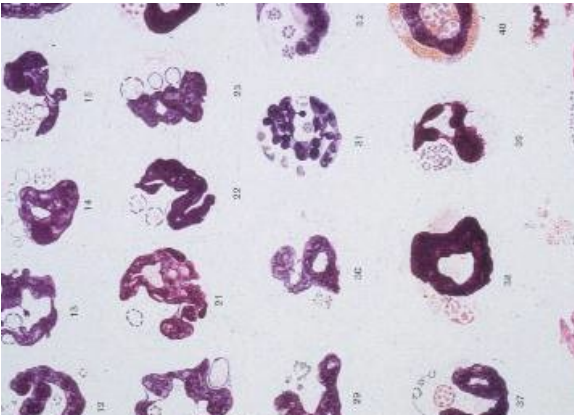
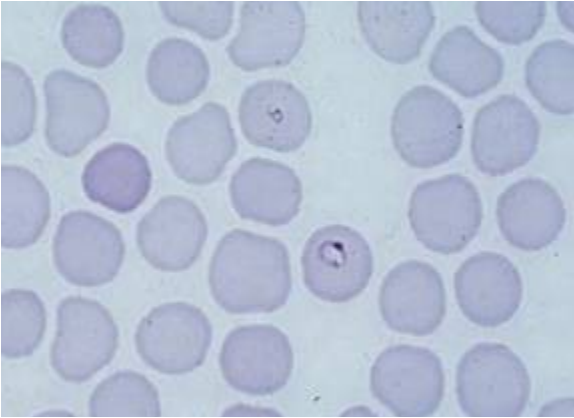


Deer tick-transmitted infections zoonotic in the eastern U.S.



- Lyme disease (*Borrelia burgdorferi* sensu lato): erythema migrans rash, fever, chills, muscle aches; can progress to arthritis or neurologic signs – 200-500 cases/100,000/year

- Babesiosis (*Babesia microti*): malaria like, fever, chills, muscle aches, fatigue, hemolysis/anemia– 100-200 cases/100,000/year

- Human granulocytic ehrlichiosis/anaplasmosis (*Anaplasma phagocytophilum*): fever, chills, muscle aches, headache—50-100 cases/100,000/year

- Borrelia miyamotoi disease (BMD): fever, chills, muscle aches, headache – 50-100 cases/100,000/year

- Deer tick virus fever/encephalitis: fever, headache, confusion, seizures– 1-5 cases/100,000/year



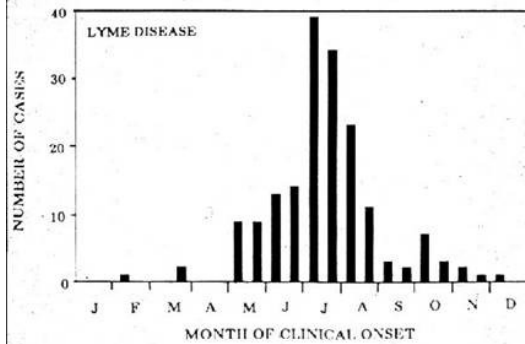
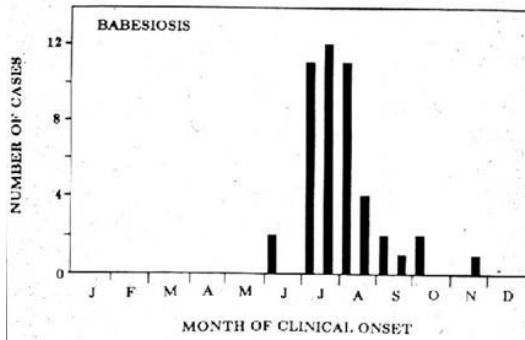
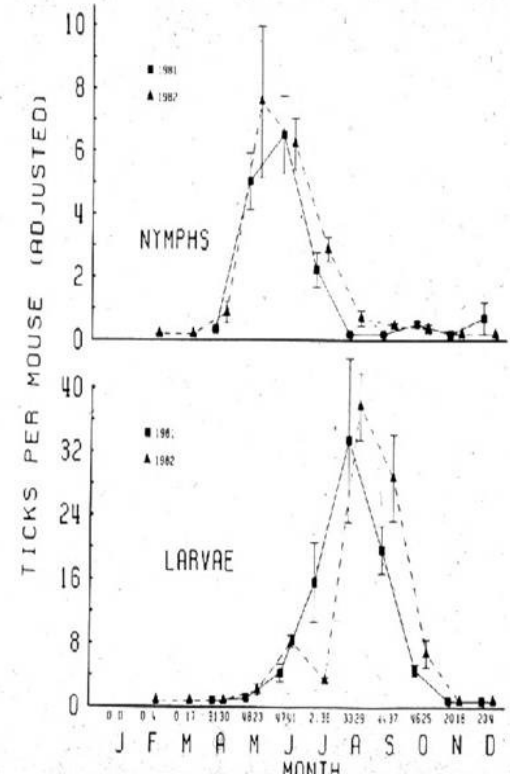
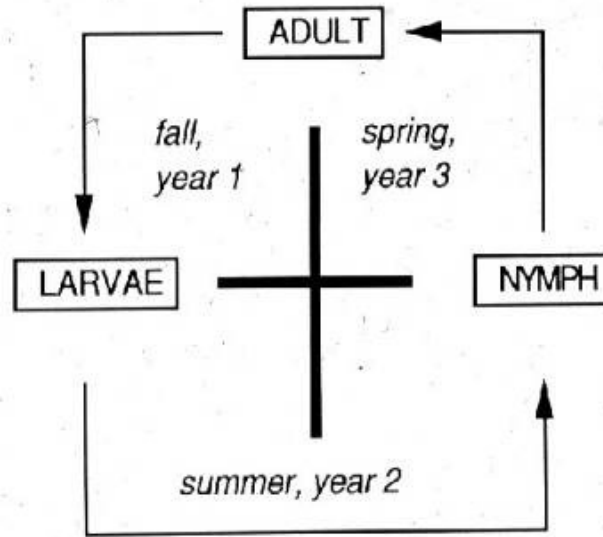
Erythema migrans: not just a “bull’s-eye”

Courtesy of Tim Lepore MD, Nantucket Cottage Hospital



Life cycle of deer ticks...critical to develop interventions

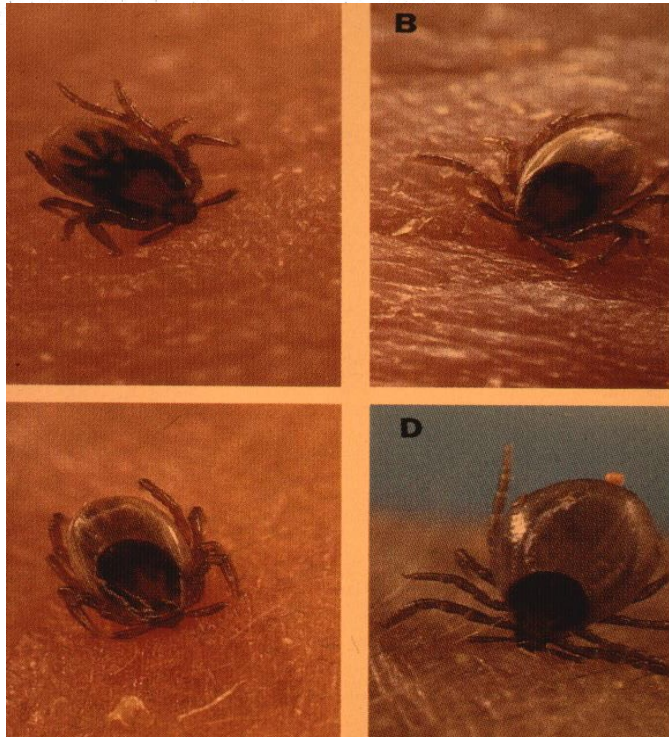
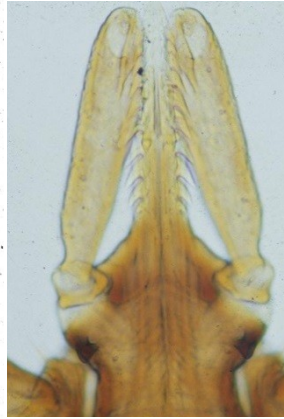
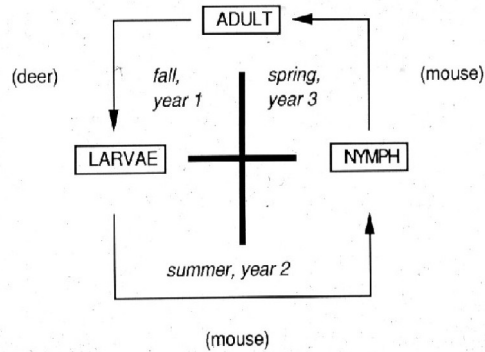
40%-70% infection rate



10%-30% infection rate



Grace period: Adaptations to extended life cycle



Borrelia burgdorferi: 24-48 hours
(upregulation of OspC, migration from gut to salivary glands)

Babesia microti: 48-62 hours
(sporogony from undifferentiated salivary sporoblast)

Anaplasma phagocytophilum: 24-36 hours
(acquisition of "slime layer"?)

Tickborne encephalitis virus: none

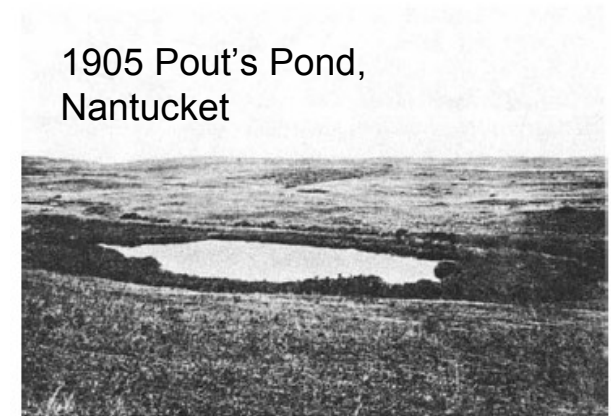
“Restore the risk landscape to what it was before 1980”

The main drivers for emergence of the Lyme disease epidemic:

Deforestation, reforestation:
dominance of successional habitat

Increased development and
recreational use in reforested sites

Burgeoning deer herds



1905 Pout's Pond,
Nantucket

1986



JOURNAL OF FOREST HISTORY / JULY 1989

Tick Management Handbook

An integrated guide for homeowners, pest control operators, and public health officials for the prevention of tick-associated disease

Revised Edition

Prepared by:

Kirby C. Stafford III, Ph.D.
Vice Director, Chief Entomologist
Connecticut Agricultural
Experiment Station, New Haven



<http://www.ct.gov/caes/lib/caes/documents/publications/bulletins/b1010.pdf>

Modes of intervention

At the level of the individual:

Repellents and toxicants
(permethrin, deet)

Appropriate clothing

Tick check

Education and awareness

Habitat avoidance

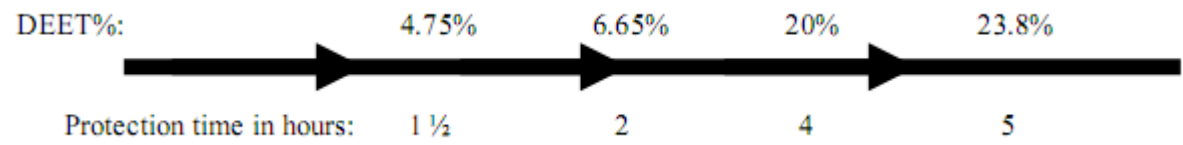
Source reduction around
homes



DEET: safe, effective, and cheap

- US military developed, first used 1946; first consumer use 1957
- Works because there is an antennal receptor for noxious substances including DEET
- 400M doses applied each year in the U.S.
 - Seizure reports 1 in 100,000,000 doses but causality not established
 - Has acetylcholinesterase activity in vitro
- EPA category III, slightly toxic (>30 grams ingestion is LD50); mutagen category D (none)

For detailed fact sheets: National Pesticide Information Center and Exttoxnet



What to do about a tick bite?

- Just pull it out but do it promptly.
Don't bother with fancy tools; use fingers or good tweezers
- Disinfect the site of the bite (wipe with alcohol)
- Save the tick taped to an index card with the date noted.
If the tick appears to be full of blood, take it and visit your healthcare provider, who may consider prophylactic treatment
If the tick is flat (hard to grab) and unlikely to have been attached more than 24-36 hours, watchful waiting is the recommended course of action (probability of infection is low even if the tick is infected)
“Tick testing” has no clinical utility; physicians will not “treat a tick’s test result”
- Watch the site of the bite for an expanding rash, or note any fever within the next week or two
See your healthcare provider immediately



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PROPHYLAXIS WITH SINGLE-DOSE DOXYCYCLINE FOR THE PREVENTION OF LYME DISEASE AFTER AN *IXODES SCAPULARIS* TICK BITE

ROBERT B. NADELMAN, M.D., JOHN NOWAKOWSKI, M.D., DURLAND FISH, Ph.D., RICHARD C. FALCO, Ph.D., KATHERINE FREEMAN, Dr.P.H., DONNA MCKENNA, R.N., PETER WELCH, M.D., ROBERT MARCUS, M.D., MARIA E. AGÜERO-ROSENFELD, M.D., DAVID T. DENNIS, M.D., AND GARY P. WORMSER, M.D., FOR THE TICK BITE STUDY GROUP*

TABLE 2. ERYTHEMA MIGRANS AT THE SITE OF AN *IXODES SCAPULARIS* TICK BITE IN 482 SUBJECTS.

TICK STAGE AND ENGORGEMENT STATUS	DOXYCYCLINE GROUP (N=235)	PLACEBO GROUP (N=247)	P VALUE*
	no. with erythema migrans/total no. (%)		
Nymphal	1/124 (0.8)	8/142 (5.6)	<0.04
Partially engorged	1/78 (1.3)	8/81 (9.9)	0.03
Unfed (flat)	0/43	0/59	1.00
Adult female	0/100	0/97	1.00
Partially engorged	0/28	0/36	1.00
Unfed (flat)	0/66	0/57	1.00
Larval	0/10	0/8	1.00
Adult male	0/1	0/0	1.00
All	1/235 (0.4)	8/247 (3.2)	<0.04

*P values were derived by the two-tailed Fisher's exact test.

TABLE 4. ADVERSE EVENTS.*

EVENT	DOXYCYCLINE GROUP (N=156)	PLACEBO GROUP (N=153)	P VALUE†
	no. of subjects (%)		
Any adverse event	47 (30.1)	17 (11.1)	<0.001
Nausea	24 (15.4)	4 (2.6)	<0.001
Vomiting	9 (5.8)	2 (1.3)	0.06
Abdominal discomfort	11 (7.1)	6 (3.9)	0.34
Diarrhea	6 (3.8)	6 (3.9)	0.79
Dizziness	4 (2.6)	1 (0.7)	0.37
Other‡	6 (3.8)	1 (0.7)	0.12

Ticks

Nymphal§

Engorgement status — no. (%)	124 (52.8)	142 (57.5)
Partially engorged	78 (62.9)	81 (57.0)
Unfed (flat)	43 (34.7)	59 (41.5)
Unknown	3 (2.4)	2 (1.4)

Estimated duration of attachment — hr

Median	30	31
Range	4–125	4–123

Adult female

Engorgement status — no. (%)	100 (42.6)	97 (39.3)
Partially engorged	28 (28.0)	36 (37.1)
Unfed (flat)	66 (66.0)	57 (58.8)
Unknown	6 (6.0)	4 (4.1)

Estimated duration of attachment — hr

Median	10	16
Range	0–148	0–110

Larval — no. (%)	10 (4.3)	8 (3.2)
Adult male — no. (%)	1 (0.4)	0

At the level of communities

- Habitat management (brush clearing, fire, dessicants)
- Education and awareness
- Spraying
- Host-targeted acaricides (Damminix, 4-poster)
- Deer reduction***
- Oral vaccination of mice?**
- Genetic modification of mice?**



American Lyme Disease Foundation

Modes of intervention



K. Stafford


CAUTION


You may unknowingly pick up the tick that transmits Lyme Disease on this property or elsewhere on Nantucket.

For your protection, stay on roads or mowed trails, keep out of shrub thickets and tall grass, and carefully check for ticks when you get home.


 Nantucket Conservation Foundation, Inc.
 an island nonprofit organization
 118 Cliff Road, Nantucket
 228-2884

FOR ADDITIONAL INFORMATION CONTACT THE NANTUCKET HEALTH DEPARTMENT (228-7226).


Smokey Bear
Helping you fight fires the old-fashioned way.


 Ad Council

Smokey Bear © 2006 EPA

Extend hunting season to help defeat public health problem

Forty years ago Nantucket's deer population was far smaller than it is today. And 40 years ago Nantucket's human population was a third of what it is today in the winter. But as the number of people living on the island has grown and spread out from the center of town into the outskirts and beyond – into land that was once open moors and hayfields – so too has the deer population grown.

That wouldn't be so much of an issue if it weren't for the fact that in those 40 years, Nantucket has also seen an explosion in tick-borne diseases from babesiosis to Lyme and newly discovered diseases which have debilitating and sometimes deadly consequences. There is a connection.

In the last 40 years, Nantucket's very healthy deer population has become an island health problem that has reached crisis proportions in the past decade. As people have built houses on once wild lands that have been the habitat of the deer, and as homeowners have landscaped their surroundings, they have also provided the deer with a high-nutrition buffet of tasty snacks as well as places to hide.

Until one h
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Speech in





Habitat management:

Deer ticks require high relative humidity (shelter from wind, sun)

-- dry things out by cutting undergrowth and removing leaf litter; apply wood chips (fresh cedar; replace old mulch) or stone; mow frequently; use controlled burns



The small animal hosts (mice, shrews, squirrels, chipmunks, ground-foraging birds) for the subadult ticks need appropriate habitat (nest sites, evasion of raptors)

-- remove undergrowth and fallen logs, thin the canopy, promote raptor nesting



Deer and small mammals are attracted to edges to forage and need thick vegetation to hide.

-- landscape to reduce edge effects

Commercial applicators

God Bless America and the Entrepreneurial Spirit!

Licensed pesticide applicators

Prompt service

Can offer mosquito control services not available from MCPs (MCPs are hampered by State Reclamation Board policy limiting any spraying to non-daylight hours to reduce impact on pollinators)

But...no specific training program; no evaluations of efficacy; expensive

DIY



HOME | ABOUT US | R

Home > Tree Care Tips > Tick Management
TICK MANAGEMENT



Meet the man behind our brand. Dread Skeeter®.

Mosquito Squad is proud to be America's most trusted mosquito and tick elimination company dedicated exclusively to controlling the annoying outdoor pests that ruin your backyard experience and transmit disease. We view our mission through the eyes of Dread Skeeter, protector against disease-infested bloodsuckers across America. His life mission: to eliminate mosquitoes and ticks, to help you "take back" your backyard.

Dread Skeeter is a man about town. You may see him driving down your street on the side of our Mosquito Squad trucks, or he may even be at your summer festivals, concerts and home shows!

Perpetuation of Lyme disease spirochetes depends on two largely INDEPENDENT factors which can be attacked as
longterm solutions

Tick production: Reproduction of the tick.

Adult female tick acquires a bloodmeal; blood becomes eggs; eggs hatch and become larvae; such larvae are NOT infected

The source of the reproductive bloodmeal is a larger animal (deer, dog, coyote, bear, moose, human, cat)

Deer reduction targets tick reproduction

Adult ticks do not feed on mice, shrews, squirrels, rabbits, birds

Infection of the tick: uninfected larvae need to get infected

White footed mice, shrews, rabbits, squirrels and certain birds (yellowthroats, wrens, robins, pheasant) are known to infect ticks

Larvae also feed on deer, cats, many ground-foraging birds but do not become infected as a result

Genetic modification of mice targets tick infection

Deer feed most adult deer ticks

Wilson ML et al. 1990. Host dependent differences in feeding and reproduction of *Ixodes dammini* (Acari:Ixodidae). *Journal of Medical Entomology* 27:945-954

Deer tick egg mass = 2000 larvae

Host	No. present on site	No.ticks per host	% of all ticks
deer	24	38.3	94
Raccoon	51	0.7	3.7
possum	8	1.2	1.0
cat	11	0.1	0.1

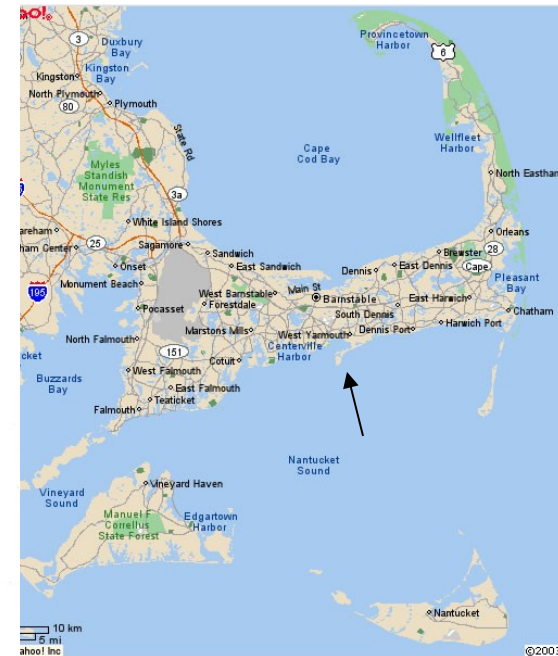


99 engorged female deer ticks from one deer, Crane Beach 2004:
 $99 \times 2000 = 198,000$ larvae; represents one week's production by one deer...there are 16 weeks to the adult tick season... $198,000 \times 16 =$

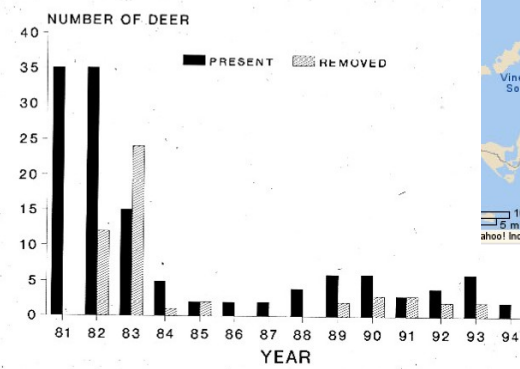
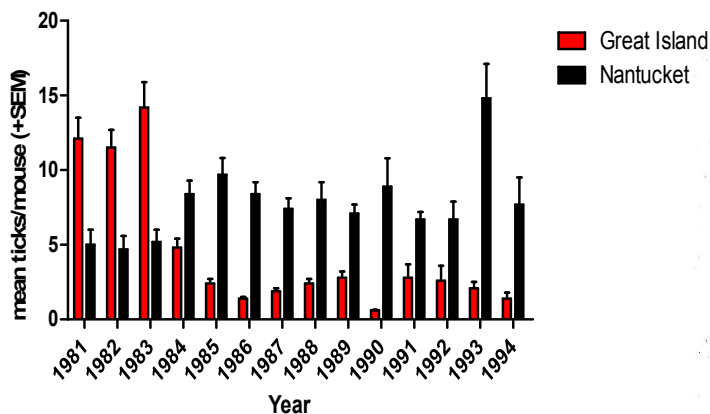
3,168,000 larvae from one deer!

Reduced Abundance of Immature *Ixodes dammini* (Acari: Ixodidae) Following Elimination of Deer

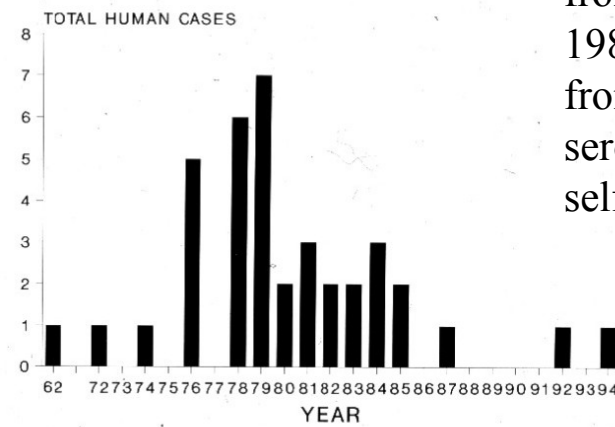
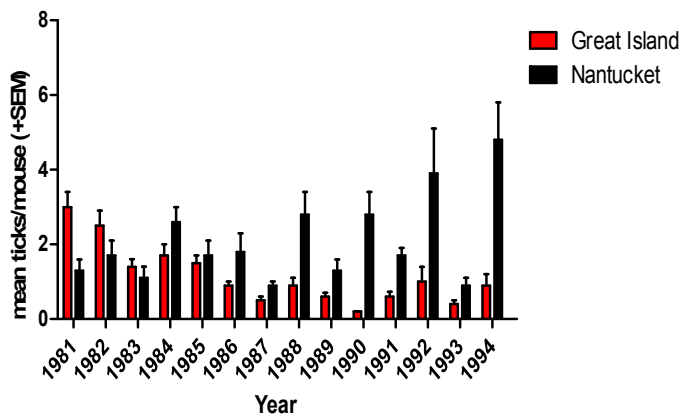
MARK L. WILSON,^{1,2} SAM R. TELFORD III,¹ JOSEPH PIESMAN,^{1,2} AND ANDREW SPIELMAN¹



Mean Larvae per Mouse

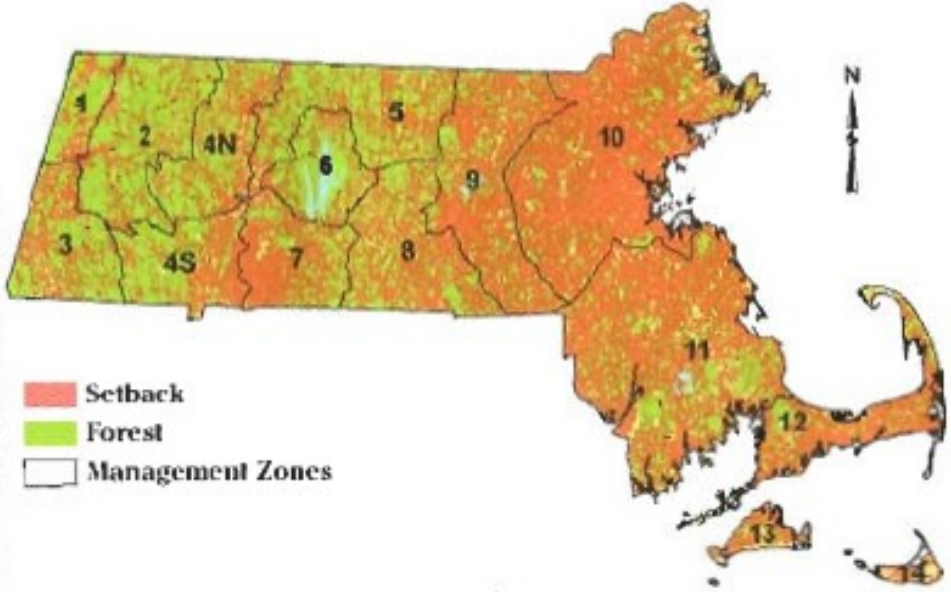
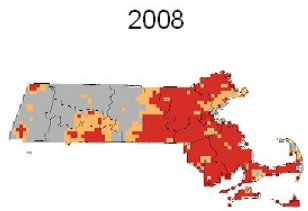
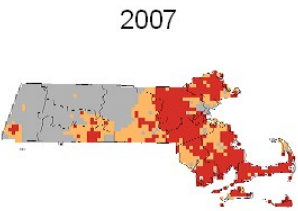
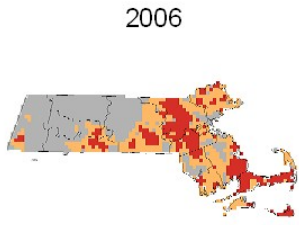
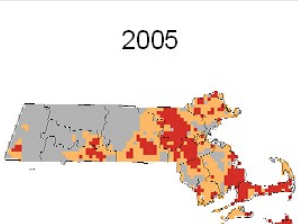
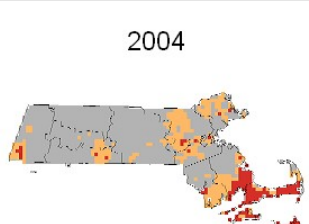
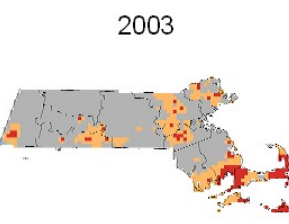


Mean Nymphs per Mouse



Cases prior to 1986 from Steere et al. 1986; other cases from prospective serosurvey as well as self reporting

GIS analysis of MADPH confirmed Lyme disease cases by year; red= towns reporting >5 cases



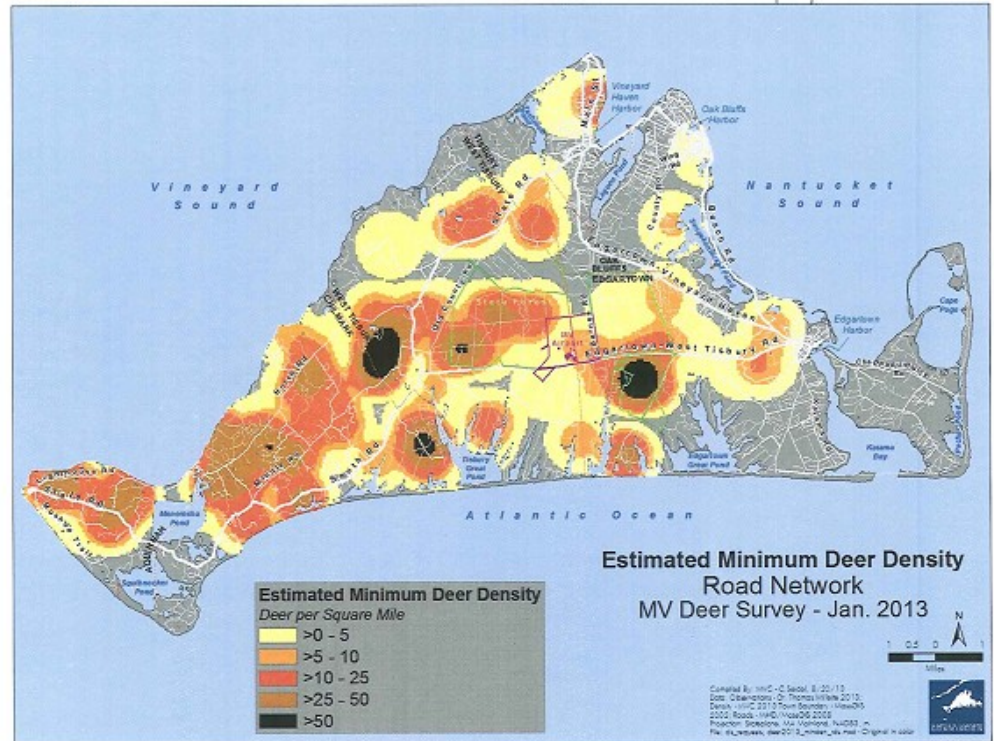
Towns with Hunting Restrictions
 Based on data last compiled in 2003, at least 161 communities in Massachusetts have enacted local hunting restrictions. The percentage of such communities has increased from about 12% in 1956 to more than 45% today.

Map prepared by MDPW biologist Michael Haggerty

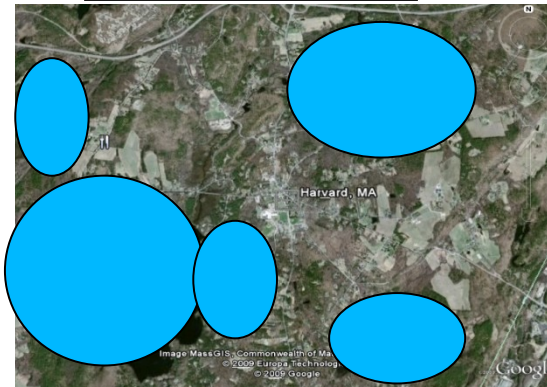
Map prepared by MDPW

Figure 2: Discharge Setbacks in Massachusetts.

Objective of deer reduction: return the landscape to what it was 40 years ago...when ticks existed in little patches as opposed to widespread infestation



Before intervention



After intervention

