatment and Prognosis
Doxycycline is effective for most cases of *B. miyamotoi* infection. Ceftriaxone or penicillin G can be used for cases with meningoencephalitis (Krause et al., 2015).

Case Statistics
*B. miyamotoi* is not a reportable disease

References

Bourbon Virus

Pathogen and Transmission
Bourbon virus is a novel virus in the genus *Thogotovirus* that was discovered in 2015 from Bourbon County, Kansas (Kosoy et al., 2015). Only two case have been reported, Kansas and Oklahoma. Bourbon virus is believed to be transmitted by tick or insect bites.

Symptoms
- Fever
- Fatigue
- Anorexia
- Vomiting
- Maculopapular rash
- Thrombocytopenia
- Leukopenia
(Kosoy et al., 2015)
Diagnosis
There are no routine laboratory tests available to determine if a person is infected with Bourbon virus. However, protocols are being developed to allow for investigational diagnostic testing of acute disease.

Treatment and Prognosis
One case of Bourbon virus was unsuccessfully treated with doxycycline. Until more is learned about how to treat Bourbon virus, supportive therapy is the recommended method of treatment (CDC 2015, Kosoy et al., 2015).

Case Statistics
Only two cases of Bourbon virus have been reported.

References

Heartland Virus

Pathogen and Transmission
Heartland virus is a novel Phlebovirus first seen in 2009 when two patients were admitted to hospitals in Missouri with febrile illness (McMullan et al., 2012). Both patients reported exposure to ticks before becoming ill. During 2012-2013, 6 additional cases of Heartland virus were identified. All 8 Heartland virus cases were in males aged 50 years or older living in Missouri, and Tennessee, with symptom onset during May-September (Pastula et al., 2014). Additional cases have been identified in Oklahoma (https://www.ok.gov/health2/documents/Heartland%20virus%202014%20May.pdf) and Missouri (Karen Yates personal communication). Studies suggest that lone star ticks may transmit the virus to humans after becoming infected through feeding on viremic hosts (Savage et al., 2013). A 2015 study found that wildlife tested positive for Heartland virus antibodies in 11 states that have not yet had human cases, including Vermont, New Hampshire, and Maine; New York was not included in the study (Riemersma & Komar, 2015).

Symptoms
- Fever
- Fatigue
- Headache
- Muscle ache
- Diarrhea

References
Nausea
Anorexia
Leukopenia
Thrombocytopenia
Elevated liver transaminases
(CDC 2014, Missouri Department of Health and Senior Services 2015)

Initial clinical laboratory results, symptoms, and occurrence of a tick bite are similar to ehrlichiosis infections, however Heartland virus infection should be considered when suspected ehrlichiosis does not improve after a few days of doxycycline treatment (McMullan et al., 2012).

**Diagnosis**

No routine laboratory test exists to diagnose Heartland virus infections.

**Treatment and Prognosis**

In most cases, patients fully recover with only supportive care. One elderly patient with comorbidities died (CDC 2014, Missouri Department of Health and Senior Services 2015).

**Case Incidence**

Heartland virus is not a reportable disease.

**References**

Centers for Disease Control and Prevention (March 26, 2014). *Heartland virus.*

http://www.cdc.gov/ncezid/dvbd/heartland/index.html


Missouri Department of Health and Senior Services. Heartland Virus and Bourbon Virus: What do I need to know? Retrieved October 2015 from

http://health.mo.gov/living/healthcondiseases/communicable/tickscarrydisease/


Powassan Virus (POWV) and Deer Tick Virus (DTV)

Pathogen and Transmission
POWV and DTV are of the genus Flavivirus, related to West Nile virus and St. Louis encephalitis virus. POWV was first found in humans in 1958; it averaged 0.7 cases per year until 1999, when it increased to approximately 1.3 cases per year and began to spread into the north-central United States (Hinten et al., 2008). POWV has two lineages: the prototype lineage referred to as lineage I POWV and lineage II POWV (AKA DTV). The two lineages are indistinguishable from each other except by genetic sequence analysis (El Khoury et al., 2013). However, they have separate vectors and reservoir hosts. POWV is transmitted by Ixodes cookei, which feeds primarily on woodchucks as reservoir hosts and DTV is transmitted by Ixodes scapularis, which feeds primarily on the white-footed mouse as the reservoir host. DTV has been shown in the laboratory to be transmitted to mice in as little as 15 minutes of attachment (Ebel & Kramer 2004). Blacklegged ticks from Suffolk County have been found to be infected with Powassan virus but the lineage was undetermined (Crowder et al., 2010, Tokarz et al., 2010, 2014).

Symptoms
Initial:
- Fever
- Headache
- Vomiting
- Weakness
- Confusion
- Seizures
- Memory loss

Later Stage:
- Long-term neurologic problems
- Loss of coordination
- Speech difficulty
- Seizures
- Encephalitis
- Meningitis
- Aphasia
- Paresis
- Cranial nerve palsies

The incubation period (time from tick bite to onset of illness) ranges from one week to one month. Not all cases display symptoms (CDC 2015b).

Diagnosis
A tentative diagnosis based on signs and symptoms can be confirmed through diagnostic testing. The CDC has given the following recommendations:

Cerebrospinal fluid (CSF) findings include lymphocytic pleocytosis of less than 500 white blood cells/mm3 in the majority of POW virus encephalitis cases; granulocytes can predominate early in the disease. CSF protein is generally normal or mildly elevated, while glucose concentration is normal. Electroencephalography (EEG) in patients with POW virus encephalitis reveals generalized slow wave activity and results can resemble those seen in herpes simplex virus encephalitis. MRI of the brain in patients with POW virus encephalitis shows changes consistent
with microvascular ischemia or demyelinating disease in the parietal or temporal lobes; results of brain CT scans have not been particularly useful.

POW virus is difficult to isolate from clinical samples; almost all isolates (and positive PCR results) have come from postmortem brain tissue or CSF. Serologic testing remains the primary method for diagnosing POW virus infection. Combined with a consistent clinical presentation in an endemic area, a diagnosis of acute neuroinvasive POW virus disease can be made by the detection of POW virus-specific IgM antibody in serum or CSF. POW virus IgM tests are not commercially available but can be requested through state health department laboratories and CDC. A positive POW virus IgM test result should be confirmed by neutralizing antibody testing of acute- and convalescent-phase serum specimens at a state public health laboratory or CDC. To submit specimens for testing at CDC, please contact your state health department. All POW virus disease cases should be reported to local public health authorities (CDC 2015b).

Diagnostic Testing

Preliminary diagnosis is often based on the patient's clinical features, places and dates of travel (if patient is from a non-endemic country or area), activities, and epidemiologic history of the location where infection occurred.

Laboratory diagnosis of arboviral infections is generally accomplished by testing of serum or cerebrospinal fluid (CSF) to detect virus-specific IgM and neutralizing antibodies.

In fatal cases, nucleic acid amplification, histopathology with immunohistochemistry and virus culture of autopsy tissues can also be useful. Only a few state laboratories or other specialized laboratories, including those at CDC, are capable of doing this specialized testing.

Test results are normally available 4 to 14 days after specimen receipt. Reporting times for test results may be longer during summer months when arbovirus activity increases. Receipt of a hard copy of the results will take at least 2 weeks after testing is completed. Initial serological testing will be performed using IgM capture ELISA, MIA (Microsphere-Based Immunoassay) and IgG ELISA. If the initial results are positive, further confirmatory testing may delay the reporting of final results. ALL RESULTS WILL BE SENT TO THE APPROPRIATE STATE HEALTH DEPARTMENT. Notify your state health department of any submissions to CDC (CDC 2015b).

Treatment and Prognosis

There is no specific treatment, but people with severe POW virus illnesses often need to be hospitalized to receive respiratory support, intravenous fluids, or medications to reduce swelling in the brain. Neurologic sequelae often remain after the acute infection has passed.

Case Incidence

One case of Powassan was reported in Suffolk County in 2009 (NYSDOH Communicable Disease Queries). In NY, a study from 2004 to 2012 of 14 POW patients found 72% of the cases in the Lower Hudson Valley with a 36% mortality rate (Khoury et al., 2013).

*For more information regarding any of the above tick-borne diseases, please see Appendix K

References


http://diseasemaps.usgs.gov/mapviewer/

**Alpha-Gal Allergy**

Alpha-gal allergy is a recently identified condition that is associated with tick bites, but not a tick-borne pathogen, which can occur after the consumption of red meat (Commins & Platts-Mills, 2013, Tripathi et al., 2014). Galactose-alpha-1,3-galactose (alpha-gal) is a carbohydrate or oligosaccharide present in the cell membranes of all non-primate mammals. Therefore, if a human is exposed to this oligosaccharide, it is recognized by the body’s immune system as being a foreign antigen. Certain tick species contain alpha-gal and presumably can deliver this carbohydrate to the host during feeding (Hamsten et al., 2013). When ticks feed on humans, the exposure of alpha-gal during feeding produces an immunological response and the production of IgE antibodies to alpha-gal. Subsequently, sensitized individuals to alpha-gal from tick bites can develop an allergic reaction to the alpha-gal carbohydrate, which is absorbed into the blood stream during the consumption and digestion of non-primate mammalian meat such as beef, pork and lamb (i.e. not poultry or fish).

Alpha-gal allergy symptoms first occur approximately 3 to 6 hours after the consumption of red meat as itching or hives and can progress to anaphylaxis. Mild alpha-gal allergy symptoms can be treated with diphenhydramine (Benadryl®) while more severe reactions (e.g. anaphylaxis) can be treated with epinephrine; however, patients with cardiac disease history should take less extreme steps initially (Tripathi et al., 2014). To assist with diagnosis, IgE antibodies levels to alpha-gal can be determined by commercial laboratories. Long-term management for alpha-gal allergy is avoidance of contact with the allergen, which includes precautions to prevent tick bites and avoidance of the ingestion of mammalian meat and associated products (e.g. gelatin). After prolonged avoidance of exposure to
alpha-gal (i.e. 1 - 2 years), IgE antibody levels to alpha-gal should decrease and patients can begin the reintroduction of red meat into the diet.

Alpha-gal allergy has been identified in various countries throughout the world as well as in Suffolk County (Commins & Platts-Mills, 2013). Locally, the first case was identified in October 2011 by Erin McGintee, MD and since then she has diagnosed approximately 250 patients with alpha-gal allergy (https://www.youtube.com/watch?v=hj96Vvr1WhQ&feature=youtu.be). Other local allergists are now diagnosing patients with alpha-gal allergy.

Data from Dr. McGintee’s first 100 patients:
- Age range 5-87 (average 47.8 years)
- 48 females, 52 males
- Alpha-gal IgE range from 1.05 to >100 kU/L
- Total serum IgE range from 26-1634 kU/L
- 12/100 patients were under 18 years at time of presentation
- Most cases presented in the middle of the night (3-6 hours after dinner)
- Most common symptoms were:
  - Urticarial, flushing, itch
  - Abdominal pain, nausea, vomiting, diarrhea
  - Pre-syncope, syncope, hypotension
  - Shortness of breath, wheezing, chest tightness
- Most patients can tolerate some meat (fattier meats may increase allergic reactions)
- Most patients can tolerate dairy
- With increase time and decreased alpha-gal exposure (i.e. red meat consumption, tick bites)
  - Decreased alpha-gal IgE
  - Decreased total IgE
  - Decreased clinical sensitivity to ingestion of red meat
- History of lone star tick bites; adult, nymphal or larval (AKA “chigger bites”)

In Suffolk County, alpha-gal allergy appears to be related to the expanding lone star tick population.

References


XI. RECOMMENDATIONS

Case Numbers and Proper Reporting
- Increase awareness in the medical community of the presence of all tick-borne diseases.
- Create case definitions for all tick-borne diseases.
• Encourage reporting of all tick-borne diseases.
• Increase tick and tick-borne pathogen surveillance to determine the incidence and distribution of ticks, tick-borne pathogens and related disease risks.
• Investigate the role of ticks in the transmission of *Bartonella* spp to humans and animals.

**Diagnosis**

• Improve serologic testing for tick-borne diseases.
• Treat patients based upon clinical diagnoses, regardless of diagnostic test results.
• Increase awareness of tick-borne diseases in the medical community.
• Develop diagnostic testing for all tick-borne diseases.
• When possible, implement PCR analysis for human testing along with antibody analysis. This would eliminate the need for follow-up confirmatory antibody analysis.

**Treatment**

• Determine the most effective length of time of antibiotic treatment for all tick-borne diseases.
• The Infectious Diseases Society of America (IDSA), International Lyme and Associated Diseases Society (ILADS), and all other entities should work together on the development of treatment strategies.
• Rely on our healthcare professionals for the diagnosis and treatment of tick-borne diseases.
• Mandate insurance companies to treat according to the course of treatment recommended by the healthcare professional.

**Prevention**

• Increase the public's awareness of all tick-borne diseases and prevention methods.
• Manage the deer herd in order to reduce tick numbers.
• Whenever possible, develop human vaccines for tick-borne pathogens.
Chapter 5

Emily Johnson, Christopher Romano, Scott R. Campbell, PhD and Medical Team*

MOSQUITO-BORNE DISEASES OF HUMANS

Table of Contents

MOSQUITO-BORNE DISEASES OF HUMANS

I. INTRODUCTION .................................................................................................................. 82
II. WEST NILE VIRUS ............................................................................................................ 83
III. EASTERN EQUINE ENCEPHALITIS .............................................................................. 87
IV. MALARIA .......................................................................................................................... 89
V. DIROFILARIASIS .............................................................................................................. 94
VI. EMERGING MOSQUITO-BORNE DISEASES ................................................................. 95
VII. MOSQUITO SURVEILLANCE AND CONTROL ............................................................. 103
VIII. PERSONAL PROTECTION .......................................................................................... 105
IX. RECOMMENDATIONS .................................................................................................... 105

*Medical Team—See page 2

I. INTRODUCTION

The human case data for this chapter was obtained from the New York State Department of Health’s CDESS (Communicable Disease Electronic Surveillance System – Oracle) and Communicable Disease Queries online systems. The human case data by zip code included in the incidence maps was obtained through CDESS. CDESS includes confirmed, probable, suspect and revoked cases. The human case data included in the incidence tables was obtained through the Communicable Disease Queries system. Currently, for the reportable diseases discussed here, Communicable Disease Queries includes confirmed and probable cases, aside from malaria which includes confirmed cases only. However, reporting criteria may have changed over the years, so what was reported in the past may not be the same as what is reported today. For example, prior to 2008 only confirmed cases of Lyme disease were reported. In 2008, the case definition was changed to included probable cases as well. Past reporting criteria for comparison to present day criteria are not readily available.
Table 1. Suffolk County Mosquito-Borne Disease Human Cases by Year. Data obtained from NYSDOH Communicable Disease Queries. Grayed out fields indicate no data available.

<table>
<thead>
<tr>
<th>Year</th>
<th>WN Fever</th>
<th>WN Encephalitis</th>
<th>WN Total</th>
<th>EEEV</th>
<th>Malaria</th>
<th>Chickungunya</th>
<th>Dengue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>2</td>
<td>8</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>4</td>
<td>5</td>
<td>9</td>
<td>0</td>
<td>11</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>11</td>
<td>14</td>
<td>25</td>
<td>0</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>11</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

References
New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Electronic Surveillance System (CDESS). Data file. Available by permission from https://commerce.health.state.ny.us/hin/

New York State Department of Health, Division of Epidemiology (December 2015). Communicable Disease Queries. Data file. Available by permission from https://commerce.health.state.ny.us/hin/

II. WEST NILE VIRUS

Pathogen and Transmission

West Nile virus is an arbovirus spread by infected mosquitoes, which have usually contracted WNV after feeding on an infected bird. In New York, Culex pipiens-restuans is the most common vector. It was first documented in New York in 1999, and has spread to all lower 48 states. See Tables 1-2 and Figures 1-3 for numbers and locations of Suffolk County West Nile virus cases. Biting an infected human does not infect a mosquito. WNV can be spread through blood transfusion, organ transplants, in utero, intrapartum, and through breastfeeding.
**Symptoms**

Symptoms typically develop 2-6 days after infection, though it can take longer; seventy to eighty percent of those infected develop no symptoms. Approximately 20% of those infected develop symptoms including:

- Fever
- Headache
- Body aches
- Joint pain
- Vomiting
- Diarrhea
- Rash

Less than 1% of those infected develop encephalitic symptoms:

- Encephalitis (fever, seizures, focal neurologic deficits, movement disorders, altered mental status)
- Meningitis (fever, headache, nuchal rigidity)
- WNV acute flaccid paralysis/WNV poliomyelitis (limb paralysis, respiratory paralysis; can occur without fever (CDC September 2015, NYSDOH 2011)

**Diagnosis**

WNV is diagnosed based on an examination of symptoms diagnostic testing. Similar infections such as La Crosse, St. Louis encephalitis, eastern equine encephalitis, and Powassan viruses should be ruled out. The CDC (September 2015) gives the following guidelines on diagnostic testing:

**WNV Antibody Testing**

Laboratory diagnosis is generally accomplished by testing of serum or cerebrospinal fluid (CSF) to detect WNV-specific IgM antibodies. Immunoassays for WNV-specific IgM are available commercially and through state public health laboratories.

WNV-specific IgM antibodies are usually detectable 3 to 8 days after onset of illness and persist for 30 to 90 days, but longer persistence has been documented. Therefore, positive IgM antibodies occasionally may reflect a past infection. If serum is collected within 8 days of illness onset, the absence of detectable virus-specific IgM does not rule out the diagnosis of WNV infection, and the test may need to be repeated on a later sample.

The presence of WNV-specific IgM in blood or CSF provides good evidence of recent infection but may also result from cross-reactive antibodies after infection with other flaviviruses or from non-specific reactivity. According to product inserts for commercially available WNV IgM assays, all positive results obtained with these assays should be confirmed by neutralizing antibody testing of acute- and convalescent-phase serum specimens at a state public health laboratory or CDC.

WNV IgG antibodies generally are detected shortly after IgM antibodies and persist for many years following a symptomatic or asymptomatic infection. Therefore, the presence of IgG antibodies alone is only evidence of previous infection and clinically compatible cases with the presence of IgG, but not IgM, should be evaluated for other etiologic agents.

Plaque-reduction neutralization tests (PRNTs) performed in reference laboratories, including some state public health laboratories and CDC, can help determine the specific infecting flavivirus. PRNTs can also confirm acute infection by demonstrating a fourfold or greater change in WNV-specific neutralizing antibody titer between acute- and convalescent-phase serum samples collected 2 to 3 weeks apart.

**Other testing for WNV disease**

Viral cultures and tests to detect viral RNA (e.g., reverse transcriptase-polymerase chain reaction [RT-PCR]) can be performed on serum, CSF, and tissue specimens that are collected early in the course of illness and, if results are positive, can confirm an infection. Immunohistochemistry (IHC) can detect WNV antigen in formalin-fixed tissue. Negative results of these tests do not rule out WNV infection. Viral culture, RT-PCR, and IHC can be requested through state public health laboratories or CDC.
Treatment and Prognosis

No specific treatment exists for West Nile Virus. In severe cases, the infected person needs hospitalization for supportive therapy. Patients with febrile WNV generally recover completely, though it can take weeks or months for fatigue to fade. In cases of West Nile encephalitis, recovery can take months, and some neurological effects can be permanent. Roughly 10% of the >1% of encephalitic cases are fatal (CDC 2015b). There is some possibility that WNV infection can persist in conjunction with renal and kidney disease. Currently there is no West Nile virus vaccine available for people (CDC September 2015).

Case Incidence

![Graph of West Nile Fever, Encephalitis and Total Suffolk County Cases per Year]

Figure 1. Confirmed and Probable. West Nile Encephalitis, West Nile Fever, and Total West Nile Cases from 1999-2014. Data obtained from NYSDOH Communicable Disease Queries.

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNV Positive Humans (Deaths)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>8(2)</td>
<td>10(2)</td>
<td>0</td>
<td>7</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNV Positive Humans (Deaths)</td>
<td>9</td>
<td>1</td>
<td>25(3)</td>
<td>4</td>
<td>14</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Human Cases of West Nile virus by year. Data obtained from Suffolk County DHS ABDL.
Figure 2. **Suffolk County West Nile Virus 2005-2009.** Data obtained from NYSDOH CDESS.

Figure 3. **Suffolk County West Nile Virus 2010-2015.** Data obtained from NYSDOH CDESS.

**References**

III. EASTERN EQUINE ENCEPHALITIS

Pathogen and Transmission

Eastern equine encephalitis is a rare but potentially deadly arthropod-borne virus (arbovirus) of the genus Alphavirus, transmitted to humans by mosquitoes. The primary carrier is the mosquito Culiseta melanura, which predominantly feeds on birds. Mosquitoes such as those of Aedes, Coquillettidia, and Culex species are responsible for transmitting EEE to humans. Approximately 5-10 cases are reported each year in the US, with most concentrated along the Atlantic and Gulf coast and in the late spring through early fall. There have been five human cases in New York, all fatal, in the years 1971, 1983, 2009, 2010 and 2011. EEE is not spread from person to person. Horses are extremely susceptible to the virus, but do not spread it to mosquitoes. (CDC August 2010, NYSDOH 2012).

Symptoms

Symptoms develop 4 to 10 days after being bitten by an infected mosquito; not all people will become infected and not all people infected will exhibit symptoms. EEE can develop into systemic or encephalitic illness. Encephalitic symptoms are more severe and are more common in those under 15 and over 50.

Systemic

- Chills
- Fever
- Malaise
- Arthralgia
- Myalgia
- Abrupt onset
- Lasts 1 to 2 weeks.
- Recovery is complete

Encephalitic

- Fever
- Headache
- Irritability
- Restlessness
- Drowsiness
- Anorexia
- Vomiting
Diarrhea
Cyanosis
Convulsions
Coma
In children and adults, begins after systemic illness; in infants, abrupt onset
(CDC August 2010, NYSDOH 2012)

Diagnosis
Diagnosis is based on symptoms, clinical evaluation, and diagnostic testing. The CDC (August 2010) provides the following guidelines:

Clinical Evaluation (for Health Care Providers)
Cerebrospinal fluid (CSF) findings include neutrophil-predominant pleocytosis and elevated protein levels; glucose levels are normal. Brain lesions are typical of encephalomyelitis and include neuronal destruction and vasculitis, which is perivascular and parenchymous at the cortex, midbrain, and brain stem. There is minimal involvement of the spinal cord.
EEEV is difficult to isolate from clinical samples; almost all isolates (and positive PCR results) have come from brain tissue or CSF. Serologic testing remains the primary method for diagnosing EEEV infection. Combined with a consistent clinical presentation in an endemic area, a rapid and accurate diagnosis of acute neuroinvasive EEEV disease can be made by the detection of EEEV-specific IgM antibody in serum or CSF. EEEV IgM tests are available commercially, in some state health department laboratories, and at CDC. A positive EEEV IgM test result should be confirmed by neutralizing antibody testing of acute- and convalescent-phase serum specimens at a state public health laboratory or CDC. To submit specimens for testing at CDC, please contact your state health department.
All EEEV disease cases should be reported to local public health authorities. Reporting can assist local, state and national authorities to recognize outbreaks of this rare disease and to institute control measures to limit future infections.

Arboviral Diagnostic Testing
Preliminary diagnosis is often based on the patient's clinical features, places and dates of travel (if patient is from a non-endemic country or area), activities, and epidemiologic history of the location where infection occurred.
Laboratory diagnosis of arboviral infections is generally accomplished by testing of serum or cerebrospinal fluid (CSF) to detect virus-specific IgM and neutralizing antibodies. In fatal cases, nucleic acid amplification, histopathology with immunohistochemistry and virus culture of autopsy tissues can also be useful. Only a few state laboratories or other specialized laboratories, including those at CDC, are capable of doing this specialized testing.

Treatment and Prognosis
No treatment exists for EEE. Hospitalization may be necessary for effective supportive care and management of symptoms. EEE is fatal in approximately 1/3 of cases. While death usually occurs 2 to 10 days after symptoms begin, severe sequelae can cause death within a few years. Sequelea include a range of intellectual impairment, personality disorders, seizures, paralysis, and cranial nerve dysfunction. Currently there is no EEE vaccine available for people (CDC August 2010, NYSDOH 2012).

Case Incidence
Suffolk County has had no known human EEE cases.

References
IV. MALARIA

Pathogen and Transmission

Malaria is a disease caused by one of four kinds of protozoal parasites, *Plasmodium falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*, which is spread by the bite of an infected *Anopheles* mosquito. In 2013, approximately 198 million cases of malaria occurred, causing 500,000 deaths. It is most severe in Africa. Most of the approximately 1,500 cases diagnosed in the US each year were contracted while in an area of the world where malaria transmission regularly occurs. Malaria can also be transmitted by blood transfusion, organ transplant, shared needles, or congenitally. It cannot be spread directly from person to person or through sexual activity. Malaria was eliminated from the US in the early 1950s, though a few locally acquired cases have arisen on Long Island and Queens as a result of travelers transmitting malarial parasites to local mosquitoes. *Anopheles* mosquitoes are still common in the US (CDC August 2015a, NYSDOH October 2011b). See Figures 4-6 for numbers and locations of Suffolk County malaria cases.

Symptoms

Malaria symptoms can vary widely, from absent to fatal. A case of malaria is categorized as uncomplicated or severe/complicated. Both are curable if diagnosed and treated properly. Symptoms usually begin 10 days (typically *P. falciparum*) to a month (usually *P. malariae*) after infection. *P. vivax* and *P. ovale* cause relapsing malaria, where the parasites remain dormant in the liver for up to four years.

Uncomplicated Malaria:

- Fever
- Chills
- Sweats
- Headache
- Nausea/vomiting
- Body aches
- Malaise
- Jaundice
- Enlarged spleen and liver
- Often confused with the flu in non-endemic areas.

The classical, and more unique, symptoms of a malaria attack, lasting 6-10 hours and repeating every two to three days is rarer.

- Cold stage (shivering, chills)
- Hot stage (fever, headaches, vomiting; seizures in children)
- Sweating stage (sweats, fever fades, tiredness)

Severe Malaria:
- Cerebral malaria (neurologic symptoms including: abnormal behavior, impairment of consciousness, seizures, coma)
- Hemolysis (destruction of red blood cells), causing anemia and hemoglobinuria
- Low blood pressure
- Abnormal blood clotting
- Hyperparasitemia (more than 5% of red blood cells infected by parasites)
- Acute respiratory distress syndrome (ARDS)
- Kidney failure
- Metabolic acidosis
- Hypoglycemia (CDC August 2015a, NYSDOH October 2011b)

Diagnosis

A diagnosis of malaria is made primarily by a blood test that shows parasites in the blood, and typically, a positive laboratory test will show anemia, thrombocytopenia, elevated bilirubin, and elevated aminotransferases. Distinction can sometimes be made in the blood test between the different strains of malaria, which allows for more specific knowledge of what pattern of infection to expect. The test is generally performed if a patient has recently traveled to an endemic area and is showing signs of fever or other flu-like, or more severe, symptoms. The use of prophylaxis can result in delayed symptoms, especially in cases of infection with *P. vivax* and *P. ovale*, resulting in misdiagnosis.

A diagnosis of malaria is made based on clinical signs and symptoms, recent travel to an endemic area, and positive results of a blood test. The CDC has issued the following guidelines for diagnosis:

Patients suspected of having malaria infection should be urgently evaluated. Treatment for malaria should not be initiated until the diagnosis has been confirmed by laboratory investigations. "Presumptive treatment" without the benefit of laboratory confirmation should be reserved for extreme circumstances (strong clinical suspicion, severe disease, impossibility of obtaining prompt laboratory confirmation, usually by microscopy).

Laboratory diagnosis of malaria can be made through microscopic examination of thick and thin blood smears. Thick blood smears are more sensitive in detecting malaria parasites because the blood is more concentrated allowing for a greater volume of blood to be examined; however, thick smears are more difficult to read. Thin smears aid in parasite species identification and quantification. Blood films need to be read immediately; off-hours, qualified personnel who can perform this function should be on-call. A negative blood smear makes the diagnosis of malaria unlikely. However, because non-immune individuals may be symptomatic at very low parasite densities that initially may be undetectable by blood smear, blood smears should be repeated every 12-24 hours for a total of 3 sets. If all 3 are negative, the diagnosis of malaria has been essentially ruled out.

After malaria parasites are detected on a blood smear, the parasite density should then be estimated. The parasite density can be estimated by looking at a monolayer of red blood cells (RBCs) on the thin smear using the oil immersion objective at 100x. The slide should be examined where the RBCs are more or less touching (approximately 400 RBCs per field). The parasite density can then be estimated from the percentage of infected RBCs, after counting 500 to 2000 RBCs.
In addition to microscopy, other laboratory diagnostic tests are available. Several antigen detection tests (rapid diagnostic tests or RDTs) using a "dipstick" or cassette format exist, but only one is approved for general diagnostic use in the United States. RDTs can more rapidly determine that the patient is infected with malaria, but they cannot confirm the species or the parasitemia. Laboratories that do not provide in-house on-the-spot microscopy services should maintain a stock of malaria RDTs so that they will be able to perform malaria diagnostic testing when urgently needed.

Parasite nucleic acid detection using polymerase chain reaction (PCR) is more sensitive and specific than microscopy but can be performed only in reference laboratories and so results are not often available quickly enough for routine diagnosis. However, PCR is a very useful tool for confirmation of species and detecting of drug resistance mutations. CDC offers malaria drug resistance testing for all malaria diagnosed in the United States free of charge. Serologic tests, also performed in reference laboratories, can be used to assess past malaria experience but not current infection by malaria parasites. Your state health department or the CDC can be contacted for more information on utilizing one of these tests (CDC August 2015a).

**Treatment, Prevention, and Prognosis**

A variety of anti-malarial drugs are available, depending on the patient (including age, pregnancy status, etc.), the location, and timing. It is recommended that those travelling to endemic areas discuss their plans with their health care provider well in advance, since some anti-malarial drugs must be started in advance. Anti-malarial drugs can be safely used for up to one year. Immunity to malaria does wear off, so each time a traveler returns to an endemic area, they should take proper precautions.

Malaria is successfully treatable by prescription drugs. The patients’ health care provider can choose a drug depending on parasite species, place of infection, age, pregnancy, and severity of the infection. Certain species from certain areas of the world have a high probability of resistance to certain drugs. If treated promptly, with the correct drug and for the correct duration, malaria can be completely cured. The CDC (CDC August 2015a) has issued the following treatment guidelines to minimize chance of complication:

It is preferable that treatment for malaria should not be initiated until the diagnosis has been established by laboratory investigations. "Presumptive treatment" without the benefit of laboratory confirmation should be reserved for extreme circumstances (strong clinical suspicion, severe disease, impossibility of obtaining prompt laboratory diagnosis). Once the diagnosis of malaria has been made, appropriate antimalarial treatment must be initiated immediately. Treatment should be guided by three main factors:

- The infecting *Plasmodium* species
- The clinical status of the patient
- The drug susceptibility of the infecting parasites as determined by the geographic area where the infection was acquired and the previous use of antimalarial medicines

The infecting *Plasmodium* species: Determination of the infecting *Plasmodium* species for treatment purposes is important for three main reasons. Firstly, *P. falciparum* and *P. knowlesi* infections can cause rapidly progressive severe illness or death while the other species, *P. vivax*, *P. ovale*, or *P. malariae*, are less likely to cause severe manifestations. Secondly, *P. vivax* and *P. ovale* infections also require treatment for the hypnozoite forms that remain dormant in the liver and can cause a relapsing infection. Finally, *P. falciparum* and *P. vivax* species have different drug resistance patterns in differing geographic regions. For *P. falciparum* and *P. knowlesi* infections, the urgent initiation of appropriate therapy is especially critical.
The clinical status of the patient: Patients diagnosed with malaria are generally categorized as having either uncomplicated or severe malaria. Patients diagnosed with uncomplicated malaria can be effectively treated with oral antimalarials. However, patients who have one or more of the following clinical criteria (impaired consciousness/coma, severe normocytic anemia [hemoglobin < 7], renal failure, acute respiratory distress syndrome, hypotension, disseminated intravascular coagulation, spontaneous bleeding, acidosis, hemoglobinuria, jaundice, repeated generalized convulsions, and/or parasitemia of ≥ 5%) are considered to have manifestations of more severe disease and should be treated aggressively with parenteral antimalarial therapy.

The drug susceptibility of the infecting parasites: Finally, knowledge of the geographic area where the infection was acquired provides information on the likelihood of drug resistance of the infecting parasite and enables the treating clinician to choose an appropriate drug or drug combination and treatment course. In addition, if a malaria infection occurred despite use of a medicine for chemoprophylaxis, that medicine should not be a part of the treatment regimen. If the diagnosis of malaria is suspected and cannot be confirmed, or if the diagnosis of malaria is confirmed but species determination is not possible, antimalarial treatment effective against chloroquine-resistant *P. falciparum* must be initiated immediately.

For more information on the following topics, visit [http://www.cdc.gov/malaria/index.html](http://www.cdc.gov/malaria/index.html)

- Treatment of Uncomplicated Malaria
- Treatment of *P. falciparum* and *P. vivax* in areas with chloroquine resistance
- Alternatives for Pregnant Women
- Treatment of Severe Malaria

**Case Incidence**

![Malaria Suffolk County Cases per Year](image)

Figure 4. **Confirmed Malaria Cases from 1992-2014.** Data obtained from NYSDOH Communicable Disease Queries.
Suffolk County Malaria Cases 2005-2009

Figure 5. Suffolk County Malaria Cases 2005-2009. Data obtained from NYSDOH CDESS.

Suffolk County Malaria Cases 2010-2014

Figure 6. Suffolk County Malaria Cases 2010-2014. Data obtained from NYSDOH CDESS.

References

V. DIROFILARIASIS

Pathogen and Transmission

Dirofilariaiiasis is caused by the parasitic roundworms in the genus *Dirofilaria*. *D. immitis, D. repens* and *D. tenuis* are species which cause human infection. *D. repens* is most common in Europe, but is not found in the U.S; *D. tenuis* is mostly limited to the raccoon population in North America. *D. immitis* causes heartworm in dogs and infects humans in the US. All three species are transmitted by mosquitoes, commonly those in the genera *Aedes, Anopheles, and Mansonia* which have fed on infected dogs, wild canids, or raccoons. In the reservoir hosts, adult *Dirofilaria* worms produce microfilariae, which are ingested by mosquitoes. In the mosquito, the microfilariae grow into larvae, which the mosquito transmits when it feeds. *Dirofilaria* worms do not sexually mature and reproduce microfilariae in humans; therefore, dirofilariasis cannot be transmitted from person to person or from person to mosquito.

As adult *Dirofilaria* worms die, they form granulomas and inflammation in pulmonary artery branches. In rare cases, *D. immitis* is found in other areas of the body such as the brain, eye, and testicle. Dirofilariaiiasis is rare in humans in the US, with only 81 reported cases between 1941 and 2005 (CDC 2012).

Symptoms

Dirofilariaiiasis does not always cause symptoms

- Cough/coughing up blood
- Chest pain
- Fever
- Pleural Effusion
- Coin lesions seen in X-rays

(CDC 2012)

Diagnosis

In cases where there are no obvious symptoms, diagnosis most commonly occurs when chest x-rays show coin lesions. This often results in the performance of an invasive procedure (e.g., biopsy) to rule out more severe causes for coin lesions. Blood tests do not diagnose dirofilariasis (CDC 2012).
Treatment

In many cases, especially when the patient displays no symptoms, no treatment is necessary. In other cases, surgical removal of granulomas is the definitive treatment (CDC 2012).

Case Incidence
Dirofilariasis is not currently a reportable condition.

References

VI. EMERGING MOSQUITO-BORNE DISEASES

Summary
The CDC defines emerging diseases as “infectious diseases whose incidence in humans has increased in the past 2 decades or threatens to increase in the near future,” including:

- New infections resulting from changes or evolution of existing organisms
- Known infections spreading to new geographic areas or populations
- Previously unrecognized infections appearing in areas undergoing ecologic transformation
- Old infections reemerging as a result of antimicrobial resistance in known agents or breakdowns in public health measures.

(http://wwwnc.cdc.gov/eid/page/background-goals)

Chikungunya

Pathogen and Transmission
Chikungunya is transmitted by mosquitoes (usually Aedes aegypti and Aedes albopictus, both of which bite during the day) infected by the chikungunya virus. It is most prevalent in Africa, Asia, and Europe, but has also been found in the Caribbean since 2013. See Figures 7-8 for numbers and locations of Suffolk County chikungunya cases. A mosquito which bites an infected person can spread the virus to other people. Rare cases of blood borne, in utero, and intrapartum transmission have been documented. It is possible for the virus to be spread by blood transfusion. Breastfeeding or other person to person contact does not spread the virus (CDC August 2015b).

Symptoms
Symptoms typically begin 3-7 days after infection. Most patients develop at least some symptoms. Symptoms persist normally for a week, though in some patients it can last for months. Chikungunya should not be mistaken for dengue, which has similar symptoms

- Fever (usually above 102°F)
- Joint pain/swelling
- Headache
- Muscle pain
- Conjunctivitis
- Nausea/vomiting
- Maculopapular rash

(CDC August 2015)
**Diagnosis**

Diagnosis of chikungunya is based on symptoms, especially fever and joint pain; exposure history; and a clinical laboratory test, which may show lymphopenia, thrombocytopenia, elevated creatinine, and elevated hepatic transaminases. Coinfection of chikungunya and dengue can occur, and have similar symptoms; correct diagnosis is extremely important. The CDC (August 2015b) provides the following guidelines:

Diagnostic testing is available through a few commercial laboratories, many state health departments, and the Centers for Disease Control and Prevention. Contact your state health department for more information and to facilitate testing.

Chikungunya virus infection should be considered in patients with acute onset of fever and polyarthritis, especially travelers who recently returned from areas with known virus transmission.

Laboratory diagnosis is generally accomplished by testing serum or plasma to detect virus, viral nucleic acid, or virus-specific immunoglobulin (Ig) M and neutralizing antibodies. Viral culture may detect virus in the first 3 days of illness; however, chikungunya virus should be handled under biosafety level (BSL) 3 conditions. During the first 8 days of illness, chikungunya viral RNA can often be identified in serum. Chikungunya virus antibodies normally develop toward the end of the first week of illness. Therefore, to definitively rule out the diagnosis, convalescent-phase samples should be obtained from patients whose acute-phase samples test negative.

**Treatment and Prognosis**

No medication exists to treat Chikungunya. In some cases, rheumatologic symptoms occur for some months after the illness has largely subsided, and joint pain can continue for several years. It is rarely fatal and usually resolves on its own with only supportive therapy. Newborns, adults about 65 years of age, and patients with high blood pressure, diabetes, or heart disease are particularly at risk. Chikungunya infection gives immunity from future infection. Rare complications include uveitis, retinitis, myocarditis, hepatitis, nephritis, bullous skin lesions, hemorrhage, meningoencephalitis, myelitis, Guillain-Barré syndrome, and cranial nerve palsy (CDC August 2015b).
Case Incidence

Suffolk County confirmed and probable chikungunya case data was not available through NYSDOH Communicable Disease Queries prior to 2014. Figures 7 and 8 were created using NYSDOH CDESS.

Figure 7. **Suffolk County Chikungunya Cases 2005-2009.** Data obtained from NYSDOH CDESS.

Figure 8. **Suffolk County Chikungunya Cases 2010-2014.** Data obtained from NYSDOH CDESS.
Dengue

Pathogen and Transmission
Dengue is spread by mosquitoes infected with one of four flaviviruses (DENV 1, DENV 2, DENV 3, or DENV 4), and can manifest as dengue, or the more severe dengue hemorrhagic fever (DHF). *Aedes aegypti* is the most common vector of dengue in the western hemisphere. *Aedes* mosquitoes can spread the disease from an infected person to an uninfected person, but dengue cannot be spread directly from person to person. It is most common in tropical areas, with 50 to 100 million cases of dengue fever worldwide annually, and several hundred thousand cases of dengue hemorrhagic fever. Approximately 100 to 200 cases per year are carried into the US by travelers. Transmission in the US was last reported in 2005 (CDC June 2015, NYSDOH October 2011a). See Figures 9-11 for numbers and locations of Suffolk County dengue cases. In 2013, there was one locally acquired dengue case in Suffolk County.

Symptoms
Dengue fever symptoms appear within 3 to 14 days after infection:
- High fever
- Severe headache
- Severe pain behind the eyes
- Joint, muscle, and bone pain
- Rash
- Mild bleeding
- Easy bruising

Dengue hemorrhagic fever; DHF begins with 2-7 days of Dengue fever symptoms. After this period, more severe symptoms develop:
- Vomiting, including vomiting blood
- Severe abdominal pain
- Difficulty breathing
- Clammy skin
- Drowsiness
- Red spots or patches on the skin
- Easy bruising
- Hemorrhagic manifestations after 24 to 48 hours, which can lead to shock and death.
(CDC June 2015, NYSDOH October 2011a)

Diagnosis
Dengue fever and dengue hemorrhagic fever is diagnosed on the basis of a blood test, clinical symptoms, and travel history. A patient with DHF will have a low platelet count (CDC June 2015, NYSDOH October 2011a).

Treatment and Prognosis
There is no specific treatment for dengue virus. Symptoms of dengue fever can be relieved with analgesics (avoid aspirin), rest, and plenty of fluids. Those who experience symptoms should seek medical attention so that DHF can be evaluated and treated by a physician or hospital using fluid replacement therapy. The fatality rate ranges from 1 to 10%, depending on early recognition and proper management of hemorrhagic symptoms. Completely untreated hemorrhagic dengue has a 40 to 50% fatality rate. Fatality is more likely in children under 15 years of age. Infection
creates immunity against that particular strain, but not against the other dengue strains (CDC June 2015, NYSDOH October 2011a).

Case Incidence

Figure 9. **Confirmed and Probable Dengue Cases from 2004-2014.** Cases were not reportable prior to 2004. Data obtained from NYSDOH Communicable Disease Queries.

Figure 10. **Suffolk County Dengue Cases 2005-2009.** Data obtained from NYSDOH CDESS.
**Rickettsia Felis**

*Rickettsia felis* is a pathogen of the Spotted Fever Group of rickettsial infections (Perez-Osario et al., 2008). First defined in 2002, more than 70 cases were reported by 2011. Fleas are a confirmed vector, but do not explain occurrences in areas where “neither cat fleas nor other arthropods have been implicated in its transmission” (Dieme et al., 2015). In a 2015 study, *Anopheles gambiae* mosquitoes, the primary vectors of malaria, were shown to be competent vectors for *R. felis*, though this has yet to be confirmed. No reservoir hosts have been confirmed, although opossums, dogs, and rodents, among others, are potential hosts (Dieme et al., 2015). Human infection has been found in Asia, northern Africa, Europe, and North, South, and Central America. Due to its similarity to other arthropod-borne illnesses and “because rickettsiosis often is misdiagnosed,” it is possible that *Rickettsia felis* is seriously underestimated (Socolovschi et al., 2010). The presence of *Rickettsia felis* has been confirmed in opossums and cat fleas in Texas and California, and may infect humans; Boostrom et al. (2002) suggests that it is commonly misdiagnosed as *R. typhus*. No human cases in the US have been confirmed.

Symptoms are nonspecific, and include:

- Fever
- Cutaneous rash
- Joint and muscle pain
- Loss of appetite
- Weakness
- Headache
- Nausea (Socolovschi et al., 2010, Richards et al., 2010)
Molecular diagnostics are the most effective method of specifically diagnosing *R. felis*; serologic assays are not useful immediately after onset, and “*R. felis* has yet to be cultured from clinical samples” (Richards et al., 2010).

**Case Incidence**

*R. felis* infection is not a reportable disease

**References**


New York State Department of Health, Division of Epidemiology (December 2015). *Communicable Disease Electronic Surveillance System (CDESS)*. Data file. Available by permission from [https://commerce.health.state.ny.us/hin/](https://commerce.health.state.ny.us/hin/)

New York State Department of Health, Division of Epidemiology (December 2015). *Communicable Disease Queries*. Data file. Available by permission from [https://commerce.health.state.ny.us/hin/](https://commerce.health.state.ny.us/hin/)

Zika virus is an RNA *Flavivirus* in the *Flaviridae* family. It was originally identified in Uganda in 1947 and is now found throughout south and south-east Asia, Oceania/Pacific Islands, Africa, and Brazil and Columbia (Hennessey et al., 2016). To date, no locally acquired cases have been reported in the continental United States. Many US infections have been identified among returning travelers, and such imported cases may result in locally acquired cases in regions where the appropriate mosquito vectors can be found. Zika virus is transmitted to humans by the mosquito *Aedes aegypti* and possibly *Aedes albopictus*, to a lesser extent. During outbreaks, humans act as the primary amplifying host (Hennessey et al., 2016). Zika virus can also be transmitted sexually and perinatally, and

**Pathogen and Transmission**

Zika virus is an RNA *Flavivirus* in the *Flaviridae* family. It was originally identified in Uganda in 1947 and is now found throughout south and south-east Asia, Oceania/Pacific Islands, Africa, and Brazil and Columbia (Hennessey et al., 2016). To date, no locally acquired cases have been reported in the continental United States. Many US infections have been identified among returning travelers, and such imported cases may result in locally acquired cases in regions where the appropriate mosquito vectors can be found. Zika virus is transmitted to humans by the mosquito *Aedes aegypti* and possibly *Aedes albopictus*, to a lesser extent. During outbreaks, humans act as the primary amplifying host (Hennessey et al., 2016). Zika virus can also be transmitted sexually and perinatally, and
by blood transfusion, and lab exposure. Links between infection among pregnant women and possible birth defects is being investigated in Brazil, due to increases in the number of infants born with microcephaly in virus-affected regions (Schuler-Faccini et al., CDC June 2015). Guillain-Barre syndrome (a disorder in which the immune system causes damage to nerve cells, leading to muscle weakness and sometimes paralysis) has also been identified in some individuals following possible Zika virus infection (Hennessey et al., 2016). Notices on areas with ongoing Zika virus outbreaks can be viewed at http://wwwnc.cdc.gov/travel/notices/. Maps showing current locations where Zika virus can be found can be view at http://www.cdc.gov/zika/geo/index.html.

Symptoms
Zika infection becomes symptomatic in approximately 20% of cases. Symptoms last several days to a week, and hospitalization and fatality is rare.

- Acute onset fever
- Maculopapular rash
- Arthralgia
- Conjunctivitis
- Myalgia
- Headache
- Retro-orbital pain
- Vomiting

(CDC June 2015)

Diagnosis
Preliminary diagnosis based on clinical signs and symptoms is complicated by Zika virus infection’s similarities to a wide range of other diseases, mosquito-borne and otherwise. A combination of symptoms, travel history, and laboratory testing can be used to diagnose Zika virus infection. The CDC (June 2015) provides the following guidelines for diagnostic testing:

During the first week after onset of symptoms, Zika virus disease can often be diagnosed by performing reverse transcriptase-polymerase chain reaction (RT-PCR) on serum. Virus-specific IgM and neutralizing antibodies typically develop toward the end of the first week of illness; cross-reaction with related flaviviruses (e.g., dengue and West Nile viruses) is common and may be difficult to discern. Plaque-reduction neutralization testing can be performed to measure virus-specific neutralizing antibodies and discriminate between cross-reacting antibodies in primary flavivirus infections.

Zika virus testing is performed at the CDC Arbovirus Diagnostic Laboratory. Contact your state health department to facilitate testing.

Treatment and Prognosis
No specific treatment or vaccine exists for Zika virus. Symptoms can be treated, but Dengue should be ruled out before NSAIDs are administered (CDC June 2015).

Case Incidence
Zika virus is now a reportable disease. Currently in early 2016, there are three reported cases in Suffolk County, acquired while traveling overseas to endemic areas.

References
VII. MOSQUITO SURVEILLANCE AND CONTROL

Integrated Pest Management (IPM) is considered the most effective method of mosquito control. It combines epidemiological and environmental surveillance, education, removal of habitats, and the use of larvicide and adulticide. According to the CDC, IPM is based on an understanding of the underlying biology of the arbovirus transmission system, and utilizes regular monitoring of vector mosquito populations and WNV activity levels to determine if, when, and where interventions are needed to keep mosquito numbers below levels which produce risk of human disease, and to respond appropriately to reduce risk when it exceeds acceptable levels (Appendix L).

Mosquito-Borne Arboviral Surveillance
Suffolk County DHS Arthropod-Borne Disease Laboratory conducts arboviral surveillance (WNV and EEEV) countywide when mosquitoes are active and the possibility of viral transmission to humans is high, which is typically June through mid-October (http://www.suffolkcountyny.gov/Departments/HealthServices/PublicHealth/PreventiveServices/ArthropodborneDiseaseProgram/PreventingMosquitoBorneIllnesses.aspx). The arboviral surveillance program is guided by the CDC and NYSDOH arboviral surveillance guidelines (Appendices L and M). Currently, CDC light and CDC gravid mosquito traps are used to collect mosquitoes at approximately 50 locations across the county, which are sorted to species and then tested for arboviruses at Wadsworth Center, NYS Department of Health, Arbovirus Laboratory. Typically, the number of mosquito surveillance sites increase as viruses are found in mosquitoes, dead-bird, horses or humans.

Dead-Bird Surveillance Program
Avian mortality surveillance or bird-based WNV surveillance for WNV is a strategy defined in the Centers for Disease Control and Prevention’s West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control (4th Revision, June 14, 2013; Appendix L). The guidelines state (p. 21) that “In programs where the objective of avian morbidity/mortality testing is simply early detection of WNV activity and not production of a quantitative index of human risk, testing of moribund or dead birds should be initiated when local adult mosquito activity begins in the spring and continue as long as local WNV activity remains undetected in the area.”, and “several studies have demonstrated the effectiveness of avian mortality testing for early detection of WNV.”
In the ABDL WNV surveillance program, dead-bird surveillance is countywide and uses WNV-positive dead birds as sentinels for WNV activity. This program monitors and identifies possible locations of circulating WNV where there may be no mosquito surveillance and to possibly guide mosquito surveillance to those locations if necessary. Dead birds are collected near mosquito surveillance sites only if the sites are negative for WNV in mosquitoes. Once a WNV-positive bird is found in a location, no more birds are collected from that area. The dead-bird
surveillance program allows us to monitor WNV activity countywide in the areas not monitored by mosquito surveillance.

SCDHS operates a Dead-Bird Hotline from June through August and is available to receive calls from the public to report dead birds. Not all bird species are wanted for testing. Desired specimens include crows and blue jays that have been dead less than 24 hours and have no signs of trauma. In 2014, the ABDL began using photo submissions by callers to increase the efficiency of collecting desired bird species and testable bird specimens. Since 2004, bird specimens (i.e. buccal swabs) are tested for WNV at the ABDL using a commercially available immunoassay test by ADAPTCO called the RAMP system (rapid analyte measurement platform). Therefore the combined dead-bird and mosquito surveillance programs for WNV detection is an countywide integrated approach that best identifies WNV activity in Suffolk County. All arboviral findings for WNV or EEEV are utilized in evaluating the need and strategy for a mosquito control response.

Table 3.  
**Mosquito arboviral surveillance 1999-2015. Data from the Suffolk County ABDL.**

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Mosquitoes Collected</td>
<td>43,659</td>
<td>93,624</td>
<td>120,802</td>
<td>48,353</td>
<td>111,458</td>
<td>67,182</td>
<td>62,011</td>
<td>80,472</td>
<td>53,568</td>
</tr>
<tr>
<td>Total Culex Collected</td>
<td>883</td>
<td>38,218</td>
<td>21,079</td>
<td>17,123</td>
<td>38,955</td>
<td>17,617</td>
<td>17,350</td>
<td>22,961</td>
<td>13,149</td>
</tr>
<tr>
<td>Mosquito Samples Sent for Testing</td>
<td>505</td>
<td>2,296</td>
<td>1,137</td>
<td>1,188</td>
<td>1,887</td>
<td>952</td>
<td>2,054</td>
<td>1,480</td>
<td>918</td>
</tr>
<tr>
<td>Mosquitoes Sent for Testing</td>
<td>22,156</td>
<td>84,527</td>
<td>33,699</td>
<td>23,696</td>
<td>49,845</td>
<td>28066</td>
<td>46,633</td>
<td>49,634</td>
<td>29,570</td>
</tr>
<tr>
<td>WNV/EEE Positive Mosquito Samples</td>
<td>1 (9 Sites)</td>
<td>121</td>
<td>68</td>
<td>40/1</td>
<td>8</td>
<td>76</td>
<td>57</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

*EEEV has not been found since 2008 in mosquitoes*

Table 4.  
**Avian surveillance for West Nile virus 1999-2015. Data from the Suffolk County ABDL.**

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds Tested</td>
<td>245</td>
<td>367</td>
<td>317</td>
<td>318</td>
<td>271</td>
<td>122</td>
<td>235</td>
<td>196</td>
<td>117</td>
</tr>
<tr>
<td>WNV Positive Birds</td>
<td>42</td>
<td>211</td>
<td>257</td>
<td>180</td>
<td>173</td>
<td>41</td>
<td>81</td>
<td>64</td>
<td>23</td>
</tr>
<tr>
<td>Year</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>Birds Tested</td>
<td>137</td>
<td>53</td>
<td>110</td>
<td>122</td>
<td>89</td>
<td>39</td>
<td>99</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>WNV Positive Birds</td>
<td>91</td>
<td>24</td>
<td>74</td>
<td>33</td>
<td>38</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.  
**Equine WNV and EEEV cases 1999-2015. Data from the Suffolk County ABDL.**

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>WNV Positive Horses</td>
<td>31</td>
<td>8</td>
<td>17</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EEEV Positive Horses</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Year</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>WNV Positive Horses</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>EEEV Positive Horses</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*Equine vaccines for WNV and EEEV reduce horse cases*
Mosquito Control Program
Suffolk County Department of Public Works, Division of Vector Control, is legally responsible for controlling mosquito infestations that are of public health importance using an Integrated Pest Management (IPM)-based program. Details on the program are available here:


- Scheduled Adult Mosquito Spraying
  Updated daily with information concerning where adult mosquito control spraying will occur.
  http://www.suffolkcountyny.gov/Departments/HealthServices/PublicHealth/PreventiveServices/PesticideApplicationNotification.aspx
- Suffolk County "No Spray" Registry
  Information about the new "No Spray" law and how to register.
- Suffolk Mosquito Control Plan
- Online Mosquito Complaint Form
- Submit mosquito related complaints online at

References

Suffolk County Department of Health Services, Arthropod Borne Disease Laboratory (December 2015) [mosquito arboviral surveillance data].

VIII. PERSONAL PROTECTION

Mosquito borne-diseases have a range of symptoms and severities, from mild and naturally resolving, to life threatening or fatal. Not all have specific treatments, and most do not have vaccinations or effective drugs for prophylaxis. The most effective way to prevent infection with a mosquito-borne disease, therefore, is by preventing mosquito bites.

- Wear bug spray when outdoors. DEET-based repellents can be used on exposed skin
- Limit the amount of skin exposed. Spray clothing with permethrin.
- Keep screens in windows or keep windows closed
- In malaria-endemic areas, use mosquito netting.
- Keep water from stagnating outside in buckets, tires, pools, bird feeders, etc. Certain species of mosquitoes rely on these habitats to lay their eggs.

IX. RECOMMENDATIONS

Case Numbers and Proper Reporting
- Increase awareness of mosquito-borne diseases in the medical community.
- Create case definitions for all mosquito-borne diseases.
- Encourage reporting of mosquito-borne diseases.

Diagnosis
- Increase awareness of mosquito-borne diseases in the medical community.
• Develop diagnostic testing for all mosquito-borne diseases.
• When possible, implement PCR analysis for human testing along with antibody analysis. This would eliminate the need for follow-up confirmatory antibody analysis.

**Treatment**
- Rely on healthcare professionals for the diagnosis and treatment of mosquito-borne diseases.
- Mandate insurance companies to treat according to the course of treatment recommended by the healthcare professional.

**Prevention**
- Increase the public’s awareness of mosquito-borne diseases and prevention methods.
- Whenever possible, develop vaccines for mosquito-borne pathogens.

**References**
New York State Department of Health, Division of Epidemiology (December 2015). *Communicable Disease Electronic Surveillance System (CDESS)*. Data file. Available by permission from [https://commerce.health.state.ny.us/hin/](https://commerce.health.state.ny.us/hin/)

New York State Department of Health, Division of Epidemiology (December 2015). *Communicable Disease Queries*. Data file. Available by permission from [https://commerce.health.state.ny.us/hin/](https://commerce.health.state.ny.us/hin/)
I. INTRODUCTION

Tick-borne and vector-borne pathogens and the associated veterinary diseases have a significant impact on animals. Everyone owning or contacting work or companion animals (e.g. veterinary medical professionals, residents, visitors) should be aware of the risk of exposure to ticks and vector-borne pathogens, the animal’s potential risks of acquiring arthropod-borne pathogens and the clinical signs for each disease.
II. EASTERN EQUINE ENCEPHALITIS

Pathogen and Transmission
Three Togaviruses (genus Alphavirus) infect horses causing encephalitic symptoms: eastern equine encephalitis (EEE), western equine encephalitis (WEE), and Venezuelan equine encephalitis (VEE). EEE is more likely to cause neuroinvasive symptoms than WEE and VEE.

EEEV infects horses, birds, dogs, pigs, and humans.

Symptoms are more severe in young animals. Incubation is typically around 2-3 days, though it can be as long as several weeks. Symptoms are progressive and last from 2 to 14 days.

- Fever
- Pyrexia
- Obtundated mentation

Animals Infected
EEEV infects horses, birds, dogs, pigs, and humans.

EEEV is maintained in enzootic cycles in birds, and the bird biting mosquito *Culiseta melanura* (Figure 1), in freshwater swamp habitats (Saxton-Shaw et al., 2015). EEEV is maintained in enzootic cycles in birds, and the bird biting mosquito *Culiseta melanura* (Figure 1), in freshwater swamp habitats (Saxton-Shaw et al., 2015). EEE virus cases in humans and horses (Table 3) are rare but severe, resulting in high mortality as well as neurologic impairment in survivors (Armstrong & Andreadis, 2013). While no vaccine exists for humans, vaccines are available for horses. EEE/WEE vaccines available are formalin inactivated adjuvanted whole virus vaccines, which have been shown to be highly efficacious (http://www.aaep.org/info/core-vaccination-guidelines).

Figure 1. EEEV Transmission Cycle (CDC)
- Ataxia
- Paralysis
- Anorexia
- Stupor
- Irregular gate
- Teeth grinding
- Incoordination
- Circling
- Staggering
- Head pressing
- Hyperexcitability
- Blindness (partial or total)
- Depression (head hanging, drooping ears, swollen and partly closed eyelids, flaccid lips, protruding tongue
- Esophageal paralysis/trouble drinking
- Seizures (Armstrong & Andreadis, 2013, Sardon-Shaw et al., 2015)

**Diagnosis**

EEE is diagnosed by a titer or ELISA test. Also, viral analysis of necropsied brain, liver, or spleen can determine the presence of the virus (Armstrong & Andreadis, 2013, Sardon-Shaw et al., 2015).

**Treatment, Prevention, and Prognosis**

EEE is a severe disease, and mortality in horses is 70-90%. Although there is no treatment, supportive therapy should be administered during the illness. Neurological problems may continue in horses that survive the infection. (Armstrong & Andreadis, 2013, Sardon-Shaw et al., 2015)

**Case Incidence for EEE**

Table 1. EEE infection in animals. Data from the Arthropod-Borne Disease Lab

<table>
<thead>
<tr>
<th>Year</th>
<th>EEE Isolates</th>
<th>Species</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1959</td>
<td>Unknown</td>
<td>Ducklings*</td>
<td>Unknown</td>
</tr>
<tr>
<td>1970</td>
<td>1</td>
<td>Horse</td>
<td>Montauk</td>
</tr>
<tr>
<td>1972</td>
<td>9</td>
<td>Pheasants</td>
<td>Southaven County Park, Yaphank</td>
</tr>
<tr>
<td>1973</td>
<td>1</td>
<td>PIP</td>
<td>Montauk</td>
</tr>
<tr>
<td>1978</td>
<td>1</td>
<td>MEL</td>
<td>Montauk</td>
</tr>
<tr>
<td>1990</td>
<td>1</td>
<td>MEL</td>
<td>Riverhead</td>
</tr>
<tr>
<td>1993</td>
<td>6</td>
<td>MEL</td>
<td>Manorville</td>
</tr>
<tr>
<td>1994</td>
<td>49</td>
<td>MEL, PER, QUA, PRE</td>
<td>Manorville, Riverhead</td>
</tr>
<tr>
<td>1996</td>
<td>26</td>
<td>MEL, PRE</td>
<td>Southaven County Park, Bayview, Camp Hero State Park, Manorville, Shelter Island</td>
</tr>
<tr>
<td>1997</td>
<td>5</td>
<td>MEL</td>
<td>Connetquot State Park</td>
</tr>
<tr>
<td>2003</td>
<td>1</td>
<td>MEL, Horses</td>
<td>Camp Hero State Park, Montauk</td>
</tr>
<tr>
<td>2008</td>
<td>3</td>
<td>MEL</td>
<td>Manorville</td>
</tr>
</tbody>
</table>


**References**


III. WEST NILE VIRUS

Pathogen and Transmission
West Nile virus (WNV) is in the Flaviviridae family and is part of the Japanese encephalitis group. Culex mosquitoes are primarily responsible for transmitting WNV. Birds, particularly corvids, are susceptible to WNV, and act as reservoir hosts for the virus (Figure 2). Transmission from infected horse to human generally does not occur, but care must be taken in handling potentially-infected tissues during post-mortem necropsies (CDC 2015).

![WNV Transmission Cycle (CDC 2015)](www.cdc.gov)

Figure 2. WNV Transmission Cycle (CDC 2015)

Animal Infected
Horses, humans, dogs, domestic birds kept outdoors

Symptoms
Affects the central nervous system in horses
- Personality changes
- Hyperexcitability
- Apprehension
- Aggression
- Compliance in excitable or aggressive horses
- narcolepsy
- Neurological signs
- Weakness
• Ataxia
• Skin and muscle tremors
• Hyperesthesia
• Systemic signs
• Increase in rectal temperature (102-103°F) (Sellon, 2007)

**Diagnosis**
A diagnosis can be made by blood work and CSF analysis. Tests will show an increase in mononuclear cells and elevated protein level.

**Treatment, Prognosis, and Prevention**
West Nile virus (WNV) was first identified in the Western Hemisphere in 1999 in New York. In that year, 20 equine cases of WNV were detected in NY, with 4 deaths. In 2000, 23 equine cases were identified in NY, with 8 deaths. In that year, additional cases were detected in New Jersey, Delaware, Rhode Island, Massachusetts, Connecticut, and Pennsylvania. Since then, equine cases of WNV have been reported throughout North America. See Tables 1 and 2 for numbers of Suffolk County WNV horse cases and horses by year.

Since the emergence of the virus in 1999, numerous vaccines have been developed and licensed by the USDA. Licensed vaccines fall into one of three categories; Killed-virus Vaccines (virus particles grown in culture and then killed), Recombinant Vaccines (genes for WNV antigens are inserted into a canarypox virus vector) and Killed Flavivirus Chimera Vaccines (two viruses are genetically spliced together, producing a ‘chimeric’ structure) (http://www.aaep.org/info/vaccination-guidelines-265). Several vaccines are currently on the market and can be purchased in combination with other vaccines, such as tetanus and eastern equine encephalitis. The following are some of the more commonly known equine vaccines that have come on the market:

- The first USDA licensed WNV vaccine for horses was developed in 2001 by Fort Dodge Animal Health (now Zoetis) in conjunction with the Centers for Disease Control, and was licensed by the USDA in 2003. It contains a formalin-inactivated, whole West Nile virus. This vaccine is currently sold under the name West Nile-Innovator® and has been found to be very effective. 12 months after two doses of West Nile-Innovator®, 94% of the animals were protected against viremia after challenge (DeFilette et al, 2012).
- Recombitek® Equine West Nile Virus Vaccine, which is a recombinant vaccine. High efficacy has been demonstrated in multiple studies (Seino et al, 2007; Siger et al, 2006)
- EquiNile West Nile Virus Vaccine (available through Merck) is a Killed Flavivirus Chimera Vaccine. High efficacy has been demonstrated in multiple studies (Seino et al, 2007; Siger et al, 2006)
- In 2005, a WNV DNA plasmid-based vaccine was licensed in the United States by Fort Dodge Animal Health, marketed as West Nile-Innovator® DNA, but was recently discontinued due to adverse side effects.
- PreveNile (Intervet) A Flavivirus chimera vaccine containing West Nile virus pre-membrane (prM) and envelope (E) genes (from the NY99 strain) in a backbone of yellow fever (YF17D vaccine virus), was granted a full license by USDA in 2006. However, it was recalled in 2010 due adverse side effects (DeFilette et al, 2012).

Management of symptoms is the only course of action in infected horses; muscle tremors can be eased with flunixin meglumine. Recumbent horses are typically euthanized.

| WNV Positive Horses by Year. Data from SCDHS Arthropod Borne Disease Laboratory |
|--------------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| **Year** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** |
| WNV Positive Horses | 31 | 8 | 17 | 4 | 3 | 1 | 0 | 0 | 0 |
| **Year** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** |
| WNV Positive Horses | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

112
Table 3.  WNV Positive Birds by Year. SCDHS Arthropod Borne Disease Laboratory

<table>
<thead>
<tr>
<th>Year</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds Tested</td>
<td>245</td>
<td>367</td>
<td>317</td>
<td>318</td>
<td>271</td>
<td>122</td>
<td>235</td>
<td>196</td>
<td>117</td>
</tr>
<tr>
<td>WNV Positive Birds</td>
<td>42</td>
<td>211</td>
<td>257</td>
<td>180</td>
<td>173</td>
<td>41</td>
<td>81</td>
<td>64</td>
<td>23</td>
</tr>
</tbody>
</table>

References


Suffolk County Department of Health Services, Arthropod Borne Disease Laboratory. (December 2015) [mosquito arboviral surveillance data].

IV. HEARTWORM

Pathogen and Transmission
Heartworm is caused by the parasitic worm *Dirofilaria immitis*, which is spread by mosquitoes, including *Aedes* and *Culex* species. Dogs and wild canids act as reservoir hosts.

The transmission and pathogenesis of *D. immitis* occurs over the five stages of the life cycle—a neonatal larval stage (microfilariae) in the host species; three larval stages in the vector, a third of which are infectious; a fourth larval stage after infection of the host; and an adult stage capable of producing microfilariae (Figure 3).

Dogs are more susceptible than cats or ferrets, as a greater proportion of larvae develop into adults, but cats are susceptible to heartworm-associated respiratory disease (HARD), caused by the death of larvae in the lungs. Pathogenesis in dogs is caused by “direct mechanical trauma” to blood vessels by both live and dead adult heartworms. Dead worms can cause the most severe effects, leading to lesions, scarring, and cardiovascular disease (Alieto et al., 2012).

![Life cycle of heartworm (Dirofilaria immitis; CDC 2012)](image)
**Symptoms**
Many infected animals will be asymptomatic in the early stages. Due to decreased cardiac function, more active animals will display symptoms quicker than sedentary animals.

In dogs:
- Mild persistent cough
- Reluctance to exercise
- Fatigue after exercise
- Decreased appetite
- Weight loss

At more severe stages:
- Cardiovascular disease
- Swollen stomach
- Caval Syndrome (labored breathing, pale gums, dark bloody urine; fatal)

Symptoms vary in cats; sometimes the first visible symptom is collapse or death. :
- Coughing
- Asthma-like attacks
- Periodic vomiting
- Lack of appetite
- Weight loss.

Occasionally:
- Difficulty walking
- Fainting or seizures
- Fluid accumulation in the abdomen.

**Diagnosis**
Annual testing of domestic dogs for heartworm is strongly advised. A combination of antigen and microfilaria testing is recommended to prevent false negatives; neither will show recent infections. Microfilaria testing also identifies whether the dog is currently functioning as a reservoir for *D. immitis*.

Microfilaria testing is not considered useful for heartworm diagnosis in cats, since microfilaria rarely develop. Antigen testing also often creates false negatives, since it relies on the presence of fully mature female worms. Antibody tests will indicate a non-specific history of infection, but cannot identify whether the infection is currently present. A combination of antigen and antibody tests are recommended. Thoracic radiography and echocardiography are also effective options for the diagnosis of cats.

For more detailed information on diagnostic testing visit:
https://www.heartwormsociety.org/veterinary-resources/american-heartworm-society-guidelines
http://www.merckvetmanual.com/mvm/circulatory_system/heartworm_disease/overview_of_heartworm_disease.html#v3259907

**Treatment**
Treatment for heartworm is complicated by the fact that dead and dying worms cause the most severe reactions. Exercise should be curtailed during treatment, even in asymptomatic dogs, to prevent complications as the worms die and decompose in the blood vessels. Severely symptomatic dogs should be normalized before adulticide
treatment begins. Melarsomine dihydrochloride injections are the FDA approved adulticide for heartworm. Adjunct treatment to target microfilaria, larvae, and Wolbachia is generally necessary, and in cases of caval syndrome, surgical extraction of the worms may be required (American Heartworm Society, 2014a).

Asymptomatic cats can be allowed to recover on their own with regular monitoring. If a radiographic test suggests lung disease, or if the cat displays symptoms and tests positive for heartworm on an antibody or antigen test, prednisone should be used, with an oral regimen of “2 mg/kg body weight/day, declining gradually to 0.5 mg/kg every other day by 2 weeks and then discontinued after an additional 2 weeks.” The use of adulticide in treating cats is ineffective. Surgery is an option in severe cases of infection, especially where caval syndrome has developed (American Heartworm Society, 2014b).

Preventive medication should be given in areas and seasons where and when heartworm is prevalent. Preventive medications kill heartworm larvae before they can mature into adult heartworms. Many preventives are currently available, with active ingredients such as Ivermectin, Milbemycin and Selamectin. These often come formulated with other medications to control additional parasites, such as roundworms or hookworms. (Alieto et al., 2012, American heartworm Society 2014 a & b).

**Incidence**
Figure 4. Canine Heartworm Incidence 2010-2015. Data from the Companion Animals Parasite Council
V. ANAPLASMOSIS

Other Names
Canine granulocytotropic ehrlichiosis, canine anaplasmosis, equine ehrlichiosis, human granulocytic ehrlichiosis,

Pathogen and Transmission
Anaplasma phagocytophilum and Anaplasma platys bacterium cause anaplasmosis (previously considered ehrlichiosis). A. phagocytophilum is transmitted by the bite of an infected Ixodes tick. A. platys is tick-borne, but vector tick species is unknown. There is no pet to human transmission of Anaplasma spp, but dogs are sentinels for human exposure.

Common Animal Host
Dogs (most often golden retrievers and Labradors) and cats 6-8 years old. See below for infection of cattle.

Symptoms
- Lameness
- Lethargy
- Decreased appetite
- Anorexia
- Stiffness
- Oculonasal discharge
- Vomiting and diarrhea
- Polydipsia
- Coughing
- Seizures
- Ataxia
- Lymph node enlargement
- Hemorrhaging
**Diagnosis**
Diagnostic tests for anaplasmosis can be performed by a veterinarian. Methods include: snap test (dot ELISA), IFA, and sequential titers.

**Treatment**
Infected animals may recover without treatment. Not all infected animals will show clinical signs. Doxycycline and tetracycline antibiotics are most commonly used. Corticosteroids can be used to treat inflammation.

**Prevention**
The only method of prevention is to prevent tick exposure. No vaccines are available.

**Incidence**

![Canine Anaplasmosis Incidence from the Companion Animals Parasite Council](image-url)
Figure 5. Canine Anaplasmosis Incidence 2010-2015. Data from the Companion Animals Parasite Council
VI. ANAPLASMOSIS IN CATTLE

Pathogen and Transmission
Anaplasma marginale is a rickettsial organism which causes anaplasmosis in cattle. In the United States, the pathogen is spread by the ticks Dermacentor variabilis and Dermacentor andersoni, and other biting insects. Cattle that survive infection can act as host reservoirs for tick and other biting insect transmission (Texas Agricultural Extension Service). Anaplasma marginale can also be spread through the use of blood contaminated equipment, such as castration devices, ear tagging tools, needles, and dehorning equipment (Wilkinson, 2005).

Symptoms
Clinical signs are displayed when greater than 1% of red blood cells are destroyed. Clinical signs are usually seen after 6 months of age. After 3 years, up to 50% of cattle may die if untreated (Wilkinson, 2005).

- Anemia
- High fever
- Decline in milk production
- Icterus
- Lethargy
- Anorexia
- Refusal to drink

Diagnosis
Diagnosis is based on symptoms and a blood smear that shows A. marginale on red blood cells.

Treatment
Treating with tetracyclines or a longer acting oxytetracycline is helpful but may not prevent the animal from becoming a host reservoir.

(Wilkinson, 2005)

References


VII. CANINE BABESIOSIS

Other Names
Piroplasmosis

Pathogen and Transmission
Canine babesiosis is caused by various protozoan parasites in the genus *Babesia*. These pathogens are spread to dogs primarily through the bite of an infected tick. Ticks must feed for 2-3 days to transmit the bacterium. Other methods of transmission include blood transfusions, shared needles, and dog fights. It can also be transmitted transplacentally from pregnant females to their fetuses.

Animals Affected
Dogs, especially American pit bull terriers and greyhounds

Symptoms
- Anemia/RBC destruction
- Lethargy
- Weakness
- Pale mucous membranes
- Icterus
- Hematuria/bilirubinuria

Diagnosis
Diagnosis should be made based on a combination of clinical signs and “microscopic examination of Giemsa-stained blood or organ smears is essential. From the live animal, thick and thin blood smears should be prepared, preferably from capillaries in the ear or tail tip” (Aiello & Steigerwald, 2012). IFA or ELISA tests can be used to detect antibodies.

Treatment
Treatment with antibiotics is effective. Chemotherapy is also used.

References


VIII. CANINE EHRLICHIOSIS

Pathogen and Transmission
The bacteria *Ehrlichia canis* and *Ehrlichia ewingii* cause canine ehrlichiosis. The bite of an infected tick, including *Rhipicephalus sanguineus* (brown dog tick), *Amblyomma americanum* (lone star tick) and *Dermacentor variabilis* spread the pathogen (Companion Animals Parasite Council 2015).

Symptoms
Symptoms typically begin 1-3 weeks after being bitten by an infected tick.

- Fever
- Anorexia
- Lethargy
- Oculonasal discharge
- Liver/spleen enlargement
- Thrombocytopenia

Less common; in more severe cases:

- Ataxia
- Weakness
- Twitching
- Cranial nerve problems
- Eye problems (uveitis, chorioretinitis)
- Edema
- Hemorrhaging (especially German shepherds and Doberman pinschers)
- Joint pain/lameness

Diagnosis
Initial diagnosis is based on symptoms and can be confirmed by an ELISA test

Treatment and Prognosis
Doxycycline is the most effective treatment. Supportive therapy may also be needed to control anemia and inflammation.
IX. LYME DISEASE IN ANIMALS

Pathogen and Transmission
*Borrelia burgdorferi* (only *B. burgdorferi* sensu stricto is pathogenic to domestic animals) is spread by *Ixodes scapularis* (blacklegged tick). Ticks must feed for 24-52 hours to transmit the pathogen. Nymphal and adult female ticks can be infected with *B. burgdorferi* and transmit this pathogen. Due to their small size, nymphs are more likely to go unnoticed than adult females, and therefore will typically feed long enough to successfully transmit the pathogen (Aiello & Steigerwald, 2012, Companion Animals Parasite Council 2015).

Symptoms
95% of dogs that test positive for borreliosis are asymptomatic.

- Fever (103-106° F)
- Anorexia
- Arthritis (warm, painful joints)
- Lymph node enlargement
- Vomiting
- Kidney problems; golden retrievers are most at risk:
  - Dehydration
  - Renal failure

References


Fluid accumulation in the body cavities (pulmonary edema and ascites)
Aortic thromboembolism
Difficulty breathing
Retinal hemorrhage
Hypertension (Aiello et al., 2012, Companion Animals Parasite Council 2015)

**Diagnosis**
Diagnosis should be based on clinical signs and serologic testing for antibodies. Coinfection with anaplasmosis can occur, and should be ruled out (Aiello et al., 2012, Companion Animals Parasite Council 2015).

**Treatment**
Symptomatic dogs can be treated with a 4-week course of doxycycline. A Lyme disease vaccine is available for animals. Dogs should also be treated for ticks and checked regularly for the presence of ticks, especially dogs which spend time outdoors in tick endemic areas (Aiello et al., 2012, Companion Animals Parasite Council 2015).

**Incidence**
Figure 7. Canine Lyme Disease Incidence 2010-2015. Data from the Companion Animals Parasite Council
X. POTOMAC HORSE FEVER

Other Names
Potomac Horse Fever: *Neorickettsia risticii*. AKA equine monocytic ehrlichiosis, equine ehrlichial colitis.

Pathogen and Transmission
The bacterium *Neorickettsia risticii* is the pathogen that causes Potomac Horse Fever (PHF). It is vertically transmitted in the trematode (*Acanthatrium oregonense*) and horizontally transmitted to bats, mayflies, and caddisflies. Horses can be infected through oral transmission if they ingest infected snails or aquatic insects while grazing or drinking from rivers or creeks. PHF cases were first detected along the Potomac River in Maryland and Virginia. The disease is present in upstate NY, but has not been identified in Suffolk County (Sellon & Long, 2007).

In June 2015, the New York State Department of Agriculture and Markets issued a letter to veterinary professionals in New York warning about a higher than normal incidence of more severe PHF (Smith, 2015).

Animals Infected
Horses

Symptoms
1-3 week incubation period
- Mild depression
- Anorexia
- Fever (102-107°F)
- Diarrhea, leading to dehydration
- Decrease in borborygmus (intestinal gut sounds)
- Toxemia
- Laminitis
- Increase in respiration and cardiac rates
- Subcutaneous edema along the ventral abdomen

Diagnosis
A diagnosis is made based on clinical signs, disease prevalence, and a cell culture PCR assay of *N. risticii* isolated from blood and/or feces. Serologic antibody testing leads commonly to false positives.

Treatment, Prevention, and Prognosis
Oxytetracycline should be administered twice a day for five days; if begun early in the course of the disease, clinical signs will begin to improve within 12 hours. Dehydration and toxemia should be treated appropriately. A vaccine is available and is recommended. The mortality rate of 5-30% is a result of toxemia and laminitis (Aiello & Steigerwald, 2012).

References

XI. ROCKY MOUNTAIN SPOTTED FEVER

Pathogen and Transmission
Rickettsia rickettsii is spread by the brown dog tick (Rhipicephalus sanguineus) or American dog tick (Dermacentor variabilis). Ticks must feed from 5 to 20 hours in order for transmission to occur. R. rickettsii replicates in small blood vessels, damaging cell membranes (Greene, 2012).

Symptoms
- Fever
- Anorexia
- Diarrhea
- Pain
- Lymph node enlargement
- Neurological signs
- Seizures
- Edema
- Liver/spleen enlargement
- Hyponatremia
- Necrosis of limbs

As the figure shows, edema of several organs, including the brain, have been reported (Greene, 2012).

Figure 8.

Diagnosis
Diagnosis of RMSF is based on clinical signs and symptoms and diagnostic testing. The Merck Veterinary Manual recommends "Indirect fluorescent antibody titer (IFA) is preferred for serologic testing. However, because of the high incidence of cross-reacting antibodies to a variety of nonpathogenic spotted fever group rickettsiae, as well as..."
long-term persistence of antibodies after acute RMSF infection, demonstration of a 4-fold rise in titer should be documented in conjunction with a compatible clinical syndrome.”

**Treatment**
Antibiotic therapy, generally with doxycycline (a dosage of 5–10 mg/kg/day, PO or IV, for 10–21 days) is effective in cases without severe infection, and should be administered based on clinical examination. Supportive care should be given as necessary “for dehydration and hemorrhagic diathesis may be necessary. Because of alterations in vascular integrity, conservative rates of fluid administration are advised (Aiello & Steigerwald, 2012). There is no vaccine for Rocky Mountain spotted fever available. (Aiello & Steigerwald, 2012)

**References**


**XII. INCIDENCE AND REPORTING**

**Incidence**
The following maps show the incidence of tick and mosquito-borne diseases in certain animals by county.


**New York State Reporting**
Under New York State Agriculture and Markets Law, Article 5, §73, certain communicable diseases in animals must be reported to the NYS Ag & Mks and/or the NYSDOH. Reporting guidelines vary by animal and disease. A disease should also be reported to the NYS Ag & Mkts if it fulfills the following guidelines:

- The disease presents as a new set of symptoms not previously recognized in the species of animal affected.
- The same disease symptoms appear to be affecting animals in multiple locations.
- A disease with a recognized seasonal or species distribution occurs in an unusual season or species.
- High Morbidity (number affected/unit of time).
- High Mortality (number dying/unit of time).
- Central Nervous System disorders.
- Vesicular disease in ruminants or horses or swine.
- Hemorrhagic disease (NYS Ag & Mkts)

The complete listing of reportable diseases by animal can be found here: [http://www.agriculture.ny.gov/AI/disease_rep.html](http://www.agriculture.ny.gov/AI/disease_rep.html)
XIII. PREVENTION

Vaccines should be given according to the recommended schedule. In addition, the following precautions should be taken:

- Clear containers and pools of stagnant water where mosquitoes can breed
- Check domestic animals for ticks regularly
- Use flea, tick, and mosquito control products as directed to kill or repel vectors
- Protect indoor animals with screened windows
- Keep horses stabled from dusk to dawn
- Protect horses with mesh fly sheets

XIV. RECOMMENDATIONS

Incidence of Diseases in Domestic Animal Surveillance

- Survey the practices of Suffolk County veterinarians for data pertaining to the prevalence of tick-borne diseases in the pet population.

Prevention

- Encourage use of WNV and EEEV equine vaccines.
- Encourage development and use of vaccines for tick-borne and mosquito-borne pathogens for companion animals.
I. INTRODUCTION

The Tick and Vector-Borne Disease Management Task Force recognizes that education is an important strategy to combat vector-borne diseases in Suffolk County. Effective education gives the public the tools to protect themselves and their families, enables health care providers and veterinarians to quickly and effectively treat tick-borne diseases, and allows legislators and public health employees to create and implement the most effective policies. The EPA considers “communication and outreach with local citizens … imperative” to effective implementation of integrated pest management (Appendix N). Educational programs and resources, targeted at different populations, are available at the federal, state, and local levels, as well as through private health and environmental organizations.

II. EDUCATIONAL PROGRAMS AND RESOURCES

Federal

Centers for Disease Control and Prevention: cdc.gov

- Traveler’s Health: Educational information for international travelers on diseases that can be contracted abroad, including chikungunya, dengue, and malaria. Information includes where it is typically contracted, by what vector, and information on symptoms, diagnosis, prevention, and treatment. http://wwwnc.cdc.gov/travel/diseases
- The CDC’s State, Tribal, Local, and Territorial Public Health Professionals Gateway provides information for local health departments with science and research news, updates on the CDC’s work, and data, with the goal of increasing the "US public health agency and system performance, capacity, agility, and resilience". They have a Facebook page. http://www.cdc.gov/stltpublichealth/index.html

http://www.cdc.gov/ncezid/dvbd/about.html
Clear and accessible information on tick and mosquito-borne diseases, including information on prevention, transmission, symptoms, and how to get properly diagnosed and treated is available on the CDC’s website, through the DVBD page or through the CDC’s A-Z Index.


Brochures on tick-borne diseases, as well as scientific information for health care providers and public health officials is available here: http://www.cdc.gov/ticks

Fact sheets for high-risk groups are available in multiple languages: http://www.cdc.gov/lyme/toolkit/

Information on a variety of disease-related issues is made accessible to the public through Facebook and Twitter:
- CDC Facebook
- CDC Traveler’s Health (Facebook)
- CDC Twitter
- CDC Traveler’s Health (Twitter)

Environmental Protection Agency: epa.gov

The EPA provides information on safe use of pesticides to manage pests: http://www2.epa.gov/safepestcontrol/got-pests-control-them-safely

Information on personal protection from arthropod-borne diseases can be found http://www2.epa.gov/insect-repellents and http://www2.epa.gov/insect-repellents/tips-prevent-tick-bites

Information for pet owners and veterinarians on tick/flea control and pesticide safety can be found http://www2.epa.gov/pets

The EPA provides substantial information on using Integrated Pest Management strategies to keep schools safe and free of ticks.
- http://www2.epa.gov/managing-pests-schools/ticks-and-schools
- http://www2.epa.gov/managing-pests-schools

Information on a variety of environment and pesticide-related issues is made accessible to the public through Facebook and Twitter

State

New York State Department of Health: https://www.health.ny.gov/

NYSDOH provides information for the public on mosquito-borne (http://www.health.ny.gov/diseases/west_nile_virus/) and tick-borne diseases (http://www.health.ny.gov/diseases/communicable/lyme/); some multilingual materials are available.

Information on pesticide use and personal insect repellent is available: http://www.health.ny.gov/diseases/west_nile_virus/repellents_and_pesticides.html


Health departments and health care providers can order educational materials in bulk, including information on bite prevention, repellent, and pesticides, in languages including Spanish, Russian, and Chinese, http://www.health.ny.gov/forms/order_forms/west_nile_virus.pdf

Fact sheets are available for outdoor workers (http://www.health.ny.gov/publications/2742/) and healthcare providers (http://www.health.ny.gov/diseases/west_nile_virus/health_care_providers.html)


New York State’s mosquito borne illness response plan is available at http://www.health.ny.gov/diseases/west_nile_virus/docs/2012_mosquito_borne_illness_surveillance_and_response_plan.pdf

Information on a variety of health-related issues is made accessible to the public through Facebook

New York State Department of Environmental Conservation: http://www.dec.ny.gov/index.html

• For any questions or concerns regarding information on NYS Environmental Conservation Law in reference to pesticide sales, use, distribution, and registration, feel free to contact the NYSDEC Region 1 Bureau of Pest Management. Staff is available Monday through Friday, 8:30am - 4:30pm. Phone number: 631-444-0340, Public email: R1Pesticides@dec.ny.gov

County

Suffolk County Department of Health: http://www.suffolkcountyny.gov/Departments/HealthServices.aspx

• Have any other 2008 recommendations (mostly improvement of site and brochure) been put in place?
• SCDH provides information on prevention of mosquito-borne and tick-borne illnesses:
  • Arthropod Borne Diseases homepage: http://www.suffolkcountyny.gov/Departments/HealthServices/PublicHealth/PreventiveServices/ArthropodborneDiseaseProgram.aspx
  • Tick-Borne Diseases: http://www.suffolkcountyny.gov/Departments/HealthServices/PublicHealth/PreventiveServices/ArthropodborneDiseaseProgram/Ticks.aspx
  • Mosquito-Borne Diseases: http://www.suffolkcountyny.gov/Departments/HealthServices/PublicHealth/PreventiveServices/ArthropodborneDiseaseProgram/PreventingMosquitoBorneIlnesses.aspx

• Each spring, the Suffolk County Department of Health Services distributes educational brochures/pamphlets to legislators, town supervisors, libraries, hospitals and health centers with a letter requesting that they share the information with the public. Electronic copies of these materials are also available online and promoted through social media and press releases to all of the above as well as to civic associations, village halls, local media and county offices.

• Mosquitoes and Mosquito-Borne Diseases http://www.suffolkcountyny.gov/Portals/0/health/pdf/Mosquito%20Publication%20ADAcompliant.pdf
• Dump the Water & Scrub the Container Campaign http://www.suffolkcountyny.gov/Portals/0/health/pdf/Mosquito%20Control%20flyer%20Dump%20the%20water%20(ADA).pdf

• SCDHS promotes YouTube interviews with entomologist Scott Campbell, PhD. One video focuses on protecting oneself from tick bites; the other is a two-part video highlighting the county’s mosquito surveillance program.
  • Public Health: The Science of Catching and Testing Mosquitoes (Part 1) https://www.youtube.com/watch?v=EtaO-GkF8Yc
  • Public Health: Preparing Mosquitoes for West Nile Virus Testing (Part 2) https://www.youtube.com/watch?v=ebOvslin8
  • How To Avoid Ticks: Tick & Mosquito Expert Dr. Campbell Provides Great Advice https://www.youtube.com/watch?v=kVQpFyFCIEU

• The Suffolk County Office of Health Education provides an educational Lyme disease presentation upon request to schools. It aims to educate students on basic blacklegged tick biology, disease transmission, and personal prevention strategies. The presentation can be requested by contacting the Office of Health Education at 853-3162
• Information on a variety of health-related issues is made accessible to the public through Facebook and Twitter

Organizations and Informational Websites

Entomological Society of America: http://entsoc.org/

• Informational materials for teachers, the public, and scientists
• Publish press releases on research and initiatives
  • The Entomological Society of America works to educate legislators through several initiatives: http://entsoc.org/esa-science-policy
  • The Entomological Society of America publishes a newsletter and several academic journals: http://entsoc.org/Pubs/Overview/index, http://entomologytoday.org/
• Information and brochures are available for:
  • Scientists: http://www.entsoc.org/scientists
Teachers: [http://www.entsoc.org/teachers](http://www.entsoc.org/teachers)
The Entomological Society of America supports students studying entomology: [http://entsoc.org/student](http://entsoc.org/student)
Information on a variety of entomology issues is made accessible through Facebook and Twitter

- The AMCA maintains a Legislative and Regulatory committee charged with communicating with lawmakers to address issues of mosquito control, pesticide use, etc.: [http://www.mosquito.org/legislation](http://www.mosquito.org/legislation)
- The AMCA provides a mosquito FAQ, factsheet, and more technical information on traps, repellents, and mosquito biology: [http://www.mosquito.org/mosquito-info](http://www.mosquito.org/mosquito-info)
- The AMCA holds conferences, hosts webinars, and publishes a newsletter and journal to keep members educated on mosquito control: [http://www.mosquito.org/meetingsevents](http://www.mosquito.org/meetingsevents) and [http://www.mosquito.org/publications](http://www.mosquito.org/publications)
- The AMCA has a web store with educational brochures geared at all ages: [http://www.mosquito.org/books-a-merchandise](http://www.mosquito.org/books-a-merchandise)
- The AMCA provides links to mosquito control and public health organizations: [http://www.mosquito.org/links](http://www.mosquito.org/links)
- Social Media: Information on a variety of mosquito-related issues is made accessible through Facebook and Twitter

Connecticut Agricultural Experiment Station (http://www.ct.gov/caes/site/default.asp) and Connecticut Department of Public Health (http://www.ct.gov/dph/site/default.asp)
- CAES provides information on ticks and tick management relevant to Connecticut and the northeast

Tick Encounter Research Center, University of Rhode Island: [http://www.tickencounter.org/about](http://www.tickencounter.org/about)
- Provides public outreach aimed to educate the public on preventing tick bites
- Provides a comprehensive, user-friendly FAQ on tick prevention and identification: [http://www.tickencounter.org/faq](http://www.tickencounter.org/faq)
- Information is also made accessible on Facebook

- The American Medical Association Handbook of First Aid and Emergency Care contains basic information on avoiding tick and mosquito bites and identifying and treating tick and mosquito-borne diseases
- The CDC provides a CME course on tick-borne illnesses. [http://www.cdc.gov/lyme/healthcare/clinicians.html#CME](http://www.cdc.gov/lyme/healthcare/clinicians.html#CME)
- The Journal of the American Medical Association publishes work on tick and mosquito-borne diseases.
- Arthropod-Borne disease has not been a topic of a meeting of the Council on Science and Public Health.

American Veterinary Medical Association: [https://www.avma.org/Pages/home.aspx](https://www.avma.org/Pages/home.aspx)
- April is Prevention of Lyme Disease in Dogs month! [https://www.avma.org/Events/pethealth/Pages/default.aspx](https://www.avma.org/Events/pethealth/Pages/default.aspx)
- Continuing education courses periodically cover veterinary entomology. [https://www.avma.org/Events/Calendar/Pages/default.aspx](https://www.avma.org/Events/Calendar/Pages/default.aspx)
- The AVMA provides information on flea and tick treatments: [https://www.avma.org/public/PetCare/Pages/Safe-Use-Of-Flea-and-Tick-Products-in-Pets.aspx](https://www.avma.org/public/PetCare/Pages/Safe-Use-Of-Flea-and-Tick-Products-in-Pets.aspx)
- The AVMA provides information on diseases acquired by pets in outdoor activity [https://www.avma.org/public/Health/Pages/Outdoor-Enthusiasts-Precautions.aspx](https://www.avma.org/public/Health/Pages/Outdoor-Enthusiasts-Precautions.aspx), information and alerts on Lyme Disease and other tick-borne diseases [https://www.avma.org/public/PetCare/Pages/lyme-disease.aspx](https://www.avma.org/public/PetCare/Pages/lyme-disease.aspx)
- SOVE publishes the Journal of Vector Ecology biannually, which is “concerned with all aspects of the biology, ecology, and control of arthropod and vertebrate vectors and the interrelationships between the vectors and the agents of disease that they transmit.” [http://www.sove.org/SOVE%20folder/Journal.html](http://www.sove.org/SOVE%20folder/Journal.html)
- SOVE publishes a periodic newsletter containing regional reports on vector-borne illness, announcements, and news. [http://www.sove.org/SOVE%20folder/Newsletter.html](http://www.sove.org/SOVE%20folder/Newsletter.html)
- Social Media: Information on a variety of vector-related issues is made accessible through Facebook

Cornell University: [http://cals.cornell.edu/](http://cals.cornell.edu/)
- Cornell University’s Entomology Extension provides entomological education to children and adults through their Engaged Entomology program [http://entomology.cals.cornell.edu/extension/engaged-entomology](http://entomology.cals.cornell.edu/extension/engaged-entomology)

Cornell Cooperative Extension of Suffolk County: [http://ccesuffolk.org/](http://ccesuffolk.org/)
- TickClick: a free app designed to help the public identify ticks, assess risk of disease, and prevent tick bites: [http://www.nysipm.cornell.edu/landscapes/tickclick.asp](http://www.nysipm.cornell.edu/landscapes/tickclick.asp)
- An integrated pest management program for the deer tick in residential areas is suggested: [https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/5842/Integrated_Pest_Management_For_The_Deer_Tick.pdf?1421781744](https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/5842/Integrated_Pest_Management_For_The_Deer_Tick.pdf?1421781744)
- Social Media: Information on a variety of agricultural issues is made accessible through Facebook

Rutgers University – Center for Vector Biology: [http://vectorbio.rutgers.edu/about.php](http://vectorbio.rutgers.edu/about.php)
- Rutgers makes publically available scholarly papers published by the Center for Vector Biology: [http://vectorbio.rutgers.edu/publications/](http://vectorbio.rutgers.edu/publications/)
- Public Outreach: The Center for Vector Biology offers fact sheets, FAQs, and materials for schools: [http://vectorbio.rutgers.edu/outreach/](http://vectorbio.rutgers.edu/outreach/)

- Services, including trainings and trap evaluation, are provided. [http://docmx8.wix.com/phes#](http://docmx8.wix.com/phes#)

Association of Schools and Programs of Public Health: [http://www.aspph.org/about/](http://www.aspph.org/about/)
- Provides resources for faculty and students in public health programs
- Includes scientific updates on mosquitoes and ticks [http://www.asphp.org/?s=tick](http://www.asphp.org/?s=tick), [http://www.asphp.org/?s=tick&_=0](http://www.asphp.org/?s=tick&_=0)

Council on Education for Public Health: [http://ceph.org/about/](http://ceph.org/about/)
- Accredits educational schools of public health

Public Health Foundation: [http://www.phf.org/Pages/default.aspx](http://www.phf.org/Pages/default.aspx)
- Work with the CDC to evaluate vector control programs [http://www.phf.org/news/Pages/Assisting_Vector_Control_Programs_Through_Performance_Improvement_Initiative.aspx](http://www.phf.org/news/Pages/Assisting_Vector_Control_Programs_Through_Performance_Improvement_Initiative.aspx)

Association of Public Health Laboratories: [http://www.aphl.org/Pages/default.aspx](http://www.aphl.org/Pages/default.aspx)
- Offer trainings on a variety of topics, including tick-borne diseases, [http://www.aphl.org/Materials/APHL2015_Webinars-Regular.pdf#search=tick](http://www.aphl.org/Materials/APHL2015_Webinars-Regular.pdf#search=tick)
Suffolk County Health Providers

Peconic Bay Medical Center Tick-Related Disease Center: http://www.pbmchealth.org/medical-centers-and-services/tick-related-disease-center-pbmchealth/
- The Peconic Bay Medical Center provides information about ticks on Long Island, including steps on prevention and what to do if you have a tick or think you have a tick-borne disease.
- During the summer, they broadcast regular PSAs regarding tick prevention

Southampton Hospital Tick Borne Disease Resource Center: https://www.southamptonhospital.org/services/tick-borne-disease-resource-center/default.aspx
- Southampton Hospital provides information on tick prevention, news related to Long Island ticks, and has a scientific and medical panel to handle tick-related issues.

III. WHO NEEDS TO BE EDUCATED

While many materials are geared toward the general public, groups particularly at risk should be targeted.
- Public--High risk groups
  - Gender
  - Age
  - Occupation (Park employees, landscapers and pool companies, construction workers)
  - Outdoor organizations (scouts, 4-H, summer camps, hikers and hunters)
  - Homeless persons
- Physicians and Healthcare Providers
- Veterinarians
- Public Health Employees
- Law Enforcement
  - Police Department
  - Sheriff’s Office
  - K-9 Units
- Lawmakers
- Miscellaneous
  - Exterminators
  - Educators
  - Social Service Employees

IV. RECOMMENDATIONS

- Make full use of electronic media as a method of public education.
  - Publically post QR codes that link to social media or tick education pages.
  - Increase the use of Facebook, Twitter, YouTube, and Pinterest to publicize information about ticks.
  - Create an electronic clearinghouse for educating the public on ticks, disease and IPM; list reputable landscape and exterminating companies that are registered with the NYSDEC and Applicator Certified.
  - Use online and electronic resources to alert the public to the use of IPM to reduce pesticide use.
  - Create dynamic, user-friendly, educational web pages.
- Continue to create and distribute updated materials on mosquitoes, tick identification and bite prevention.
  - Target homeowners, medical and veterinary offices, and at-risk groups.
  - Use quality color images with information on respective associated pathogens/diseases, symptoms, and reservoir hosts.
  - Distribute in a variety of formats (online, brochures, multimedia, print) and languages to maximize accessibility.
- Publicize SCDHS’s efforts through inclusion of our webpage on AMCA’s list of links.
- Educate medical and veterinary community through continuing medical education courses. Topics should include:
  - Consideration of performance data for tick repellents
- Tick and mosquito-borne pathogen prevention for domestic animals
- Ensuring that recommendations of therapies are clear and consistent
- Recommended and alternative therapies, along with pros and cons

- Educate public health employees about tick-borne and mosquito-borne pathogens and related topics, to ensure that important information is provided to the public.
Chapter 8
Tick and Vector-Borne Diseases Task Force Members

THE FUTURE: COLLABORATION AND FUNDING

Everyone, in all professions and levels of government, involved with tick-borne and mosquito-borne diseases should be encouraged to collaborate within their professional group as well as entities on the local, state and federal levels. This collaboration would foster expanding knowledge about these subjects.

Some possible entities for collaboration are:

**Local and County** –
- Cornell Cooperative Extension
- Suffolk County Medical Society
- SCDHS
- SCDPW
- SCDParks

**State** –
- NYSDOH
- NYSDEC
- NYSDParks

**Federal** –
- CDC
- EPA

**Academic** –
- SUNY Stony Brook
- Cornell University

In order to address the issues related to tick-borne and mosquito-borne pathogens and related diseases, adequate funding is required. All possible efforts should be made to provide adequate funding from local, county, state and federal sources to properly address the needs associated with tick-borne and mosquito-borne pathogens and related diseases.