Interim report.....

Nantucket Tick-borne Disease Committee

Malcolm W. MacNab MD, PhD
President, Great Point Research LLC
Committee Chairman

The deliberations of the Nantucket Tick-borne Disease Committee are ongoing. We are in a fact-finding phase and we have not developed any recommendations.

Any opinions expressed are not necessarily those of the Committee.

The purpose of this presentation is to present an update on the Committee work to-date without any specific recommendations.

Today's presentation

- Defining the problem – why we need to intervene
  - Tick-borne disease on Nantucket
  - Epidemiology of tick-borne disease
  - Medical aspects of tick-borne disease
  - Health care & social costs associated with tick-borne diseases
- Finding a solution
  - Formation of the Nantucket Tick-borne Disease Committee
    - Update on the Committee activities
  - Modes of Intervention / Possible Solutions
- Next Steps

Tick-borne disease on Nantucket

Do we have a problem?

Tick-borne diseases on Nantucket

Blacklegged (or deer) ticks (*Ixodes scapularis [=I. dammini]*) can transmit several tick-borne diseases; three are found on Nantucket:

- **Lyme disease** (*Borrelia Burgdorferi*)
- **Anaplasmosis** (*Anaplasma phagocytophilum*) – also known as human granuolocytic anaplasmosis (HGA) or previously as human granulocytic ehrlichiosis (HGE)
- **Babesiosis** (*Babesia microti)*

Top ten US counties for Lyme disease 1992 - 2006

TABLE 2. Average rate* and number of cases of Lyme disease, by county and 5-year period — United States, 1992–2006

	1992–1996			1997–2001			2002–2006		
Rank	County	Rate	(No. cases)	County	Rate	(No. cases)	County	Rate	(No. cases)
1	Nantucket County, MA	755	(55)	Nantucket County, MA	669	(60)	Columbia County, NY	962	(609)
2	Hunterdon County, NJ	337	(385)	Columbia County, NY	639	(403)	Dutchess County, NY	439	(1281)
3	Dutchess County, NY	337	(899)	Dutchess County, NY	445	(1234)	Nantucket County, MA	361	(36)
4	Putnam County, NY	278	(248)	Hunterdon County, NJ	443	(535)	Dukes County, MA	337	(52)
5	Washington County, RI	227	(262)	Windham County, CT	304	(330)	Hunterdon County, NJ	276	(356)
6	Middlesex County, CT	197	(290)	Washington County, RI	296	(361)	Greene County, NY	271	(133)
7	Washburn County, WI	182	(27)	Putnam County, NY	222	(211)	Cameron County, PA	239	(14)
8	Burnett County, WI	161	(23)	Dukes County, MA	201	(30)	Washburn County, WI	238	(39)
9	New London County, CT	156	(400)	Litchfield County, CT	195	(355)	Windham County, CT	220	(249)
10	Windham County, CT	130	(137)	New London County, CT	183	(472)	Putnam County, NY	219	(219)

* Per 100,000 population.

Bacon RM et al.. Surveillance for Lyme Disease - United States, 1992—2006. Centers for Disease Control, *Morbidity and Mortality Weekly Report*. 2008; 57:1-9

Nantucket Cottage Hospital Statistics

- Reported cases on Nantucket (diagnosed on-island)

	Lyme	Ehrlichiosis	Babesiosis	Total
2007	190	15	53	258
2008	325	17	69	411

Based upon laboratory diagnosis confirmed by Infection Control Nurse

Tom Nevers Civic Association Survey * [1]

Survey conducted of the voting members of the Tom Nevers Civic Association in December 08 and January 09 – 37.1% response rate

- 60% of households responding reported being infected with a tick-borne disease – family members, guests or renters ever having a tick-borne disease reported:
  - Lyme disease.....61.3 %
  - Babesiosis.....17.2 %
  - Ehrlichiosis.....8.6 %
- On average, 2.3 people per household have been infected in households having had a tick-borne disease.

* Survey may have "response bias"

Tom Nevers Civic Association Voting Members Survey on Tick-borne Disease; February 2009

Tom Nevers Civic Association Survey [2]

- Off-island diagnosis and treatment – as many as 9-out-of-10 being non-resident short term visitors:
  - Percent diagnosed.....31.6 %
  - Percent treated.....35.0 %

- Multiple infections over time were reported ranging from 3 to as high as 9 (based upon write-in comments).

Tom Nevers Civic Association Survey [3]

- Percent reporting an initial miss-diagnosis:
  - Lyme disease.....18.6 %
  - Babesiosis.....15.8 %
  - Ehrlichiosis.....30.0 %

- Percent reporting an ongoing health problem related to a tick-borne disease::
  - Lyme disease.....10.8 %
  - Babesiosis.....15.8 %
  - Ehrlichiosis.....20.0 %

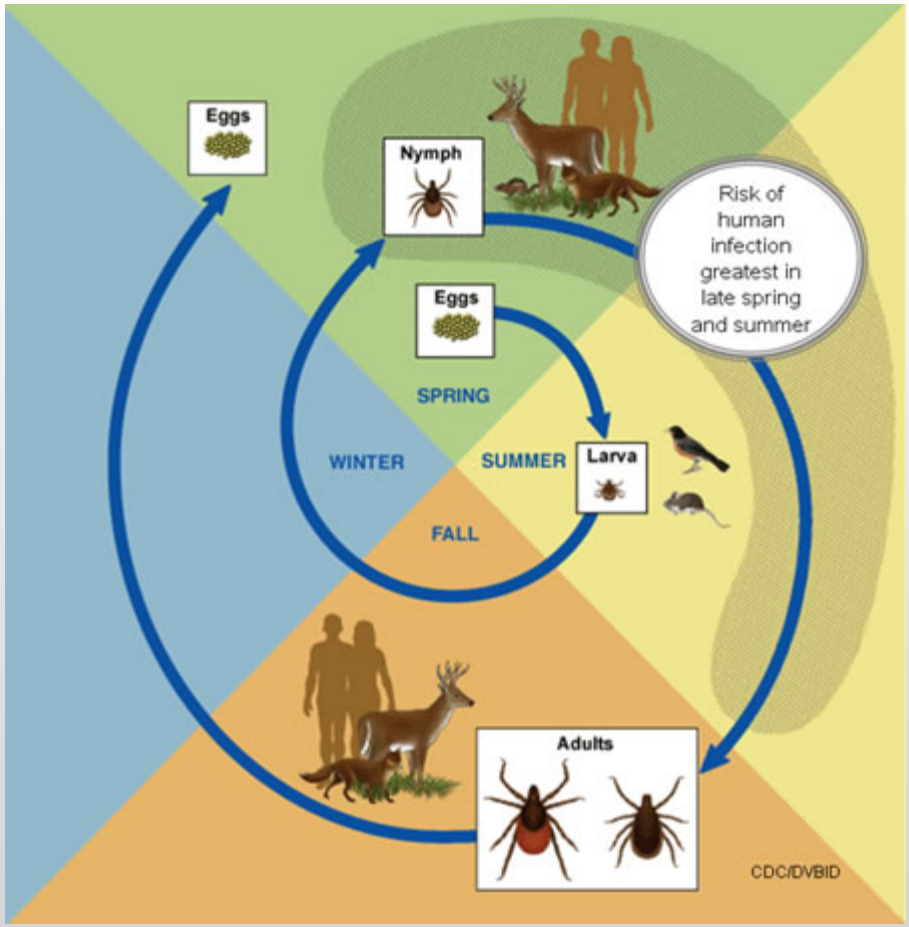
Tick-borne diseases on Nantucket - Conclusions

- The true incidence of tick-borne disease on the island is difficult to determine:
  - Constant changing nature of our population – unknown and changing "denominator";
  - Many cases are acquired on-island but diagnosed off-island;
  - Under reporting because of an inadequate reporting system;
  - Missed diagnosis; and
  - Clinical diagnosis was made without laboratory confirmation and not captured in the official statistics.
- We can conclude that we have a high incidence of tick-borne disease and the official 2008 statistics reporting 411 cases is an underestimation of the true number of cases acquired on the island.
- Tick-borne disease is a significant public health issue on the island.

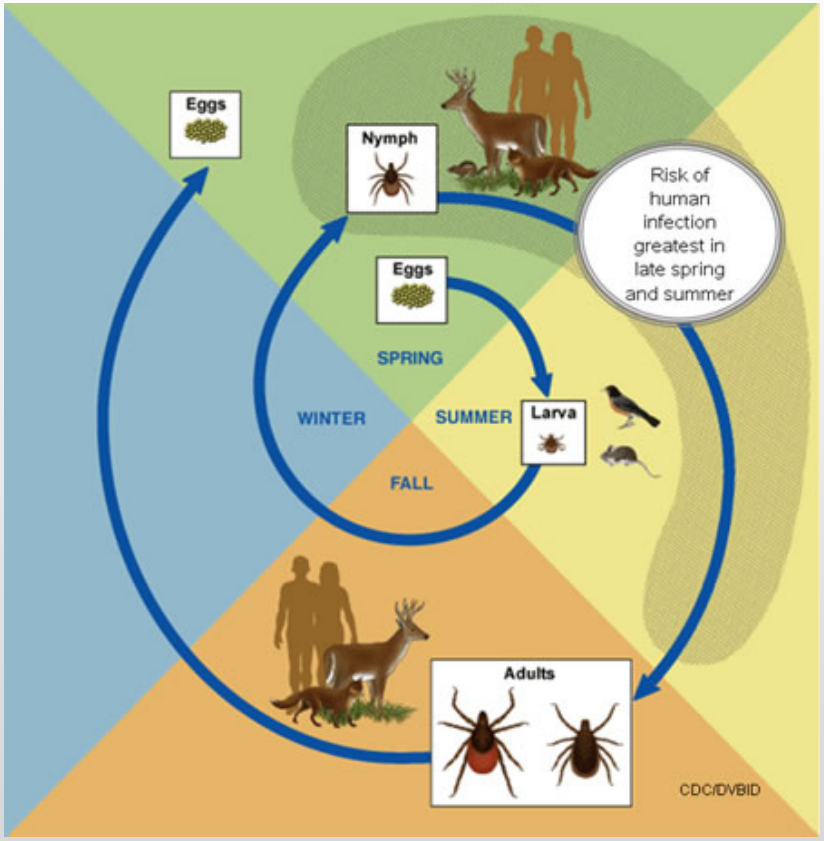
Epidemiology of tick-borne disease

How are the diseases transmitted

Life cycle of blacklegged ticks

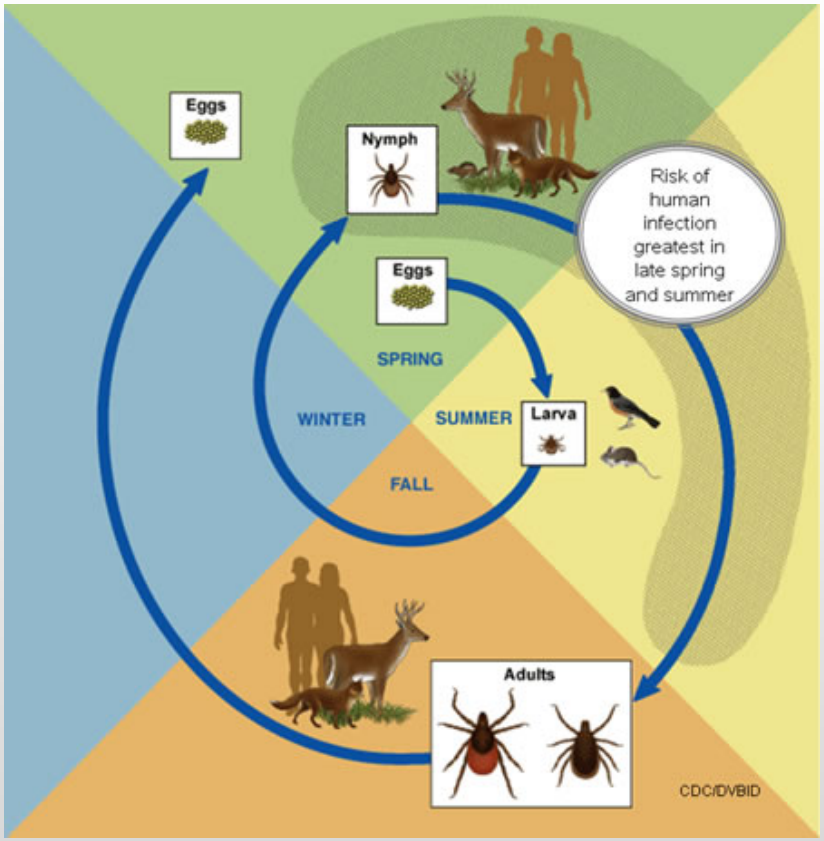


Life cycle of blacklegged ticks



- 2-year life cycle with 3 feeding stages
- First year:
  - Eggs laid in the spring → hatch into six-legged Larva
- Second year:
  - Larva → molt into eight-legged Nymphs in the spring
  - Nymphs → molt into Adults in the fall

Tick-borne disease transmission factors [1]



- Perpetuation of Lyme disease organism depends on two factors:

- **Tick production**: Reproduction of the tick
  - Adult female tick acquires a bloodmeal → blood becomes eggs → eggs hatch and become larva – Larvae are not infected
  - The source of a reproductive bloodmeal is a larger animal (deer, dog, coyote, bear, moose, human, cat)
  - Adult ticks do not feed on mice, shrews, squirrels, rabbits, birds
- **Infection of the tick**: uninfected larvae need to get infected
  - White-footed mice (primary reservoir), 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

Tick-borne disease transmission factors [2]

- Perpetuation of the Lyme disease organism depends on two largely independent factors
  - **Tick production**: Reproduction of the tick
    - Adult female tick acquires a bloodmeal → blood becomes eggs → eggs hatch and become larva – Larvae are <u>not</u> infected
    - The source of a reproductive bloodmeal is a larger animal (deer, dog, coyote, bear, moose, human, cat)
    - Adult ticks do not feed on mice, shrews, squirrels, rabbits, birds
  - **Infection of the tick**: uninfected larvae need to get infected
    - White-footed mice are the primary reservoir.
    - Shrews, rabbits, squirrels and certain birds (yellow throats, 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

Tick-borne disease transmission factors [3]

- Transmission of anaplasmosis, babesiosis and Lyme disease are similar.
- One, two, or all agents can be acquired when larva and nymphs feed on reservoirs and more than one disease can infect an individual human.
- Tick stages responsible for transmission to humans are principally the nymph, followed by the adult.
- Tick attachment duration affect transmission likelihood.
- Exposure potential (risk) is directly related to:
  - Disease endemic levels
  - Season of the year
  - Activities and / or expansion in tick laden areas
  - Deer tick levels and tick infection rates
- Deer are the main reproductive hosts for the deer tick
  - Each female tick produces about 2000 eggs

Tick-borne disease transmission factors [4]

Deer are the main reproductive hosts for the deer tick

Host	Number present on site *	Number of 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

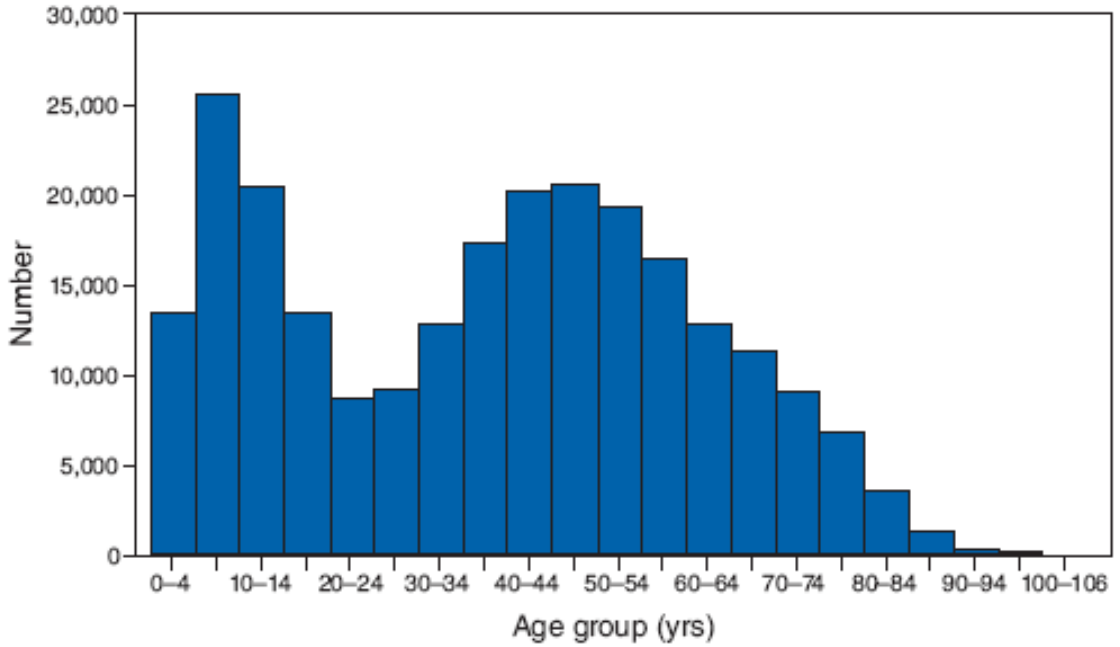
* Long Island study area

Wilson ML et al.. Host dependent differences in feeding and reproduction of *Ixodes dammini* (Acari:Ixodidae). *J Med Entomol.* 1990;27:945-954.

Medical aspects of tick-borne disease

Lyme Disease cases distribution by age

FIGURE 3. Number* of reported Lyme disease cases, by age group — United States, 1992–2006



* N = 241,931.

Bacon RM et al. Surveillance for Lyme - United States, 1992—2006. Centers for Disease Control, *Morbidity and Mortality Weekly Report*. 2008; 57:1-9

Lyme Disease [1]

- Pathology:
  - The bacteria are inoculated into the skin by the bite of the deer tick.
  - At the site of inoculation a skin rash develops in the majority of people who develop symptomatic disease (erythema migrans) - this is characteristic of the disease and is the finding that leads to diagnosis of acute Lyme disease in the vast majority of cases.
  - The organism may localize in joints, heart and nervous system causing symptoms in each of these areas.
  - It also leads to immunologic reactions that may lead to symptoms of arthritis at later times.

- Symptoms: Skin rash, fever, myalgias, arthralgias, facial palsy, headache, fatigue and a variety of other symptoms may be seen.

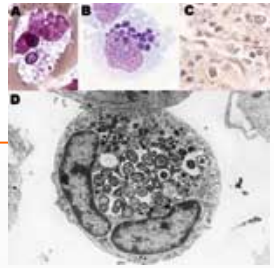
Lyme Disease [2]

- Diagnosis:
  - The acute disease is diagnosed primarily by the skin rash, but may also be diagnosed in endemic areas by the presence of the other symptoms, especially when tick exposure has been documented or suspected.

  - Serologies are not useful in the acute phases of the illness since the antibody responses arise later in the course of the illness (weeks to months).

- Treatment: Appropriate antibiotic therapy

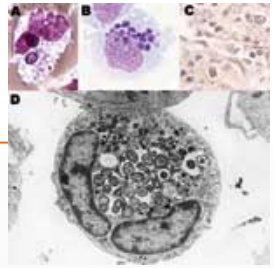
Anaplasmosis (Ehrlichiosis) [1]



- Pathology:
  - The organism enters the bloodstream after inoculation from the bite of a deer tick.
  - The organisms concentrate in circulating white blood cells and travel throughout the body.
  - They cause low white cell and platelet levels and elevated liver enzymes.

- Symptoms: Fever, chills, headache, anorexia, nausea, fatigue and myalgias are the most common symptoms.

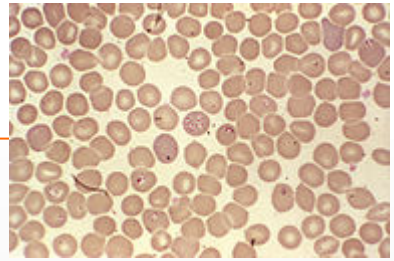
Anaplasmosis (Ehrlichiosis) [2]



- Diagnosis:
  - Various immunofluorescence assays are used to detect anti- anaplasma antibodies.
  - One may occasionally find intracellular inclusions in white blood cells on stained blood smears and these can be diagnostic in the right clinical setting.

- Treatment: Appropriate antibiotic therapy

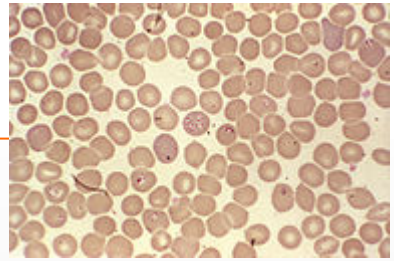
Babesiosis [1]



- Pathology:
  - The protozoa enter the bloodstream after inoculation from a deer tick bite.
  - They localize and replicate in red blood cells in a manner similar to malaria leading to a hemolytic anemia.
  - There may be splenomegaly and hepatomegaly.
  - Most cases in otherwise healthy individuals are asymptomatic and self limited. Especially in persons who are asplenic or have underlying immunologic diseases or malignancies, the disease may be severe.

- Symptoms: Fever, chills, myalgias, arthralgias, nausea, vomiting and fatigue are seen.

Babesiosis [2]



- Diagnosis:
  - Signs of hemolytic anemia, low platelet count, elevated liver function tests, elevated renal function tests may be seen.
  - Intraerythrocytic protozoa may be seen, but the percentage of parasitized erythrocytes is usually small.
  - Fluorescent antibody tests are usually positive in 4 to 6 weeks.

- Treatment: Appropriate antiprotozoa and antibiotic therapy

Health care & social costs associated with tick-borne diseases

- Lost school and work time
  - Lost wages
- Nantucket Island reputation
  - Lost tourism
- Direct Health Care Costs – no sequelae
  - Office visits, antibiotics, laboratory costs
- Direct Health Care Cost – with sequale
  - Treatment of cardiac, neurological and arthritic complications; ruptured spleen; hospitalizations etc.

Formation of the Nantucket Tick-borne Disease Committee

Tick-borne Disease Committee Members

- Malcolm MacNab; MD, PhD (Chairman)
- Scott White; DVM, MPH (Vice-chairman)
- David Boyce
- Tristram Dammin; MD
- John Goldman; MD
- Bruce Hopper; MD
- Meredith Lepore; RN-NP
- Kevin Madden
- Beverly Mclaughlin
- Patricia Roggeveen
- Elizabeth Tri11os
- Helen Weld; RN

Tick-borne Disease Committee Mission Statement

In recognizing the increased incidence of tick borne disease on Nantucket, it shall be the responsibility of the Tick-borne Disease Committee to review all pertinent remediation and disease reduction approaches for known and emergent tick-borne disease's including but not limited to, public education, sterilization, four poster use, and selective deer herd culling and present their findings, with a recommended plan of action, to the Nantucket Board of Health prior to December 1, 2009.

Nantucket Tick-borne Disease Committee Goals

- Develop a *sustainable* program to reduce the incidence of tick-borne disease on Nantucket
  - There are no short-term solutions
  - Complementary actions will need to be developed
    - There is no single "magic bullet"
- Develop achievable measurable milestones
- Achieve community wide acceptance of the plan

Update on the Committee's Activities

Tick-borne Disease Committee Work Plan [1]

Session	Topic	Speakers
May 29	Tick-borne disease on Nantucket	R. Ray - Nantucket Health Director
May 29	Epidemiology of Tick-borne diseases	S. White, DVM, MPH * - Nantucket Veterinarian
May 29	Effects of Tick-borne disease in humans	J. Goldman, MD * - Prof. Medicine, Penn State Hershey Medical Center
June 19	The New England / Nantucket experience	S. Telford, DSc. - Assoc. Prof., Tufts School of Veterinary Medicine
July 10	Deer Management Programs	R. Deblinger, PhD – Deputy Director MA Division of Fisheries & Wildlife

* Committee member

Tick-borne Disease Committee Work Plan [2]

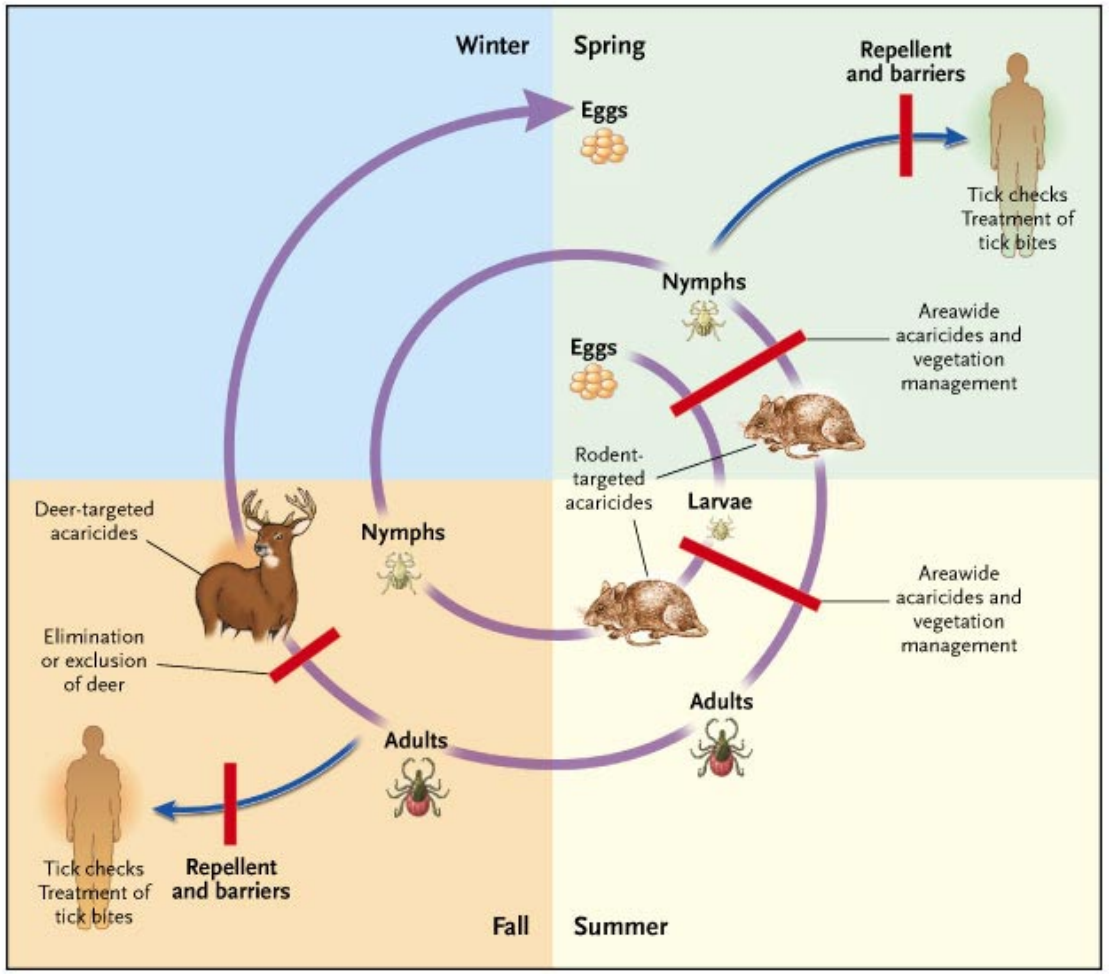
Session	Topic	Speakers
July 31	Pesticide control (pesticide use, four poster, Daminex tubes)	D. Simser – Barnstable County Extension Service A. Ganak – Daminex tick tube distributor J. Cook – Bartlett Tree Service
Aug 14	Deer Management Programs – The Humane Society Perspective	L. Simon - Field Director, Urban Wildlife Program, Humane Society
Aug. 21	Pesticide control programs – Review	Committee
Sept.11	Deer Management Programs – Review	Committee
Nov. 13	Complete Final Report	Committee

** Nantucket physicians' perspective to be scheduled

Modes of Intervention

Possible Solutions

Modes of intervention



Hayes E and Piesman J. *N Engl J Med.* 2003;348:2424-2430

Modes of intervention

- Tick interventions
  - Acaricides
    - Area-wide spraying
    - 4-poster (permethrin)
    - Damminix tubes
  - Vegetation management
  - Repellents
    - DEET (*N*,*N*-diethyl-*m*-toluamide)
  - Inspection and removal

- Deer interventions
  - Deer reduction
  - Deer exclusion

Tick Management

4- Poster Device

- Consists of a central bin containing whole kernel corn (± apples) used as a bait and two application/feeding stations located at either end of the device.

- The deer feed on the bait - the design of the device forces them to rub against permethrin (10%) impregnated applicator rollers – the permethrin transferred to the head, neck and ears.

- Method is ongoing at Shelter Island, New York

4- Poster Device: Results [1]

- Maryland study

  - Treated location: NASA facility in Beltsville
  - Non-treated site: Patuxent Wildlife Research Center

  - Results for 3rd year of treatment
    - Adult, nymphal and larval questing ticks were reduced by 91-100% from sample plots
    - Nymphal and larval ticks were reduced 70-95% on sampled mice

4- Poster Device: Results [2]

- Massachusetts study [Needs updating]
  - Treated locations: Seven sites (Nantucket, Martha's Vineyard, Chappaquiddick, and Barnstable County)
    - Four stations on Nantucket are situated within the Linda Loring Nature Center property
  - Non-treated sites: Seven comparable sites
    - Nantucket site around Almanack Pond
  - Results to-date

	2007	2008	2009
Adult ticks			
4-poster sites	71 nymphs / hr	34 nymphs / hr	?
Untreated sites	78 nymphs / hr	49 nymphs / hr	?
Nymphs			
4-poster sites	146 nymphs / hr	113 nymphs / hr	?
Untreated sites	102 nymphs / hr	206 nymphs / hr	?

Damminix Tick Tubes®

- Cardboard tubes filled with permethrin treated cotton balls
- Mice collect the cotton to build their nests → ticks that feed on mice in the Spring and the Fall are exposed to permethrin

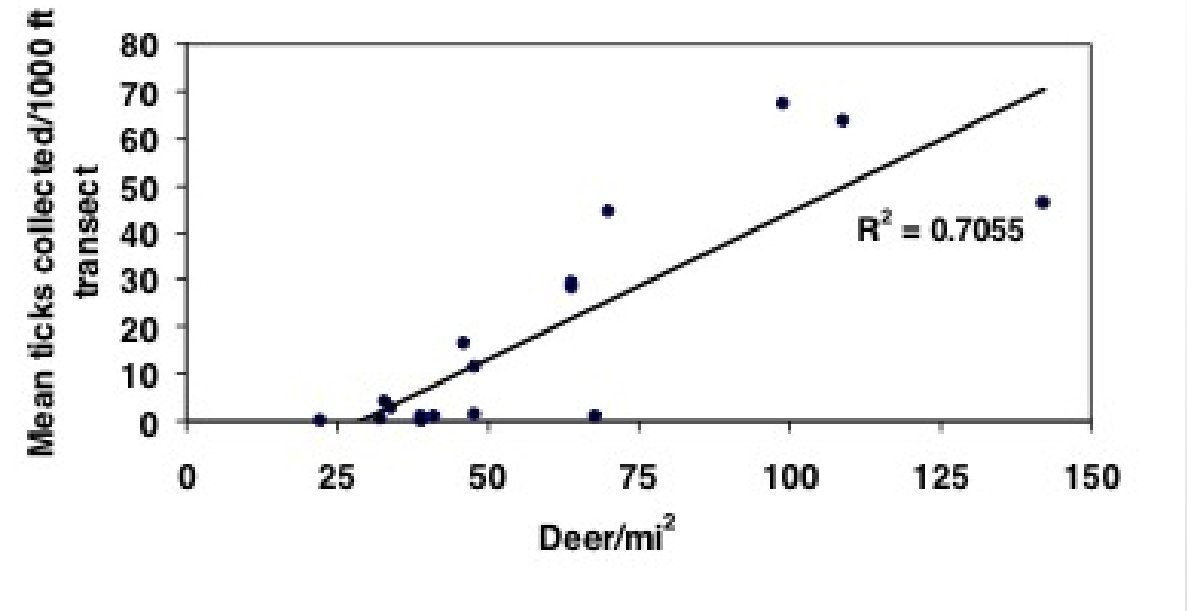
Some questions & potential issues concerning tick management

- Small property control vs. local area control vs. island-wide control?
- Environmental impact of pesticides?
- Long-term safety?
- Development of pesticide resistance in ticks?
- The role of deer reduction in regulating tick abundance?

Deer Management

To cull, or not to cull: that is the question:
Whether 'tis nobler in the mind to suffer
The slings and arrows of outrageous fortune,
Or to take arms against a sea of troubles,
And by opposing end them?

Relationship of tick density to deer abundance



- Deer density positively correlated with tick abundance.

Rand PW et al. Density and the Abundance of *Ixodes scapularis* (Acari: Ixodidae). *J Med Entomol*. 2003;40:179-184.

Mumford Cove Connecticut experience [1]

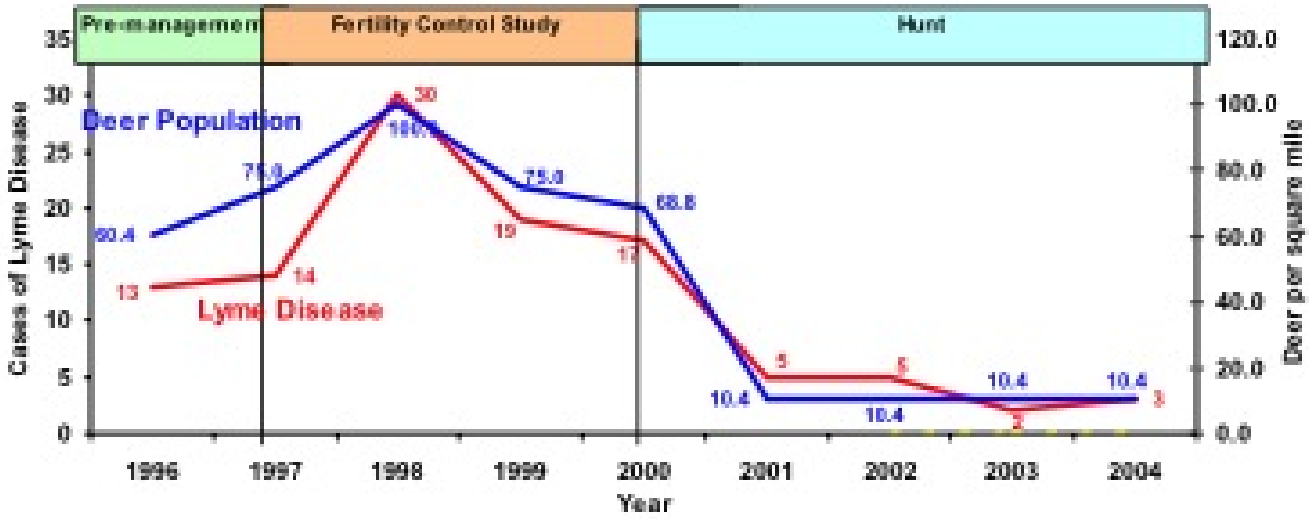
- Study site
  - 150 homes surrounded by significant open space and woodlands, bordered by Noank Connecticut's Haley's Farm nature preserve, Palmer's Cove, and Fisher's Island Sound
- Immunocontraception project failed and controlled deer hunts were started in 2000
- Deer were reduced by 82%
  - 100 deer/mi^2 → 10 - 12/mi^2
- Reduced Lyme infection rate
  - 30 new cases a year → 2 - 3 /year

(1) Kilpatrick and LaBonte. Deer Hunting in a residential community. *Wildl.Soc.Bull*. 2003;31:340-348

(2) Connecticut Department of Environmental Protection

Mumford Cove Connecticut experience [2]

Changes in deer density and cases of Lyme disease in Mumford Cove, CT 1996-2004



(1) Kilpatrick and LaBonte. Deer Hunting in a residential community. *Wildl.Soc.Bull*. 2003;31:340-348

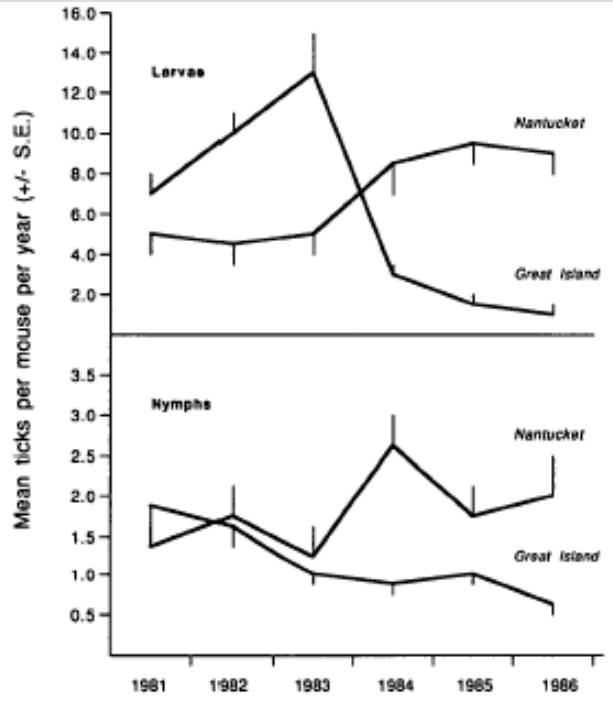
(2) Connecticut Department of Environmental Protection

Great Island Massachusetts experience

- Study site
  - 200-ha island connected to Cape Cod by causeway
  - Initial deer population of 30
  - 100-300 summer residents
- An effort to capture deer and treat with acaricide failed to reduce tick density
- Deer were reduced by approximately 90% resulting in:
  - Reduced tick density
  - Reduced Lyme disease infection rate

    from >3 cases /100 people/ yr to <0.2 / 100/yr

Abundance of larval & nymphal ticks on Great Island & Nantucket

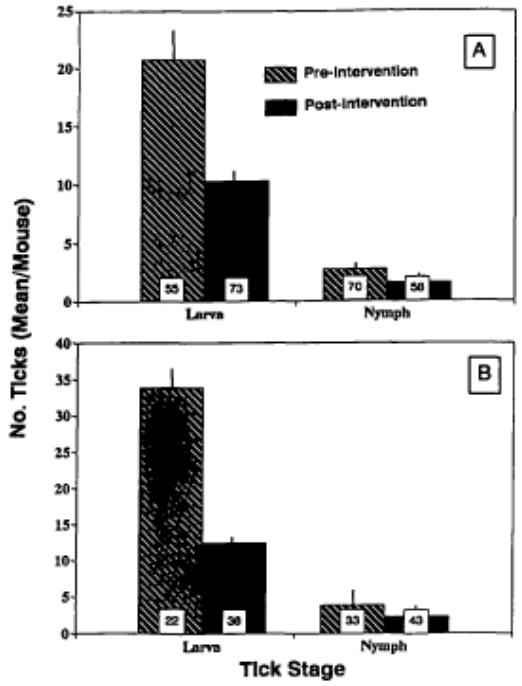


(1) Wilson ML et al. Reduced abundance of immature *Ixodes dammini* following elimination of deer. *J Med Entomol*. 1988;224-228.

(2) Wilson ML and Childs JE. Vertebrate abundance and the epidemiology of zoonotic diseases. Pages 224-248 McShea WJ, Underwood HB and Rappole JH, eds. The science of overabundance: deer ecology and population management. Smithsonian Institution Press.

Crane Reservation Massachusetts experience

- Study site
  - Costal, 2.2 mile^2
  - Initial deer population of ~350
- Deer were reduced by 82% over a six yr. period
  - 350 → 60 or a density of 171 deer/mi^2 → to 29 deer/mi^2
- Annual tick density fluctuations were large
  - Mean larval: 20.8 per white-footed mouse → 10.3 per mouse
  - Mean nymphal: 2.7 per mouse → 1.6 per mouse
- The number of feeding adult female ticks on deer increased as deer density decreased



Average number of larvae & nymphs

A: Monthly means May – Sept

B: Monthly means when most abundant

Larvae: Aug – Sept

Nymphs: May - July

Deblinger RD et al. Reduced abundance of immature *Ixodes dammini (Acari: Ixodidae)* following incremental removal of deer. *J Med Entomol.* 1993;330:144-150.

Monhegan Island Maine experience

- Study site
  - 237-ha island lying 16 km off the coast of Maine
- White-tailed deer were introduced in 1955
- Deer density reached 100/mi^2 by the mid-1990s
- The intermediate host was the Norway rat
- By 1996, 13% of year-round residents had contracted Lyme Disease
- From 1990 to 1998 the tick density was 6-17 adult ticks/h, of which 24-41% were infected with the Lyme Disease
- From November 1996 to March 1999, all deer were removed from the island
- Initially, the density of host-seeking adult ticks and infection prevalence rose substantially to 28/h and 75.0%, respectively
- By the summer of 2003, however, no sub-adult ticks were found on rats, and that Fall, the adult tick density was 0.67 adult ticks/h
- In 2007, ticks were very scarce - not eradicated
- The incidence of Lyme Disease is now reported as practically nil

(1) Rand PW et al. Abundance of *Ixodes scapularis* after the complete removal of deer from an isolated offshore island, endemic for Lyme Disease. *J Med Entomol*. 2004;41:779-784 (2) S. Telford - personal communication

Bernards Township NJ experience

- Study site
  - North-central New Jersey – rural, semirural, open space, residential, farmland
  - 63.5 km^2 or 24.5 $miles^2$
  - Population in 2000: 24,500; 2008: 28,000
- Surrounding towns served as a control
- Between 2002 and 2005 deer were reduced by 46.7%
  - Estimated 2,899 (45.6 deer/km^2) → 1,540 (24.3 deer /km^2)
- There was no apparent effect on the numbers tick subadults
- The Lyme Disease incidence rate did not vary with declining deer

Jordan RA et al. Effects of reduced deer density on the abundance of *Ixodes scapularis* and Lyme disease incidence in Northern New Jersey endemic area. *J Med Entomol*. 2007;44:752-757.

Dutchess County New York experience

- Assessment of Lyme Disease risk (density of tick-infection prevalence of nymphal ticks)
- 13 year data on several field plots within Dutchess County
- Model comparison approach
- In predicting entomological risk:

Predictor	Risk
Deer abundance	No predictive power
Precipitation in the current year and temperature in the prior year	Weak effect on risk
Abundance of mice, chipmunks and acorns 2 yr. previously	Strongest predictors of risk

Ostfeld RS et al. Climate, deer, rodents, and acorns as determinants on variation in Lyme-disease risk. *PLoS Biology* 2006;4:1058-1068.

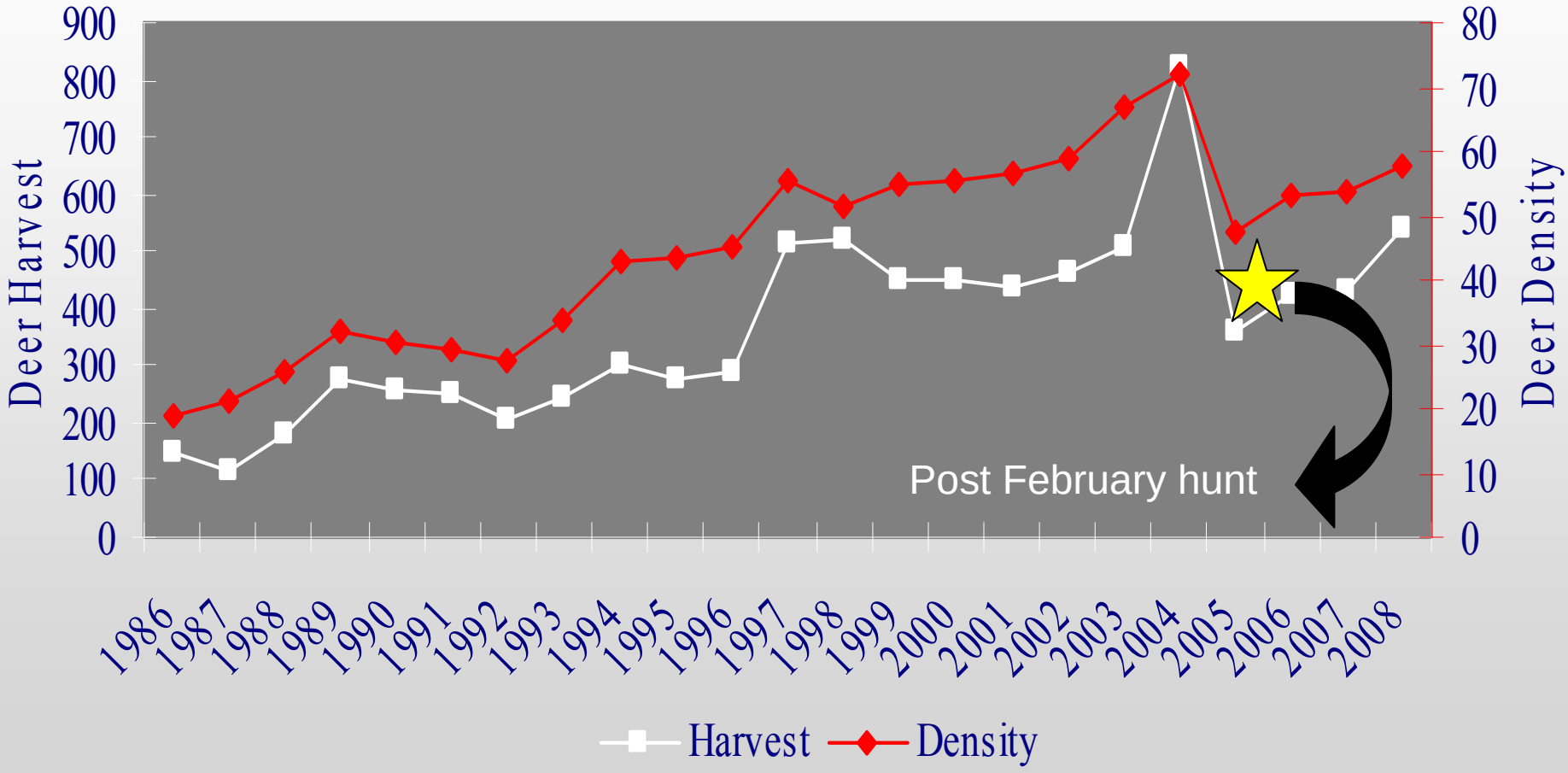
Potential for deer management on Nantucket ?

- Island - 48.5 miles^2
- Approximately 40 miles^2 of deer range
- Habitat
  - Few Forested Acres - 5.3 miles^2 of forest
  - Understory of Shrubs including Oak
  - High Nutritional Value for Deer (Mast)
  - Good Cover
  - High Biotic Potential
  - Ecological Carrying Capacity – HIGH!!

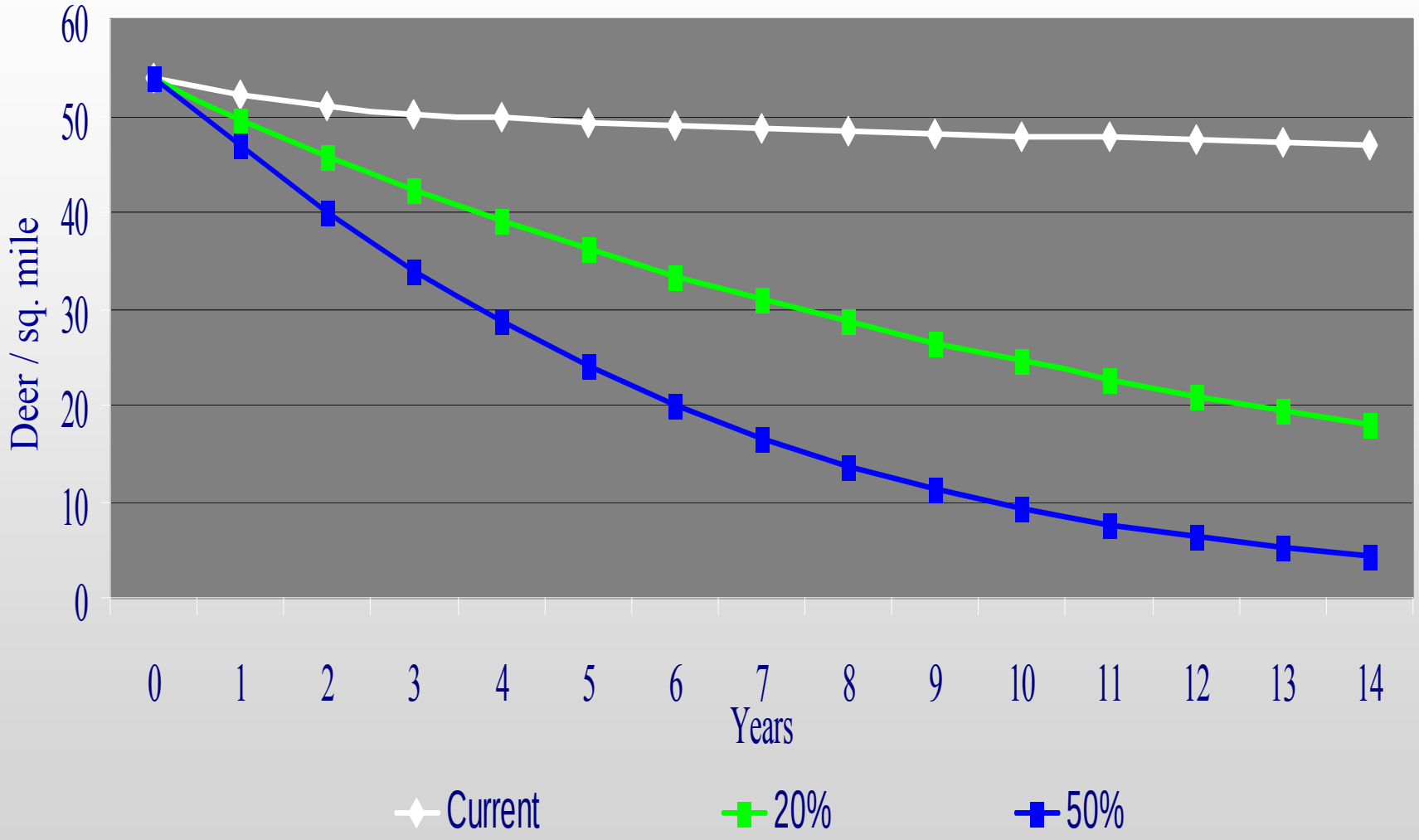
- Nantucket has an estimated 2500 deer or approximately 50-60 /mile^2
- Highest deer concentration in Massachusetts
- The Massachusetts Division of Fisheries and Wildlife goal is 6-8 / mile^2
  - "Ecological carrying capacity" & "cultural carrying capacity"

R. Deblinger PhD and MA Division of Fisheries & Wildlife

Density estimate from harvest data only: 1986-2008



Deer density & harvest rates



Alternatives to hunting [1]

- Capture & Relocate
  - Attractive to some people = Non-lethal
  - Costly: $400 - $3,200/deer
  - All Habitat in NE already has deer
  - Transfers Problem
  - Requires F&W Board Approval

- Capture and Euthanize
  - Lethal but humane to MSPCA
  - Cost/Efficiency
  - Trap or Dart
  - Disposal ?
  - Requires F&W Board Approval

Alternatives to hunting [2]

- Paid Exterminators (i.e. “Sharpshooters”)
  - Cost: $200 to $650 per deer
  - Firearms must comply with state gun laws
  - Efficiency? Carcass Disposal?
  - Ethics?
  - Requires F&W Board Approval

- Birth Control –
  - IMMUNOCONTRACEPTION: Experimental; No Hunting; No consumption
  - Treat >80% of Females
  - Multiple treatments per year/Requires tagging
  - Costly: $1,000/deer
  - No Oral Contraception
  - VASECTOMY: Capture, Immobilize, Surgery
  - Requires F&W Board Approval

The cost of alternative hunting programs

Nantucket 2004 Season

Harvest	Number of deer	Capture & Relocate	Paid Exterminators	Birth Control
Cost / Deer (Range)		$400 to 3,200	$200 to 650	~$1,000/ deer
Regular Season	577	$230,000 to 1,846,400	$115,400 to 375,050	~$577,000
Special Winter	246	$98,400 to 787,200	$49,200 to 159,900	~$246,000
Total	823	$329,200 to 2,633,600	$164,600 to 534,950	~$823,000

Some questions & potential issues concerning deer management

- Birth control is experimental and expensive
- Relocation is impractical and expensive
- Hunting
  - Some community members have a moral objection to hunting.
  - The 2004 winter hunt was not well received by the community.
  - Is our isolation a benefit because of the impediment of deer movement from other locales considering our relative high human population and high deer density compared to other isolated areas where hunts have been "successful"?
  - Does deer reduction just increase the tick density on the remaining deer and not reduce the total infected tick population?
  - To what degree would other hosts replace a lower deer population?
  - To what degree would ticks transported to the island by birds off-set a potential tick reduction?
  - What is the best season for hunting with the goal of reducing the incidence of tick-borne disease? Is the present season too late?
  - What is the deer density needed to reduce the incidence of tick-borne disease? How long will it take to achieve? Is it practical?

Modes of intervention

- At the level of the individual
  - Repellants
  - Appropriate clothing
  - Tick check and prompt removal
  - Education and awareness
  - Habitat avoidance
  - Source reduction around homes

- At the community level
  - Habitat management (brush clearing, fire, dessicants)
  - Education and awareness
  - Spraying
  - Host-targeted acaricides (Damminix, 4-poster)
  - Deer reduction

Next steps……..

- Review the pros and cons of the efficacy of a deer reduction program.
  - IF deer culling is part of the final recommendations, developed an improved program compared to the 2004 hunt.
- Review the pros and cons of the efficacy of pesticide control
- Develop an improved method for collecting tick-borne diseases statistics.
  - We need a better way to measure our results.
- Develop a program to measure our progress
  - Tick abundance, infected ticks, deer density, tick-borne disease incidence etc.
- Review our present educational program and expand and improve as needed.
- Complete a sustainable, integrated and comprehensive approach to reduce the incidence of tick-borne disease on Nantucket by December.
  - Actions, timing and cost