Lyme Disease, the Ecology of a Complex System, Richard Ostfeld, Cary Institute of Ecological Studies, NY – This is a great book. Rick has been very generous in helping me with my education on ticks and tick-borne diseases. He challenges dogma and is a mythbuster...things that are key to supporting our educational objectives.
Everyone hates ticks !!!

- “I love everything in the world…except for ticks…”
“Actually, NFL Commissioner Roger Goodell is \textit{TIED} with ticks on my list of the unworthy…”
Incidence Rate Lyme: 2013 - 2015

State Ranking

1 - Vermont 88*  
2 - Maine 83  
3 - New Hampshire 60  
4 - Connecticut 53  
5 - Massachusetts 51  
6 - Rhode Island 50  
7 - Pennsylvania 49  

U.S. 8

* Confirmed cases  
Per 100,000
How did Lyme get to be such a problem?!...
Forest Acreage: 1951 & 2011

[Image of forested acreage comparison between two years]
Land-use change

1950

2009
American Dog Tick
*Dermacentor variabilis*

Vectors Rocky Mountain Spotted Fever and Tuluremia. Very rare in MA.
Lone Star Tick

*Amblyomma americanum*

Good vision. Can run as quickly as spiders.
Lone Star Tick Distribution

Has been moving steadily north for many years...Climate change? ...perhaps. Up until 2014 the northern most established populations were found on the Elizabeth Islands.
Cape Cod Mosquito Control works in Sandy Neck Beach Park and brought lone star to the attention of L. Dapsis. Sampling the park end to end (about 6 miles) confirmed the first established population of lone star on the MA mainland. Larry found a second established population last fall in West Falmouth. We believe migratory birds introduced it and, that wild turkeys and coyotes are spreading it. Surveillance needs to be conducted off-Cape.
Lone Star Tick

- **Aggressive biter**
  - Erlichiosis
  - STARI
  - Tularemia

**Allergy to red meat consumption**

**Beef, Pork, Lamb and by-products...gelatin**

Female lone star ticks lay eggs in masses...3,000+ Eggs hatch into tiny larvae August into September...will quickly swarm host and attach. They do not vector the pathogens that cause Lyme but have their own set of pathogens. One unique aspect of this tick is that the bite of a lone star tick can trigger an allergy to red meat consumption. This has already happened to people on Cape Cod.
Deer Tick, or Blacklegged Tick

...name Blacklegged Tick is more accurate...deer are part of the equation
Ticks are found at ground level (larvae, nymphs) or on vegetation up to 2 feet off the ground. They do not run, jump or fall out of trees.
Ticks are designed to stay a while...

The beak has recurved barbs to help hold it in place. Ticks may feed for 3-5 days to fully engorge.
About Hosts…

125 vertebrate species

Complex Ecosystem…

Rodents are KEY infective hosts – Mice, chipmunks, rats are extremely “competent”

Birds play a role

“Incompetent” hosts – Deer, raccoons, dogs, people

Birds can harbor Lyme, e.g. American robin, wild turkey. Incompetent hosts do not carry Lyme, this includes deer.
Risk of infection is year round, but the greatest risk...

is NOT the tick adults
Fall thru Spring, 50% infected
Bite more likely to be detected

…it’s from the nymph stage
Late May into August, 25% infected
Bite is more difficult to detect
Tick SIZE WISE?
check your bagels

Adult

Nymph
85% of Lyme cases occur during May to August when the nymph stage is active. Adult stage ticks are out from Sept. to April...active during winter when temps are above freezing
Massachusetts Winters: *Kill Ticks?*

Perennial question that Larry fields every spring. No Impact. Winters in Eastern MA are overall relatively mild compared to other regions.
Larry was in the cranberry industry for 24 years and often travelled to Wisconsin. -25 F for extended periods of time is quite common. In WI deer ticks are widely distributed...winter does essentially nothing to them. WI is quite endemic for Lyme disease.
Ticks make glycerol...

...antifreeze

Glycerol prevents ice crystal formation in cells

Lyme bacteria use glycerol as a carbon (= energy) source

The Lyme disease bacteria and deer ticks are a well engineered package!
LMZ - Major research collaborators with CC Coop Extension. Dr. Steve Rich (left), Dr. Guang Xu (right). Center, Emily, one of Steve’s grad students.
Adult stage ticks collected in the spring of 2016. LMZ had to develop a test from scratch in short order...they succeeded.
<table>
<thead>
<tr>
<th>Location</th>
<th>% Infection</th>
<th>Number of Ticks Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truro</td>
<td>10.4</td>
<td>115</td>
</tr>
<tr>
<td>Orleans</td>
<td>2.5</td>
<td>118</td>
</tr>
<tr>
<td>Brewster 1</td>
<td>7.0</td>
<td>129</td>
</tr>
<tr>
<td>Brewster 2</td>
<td>0</td>
<td>114</td>
</tr>
<tr>
<td>Barnstable</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Falmouth</td>
<td>4.0</td>
<td>101</td>
</tr>
</tbody>
</table>

Expanded surveillance is CC Extension’s next step...
Phase 1 Game Plan- Protect Yourself

An “average” family that needs protection....
Phase 1 Game Plan- Protect Yourself

- Proper Tweezers
- Proper Removal
- Record Date...Save the Tick

Infection Test Available
- Laboratory of Medical Zoology...UMass-Amherst
- www.TickReport.com

Pointy tweezers. Umass can test ticks for all pathogens...unlike the human blood test for Lyme, this is spot-on accurate. People generally get the results in 3 – 5 days. Good info for talking with your doctor.
<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Date Ordered</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrelia mayonii</td>
<td>4/6/2016</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>Borrelia burgdorferi</td>
<td>3/30/2016</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>Anaplasma</td>
<td>3/30/2016</td>
<td>NEGATIVE</td>
</tr>
<tr>
<td>Babesia</td>
<td>3/30/2016</td>
<td>POSITIVE</td>
</tr>
<tr>
<td>Borrelia miyamotii</td>
<td>3/30/2016</td>
<td>NEGATIVE</td>
</tr>
</tbody>
</table>

Patient Information:
- Host Source: human
- Gender: male
- Age: 3
- City: Norwell
- State: MA
- Zip: 02061
- Attached: Yes
- Site of Attachment: Head
- Rash Present: No

Tick Information:
- Species: *Ixodes scapularis*
- Sex: female
- Stage: adult
- Feeding State: engorged

This tick was co-infected...people can get more than one disease at the same time. In our research we found that 8% of nymph stage ticks are co-infected.
<table>
<thead>
<tr>
<th>Tests Ordered</th>
<th>Patient Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathogen</td>
<td>Host Source: human</td>
</tr>
<tr>
<td></td>
<td>Gender: female</td>
</tr>
<tr>
<td></td>
<td>Age: 63</td>
</tr>
<tr>
<td></td>
<td>City: Eastham</td>
</tr>
<tr>
<td></td>
<td>State: MA</td>
</tr>
<tr>
<td></td>
<td>Zip: 02642</td>
</tr>
<tr>
<td></td>
<td>Attached: Yes</td>
</tr>
<tr>
<td></td>
<td>Site of Attachment:</td>
</tr>
<tr>
<td></td>
<td>Upper Leg</td>
</tr>
<tr>
<td></td>
<td>Rash Present: No</td>
</tr>
<tr>
<td>Date Ordered</td>
<td></td>
</tr>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>Borrelia burgdorferi</td>
<td>11/19/2016</td>
</tr>
<tr>
<td>Anaplasma</td>
<td>11/19/2016</td>
</tr>
<tr>
<td>Babesia</td>
<td>11/19/2016</td>
</tr>
<tr>
<td>Borrelia miyamotoi</td>
<td>11/19/2016</td>
</tr>
</tbody>
</table>

Tick Information
Species: *Ixodes scapularis* (Deer tick)
Sex: female
Stage: adult
Feeding State: partially fed

Note, a tick test only shows you what you were potentially exposed to...it does not mean you are going to get sick. It does provide hard data to share with your doctor to help guide towards an accurate diagnosis.
Protect Yourself

- Long pants - tucked into socks
- Light colors...easier to see ticks
- Tumble-dry clothes for 20 minutes
- Shoes

Standard recommendations. High school science student found out 5 minutes in the dryer will kill ticks...they do survive a wash machine cycle.
- Deet, Picaridan, IR3535, Oil of Lemon Eucalyptus to treat *exposed skin*

- “All Natural”?

All natural are NOT EPA registered unlike Deet, etc. Therefore producers of the all natural products are not required to show ANY proof that they work...
By far, the most effective tool in the box. LD found that 60 seconds of exposure is sufficient to kill ticks. Treating footwear is very important since nymph stage ticks (poppy seed sized) are in the leaf litter. If treating pants, after the spray dries turn them inside out and treat the bottom 6” of cuff. This is hands down the most effective tool in the box...Larry wears treated clothing year ‘round.
Pre-treated Tick Repellent Clothing

- 70 Washings EPA Claim

Or, send clothing to Insect Shield for treatment

Same performance as do-it-yourself, just longer lasting. If you send your own clothing to Insect-Shield they will treat them for you...same 70 washings performance claim applies. www.insectshield.com
Permethrin Facts

- 2,250 times more toxic to ticks than humans
- EPA: Reasonable certainty that permethrin-treated clothing poses no harm to infants, children, pregnant women or nursing mothers
- Low skin absorption...metabolized quickly
- Exposure data also studied by National Academy of Sciences
- Also used for scabies and head lice control

NAS study assumed exposure from all clothing, 18 hours/day for 10 years...no adverse effects anticipated. Active ingredient in treating infants for scabies mite and kids for head lice. Consider very low risks from exposure vs. long-term consequences of a tick-borne disease. L.Dapsis wears treated clothing year-round...not a single tick bite (knock-on-wood).
Phase 2 Game Plan - Protect Your Yard
Permethrin-treated cotton balls...mice self-treat. Safe and easy to use but, do they really work? Two multi-year, replicated trials demonstrated that this product has no material effect on tick populations.
Phase 3 Game Plan - Protect Your Pets

- Tick check
- Topical products: K9 Advantix II, Frontline
- Seresto collar

Compare price points topicals vs collar. Collar is the better value.
This vest makes me look GOOD!!!
Don’t Let...one bite change your life...

Simplified Game Plan Summary

- Tick Checks and Use of Permethrin-Treated Clothing
- Perimeter Yard Spray
- Pet Protection

1, 2, 3 – Doing #1 alone will significantly reduce your risk of getting a tick bite and potentially having your life changed significantly....
Questions?
Several initial university studies looked promising
  – Fewer ticks on mice

Follow-up studies, NY & CT
  – Replicated, multi-year
  – No significant effect on *nymph* tick populations
    …not all tick-carrying animals take cotton

Company website – testimonial driven, no baseline data in company trial

Two well executed studies Stafford (CT Ag Stn) and Daniels (Fordham U., NY)...demonstrated significant lack of performance for reasons cited. If you use this product and it makes you sleep better at nite, have at it but I do not believe that it materially lowers risk of tick-borne diseases.
TCS – Tick Box Technology Corporation
- Mice, chipmunks, meadow voles

CDC
- 500 Households 2012 – 2015  CT
- Final Report Pending
“Jamie...I’ve been told that if you agitate a tick with something like a chemical, it will throw up and infect you with Lyme...”

“Well Adam...I think that it’s time to take a serious look at tick morphology...”
Pharyngeal Valve

Saliva Out

Blood In

FIGURE 6.6: Diagram illustrating the mouthparts of a representative ixodid tick (Dermacentor andersoni) as seen in tangential and cross-section. Tangential section through the capitulum: ala, Aala (indicated by the heavy black line); salivary muscles indicated by fine parallel lines on either side of the salivary ducts. c.a.c., buccal cavity (mouth); ch., chelicera; c.s.b., cheliceral sheath (inner sheath or cone sheath in Ixodopsis (1950)); d.t., cheliceral digits; d.o., Gen's organ; h.d., hood; h.p., hypostome; l.c.b., inter-costaal bridge; l.a., labrum; m.b., membrane over preoral canal; p.c.s., outer cheliceral sheath; p.m., oval membrane-covered area of chelicera; p.p., palatal segment II; p.w., parasome areas (indicated by lines through the cuticle); p.c.s., posterior cheliceral sheath; P.C.C., preoral canal; p.s., pharynx; p.s., pharyngeal valve (indicated by curved semi-circle); R.d., retractor muscle; s.a., salivarium; s.d., salivary duct; s.o.b., subcheliceral plate (epistome); T.e., tectum. Redrawn and labeled from Gregoons, J.D. (1980) Morphology and functioning of the mouthparts of Dermacentor andersoni Stiles. Part II. The feeding mechanism in relation to the tick. Acta Tropica 27:48-72, with permission from Elsevier.
FIFRA Section 25(c) Minimum Risk Pesticides

- Active Ingredient *List*
- Claims Linking Pest to Specific Diseases – **NO**
- False or Misleading Statements – i.e. “Chemical Free”
  - Federal Trade Commission
- EPA Registration Exemption
  - Performance Data **NOT** Required

- Note: Some actives ID’d as known human allergens
  - Negative interaction observed with sunscreens
**BE INFORMED**

**How to Submit a Tick for Testing**

Don't Let ONE BITE

**SEND A TICK TO COLLEGE**

www.TickReport.com

The Laboratory of Medical Zoology (LMZ) has tested thousands of ticks from all over the country. Having your tick tested couldn’t be easier. Just follow five simple steps:

1. Place the tick in a sealable plastic bag.
2. Complete the online submission form at www.TickReport.com. Pay the $15 fee online with a credit card or enclose a check.
3. Label the bag with the order number assigned by TickReport.
4. Send the tick to the Laboratory of Medical Zoology, 2346 Forest Hall, University of Massachusetts 140, Amherst, MA 01003
5. Your TickReport will be sent to you in 3 business days.

**SEND A TICK TO COLLEGE**

**$15** Tick testing for Cape Cod residents.

Lyme isn’t the Only Concern

Cape Cod is a known area with the vectors that may cause Lyme, babesiosis, anaplasmosis, and Rochalimaea henselae. Some hard ticks can transmit different microbes as well. Learn more by visiting www.capecoastextension.org/ticknews.

Cape Cod Cooperative Extension
Larry Deppe, Entomologist
508-375-5043
tdeppe@co.stephyllcounty.org

Tick & Insect Management

**www.capecodextension.org**
Cape Cod Mosquito Control works in Sandy Neck Beach Park and brought lone star to the attention of L. Dapsis. Sampling the park end to end (about 6 miles) confirmed the first established population of lone star on the MA mainland.
Kids – High Risk Group!!! In addition to older people.
CDC updated their number in 2015 from 30,000 to an estimated 300,000 case per year, a 10-fold underreporting problem. 14 states account for 90+% of all cases. Lyme has been confirmed in 49 out of 50 states (not in Hawaii).
“Upon further examination the complexity of this problem continues to grow….”

For many years it was just about Lyme disease...the picture is changing
Babesiosis
Invades Red Blood Cells

Symptoms include fever/chills, severe anemia

Blood Transfusion

Serious and can be directly fatal. Blood supply quality is a major concern.
On the increase...over half of the cases of Babesiosis in Southeastern MA.
Symptoms can appear “lyme-like” which challenges proper diagnosis.
More widespread than Babesiosis and, also on the increase.
Not common in younger people.
Borrelia miyamotoi

- First linkage to human disease in 2012 – Russia
- U.S. cases followed…Relapsing Fever
- Found in 2.3% of ticks tested from Cape - 2016

Vectored by deer ticks.
Powassan Massachusetts 2013-2015

- 13 cases
- Exposure occurred in Massachusetts
- Month of onset
  - May, June, September and October
- Encephalitis requiring hospitalization
  - 3 fatalities