

WHY LYME DISEASE IS INCREASING

Areas with Low Biodiversity Increase the Threat of Lyme Disease

Typical indicators are:

- Few species of small vertebrates (**but** deer mice are a constant presence).
- Few predators of deer mice.
- Favorable deer mouse habitat created by small forest fragments.
- Areas dominated by certain invasive plants.
- High deer density causes a decline in native plants in a forest understory, thus enabling the spread of more invasive plants into the forest.
- High numbers of deer make it easy for adult ticks to locate a final host.

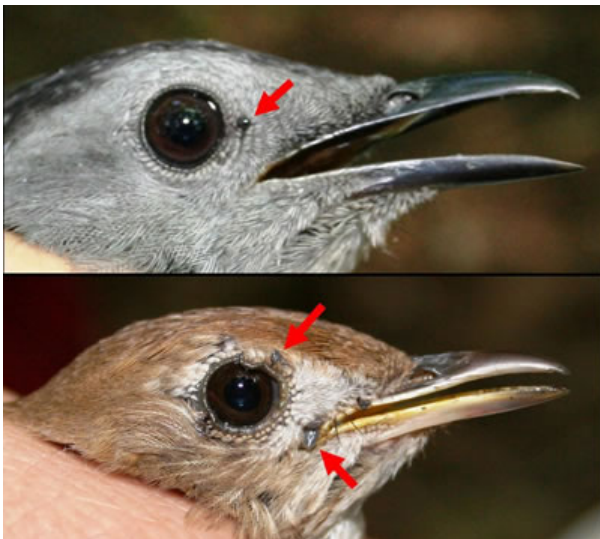
We can't control some of these factors directly; others we can begin to address. [12] [13] [20]

More Deer Mice Means More Infected Deer Ticks [20]

Deer mice, also called white-footed mice (*Peromyscus leucopus*), are **the most effective 'host' for the bacteria**. Increased numbers of these mice are a good indicator of increased Lyme Disease.



Ostfeld estimates that 75% to 95% of infected ticks acquire the Lyme Disease spirochete from deer mice. Other primary hosts for transmitting the infection are chipmunks, short tailed shrew, masked shrews and birds such as thrashers, thrushes (such as robins) and other ground-feeding or ground-nesting birds. [21]



While deer ticks feed on many vertebrate hosts, (observe the ticks on eyelids of the catbird and thrush) some hosts are not very successful in transmitting the disease. Reasons for this could be Immunity to the bacteria or the animal's grooming habits. For example, opossums are good groomers, and kill most ticks that start to feed on them.

When there are many different hosts for immature ticks, or where there are many predators for mice (such as the fox), levels of infected mice are much lower, thus ticks have a lower chance of becoming infected.

Since Lyme Disease was first discovered in areas with high deer density, deer were believed to be the tick's primary host for the disease and the source of its infection. However, most ticks are infected well before they feast on deer. Ostfeld estimates that deer are responsible for only 1% of infected ticks. **However, deer are where most adult ticks find mates and have their final blood meal.**

High Deer Density is Associated with Abundant Deer Ticks

Several studies establish that elevated numbers of deer are associated with increased numbers of deer ticks. Although immune to the Lyme spirochete, deer are a final host for most adult deer ticks, they help promote the tick's life cycle and spread.

Relation of Tick Counts to Deer Density: In 2003, a study in Maine found that ticks on deer decreased with elevation and with distance from the coast. *Few ticks were collected at deer densities of less than 15 deer per square mile. [6]*

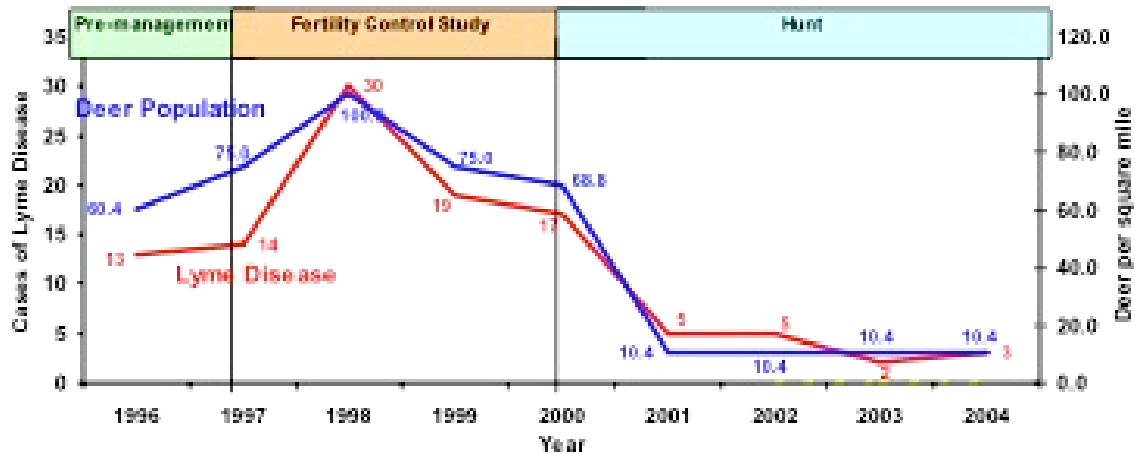
Monhegan Island and Deer Removal: Deer were introduced in 1955 to this coastal Maine island, and deer ticks were first noticed in 1980s. By 1996 about 13% of the human population had contracted Lyme Disease. Deer were removed by controlled hunting during 1990s, and by 1999, all deer had been removed from the island. By 2003, tick density had been reduced substantially since humans and their dogs and cats were the only remaining large hosts. [7]



Birds also play an important role in dispersing ticks carrying Lyme Disease to new areas. A study on Monhegan Island in 2011 reported few adult or immature deer ticks. It appears that 1) birds are importing immature deer ticks to the island, and 2) the lack of deer interrupts the tick's life cycle. [8]

Mumford Cove Connecticut: The incidence of Lyme Disease closely tracked the density of the deer herd as it grew and was subsequently controlled in the Mumford Cove enclave of 150 homes in Groton, CT. After two years of controlled hunting, the deer population in Mumford Cove was reduced from about 77 deer per square mile to about 10 deer per square mile. Since the initial reduction, the deer population has been maintained at low levels and incidences of Lyme Disease among residents has decreased 83% and continues at low levels. The following chart clearly illustrates the Mumford Cove history. *The deer have been maintained at 10 per sq mile for the following 8 years by removing only 10 deer each year, by bow hunters who use tree stands in just 3 locations. [5] [9] [10]*

Figure 2. Changes in deer density and cases of Lyme disease in Mumford Cove, Connecticut, 1996-2004 (CT DEP data).



Managing a Deer Herd

The Connecticut Bureau of Natural Resources / Wildlife Division's [Managing Urban Deer in CT: A guide for Residents and Communities](#) outlines possible measures to help thin a deer herd. This document outlines the history of deer reduction in Connecticut. Beginning in 1974, legislation allowed for more aggressive hunting of deer. However, the program was unsuccessful until 1988 when unlimited antlerless deer hunting was permitted. Connecticut has also tightened the training needed for a hunting license. The report details impacts caused by inflated deer density such as vehicle accidents, Lyme Disease, the loss of native vegetation and threat to forest re-generation. Connecticut, NJ and a few other states have used a 'earn a buck' program that allows hunters to take a buck only after a certain number of does have been taken. It also details seven case studies, including the ambitious efforts to control deer in Fairfield County. [9]

[Community-Based Deer Management](#) (2004) Daniel J. Decker, Daniela B. Raik, and William F. Siemer of Cornell University. The report outlines strategies for engaging the public in decision-making for deer control. [11]

The NH Fish and Game Department [Wildlife Harvest Summary for 2012](#) shows 163 deer (88 male and 75 female) taken in Hanover. Due to deer population pressure, Hanover is now in a new deer management area where taking a second doe is permitted.

Certain Invasive Plants Lead to Increased Deer Ticks

Deer do not eat [Japanese Barberry](#) and certain other non-native woody invasive plants, such as shrub honeysuckle, bittersweet and glossy buckthorn. With many dense branches close to the ground these plants create shelter, shade and moisture – thus providing ideal conditions for the deer mice that harbor immature deer ticks. Destructive browsing of a native understory by excess deer can open a forest to rapid invasion by deer-resistant vegetation, such as Barberry. [12]

Invasive Plants in Forest Understory are tied to Increase in Tick Counts

Research at Maine's Vector-Borne Disease Research Laboratory shows that *dense thickets of certain invasive plants such as Japanese barberry, honeysuckles, buckthorns and oriental bittersweet can increase the deer tick population and elevate the risk for human exposure to Lyme disease.* In three Maine towns where Lyme disease is endemic, the number of tick adults and nymphs found in sample plots dominated by invasive shrubs was twice that of plots with a more open understory. Tick numbers were lowest in coniferous forests. Other indicators tied to increased adult tick counts are increased leaf litter, soil moisture and deer. [12]

Tick Counts Decline with the Removal of Barberry

A 2012 article from the University of Connecticut summarizes work where deer ticks were counted in areas where barberry was removed. It reported that when they measured the presence of the ticks carrying the Lyme spirochete (*Borrelia burgdorferi*) they found 120 infected ticks per acre where Barberry was not removed, 40 ticks per acre where Barberry was removed, and only 10 infected ticks per acre where no Barberry was present prior to the survey. [13]

Connecticut has produced a new [bulletin](#) (2013) that outlines techniques for control of Japanese barberry, including use of a propane torch (not for amateurs). [14]

Other Environmental Factors Influence Deer Tick Populations:

Acorn crop variability and forest fragmentation play a major role in helping deer mice thrive; to a lesser extent, climate change (warmer winters and wetter weather) may have an effect on the number of mice (and thus ticks).

- **More Acorns:** Years with higher acorn production means an increase in deer mice and chipmunks in the following year and a subsequent increase in tick nymphs two years after the high acorn crop. [15]
- **Forest Fragmentation - Loss of predators:** Typical predators for deer mice are weasels, foxes, coyotes and owls. The increase of forest fragmentation and reduced size of forest patches suggest that these natural predators of deer mice have too little habitat, thus provide less control over the deer mouse population. In patches smaller than 5 acres, researchers have found a low diversity of mammalian species and high deer mouse density, and thus an increase in the density of infected deer tick nymphs. *Risk of human exposure to Lyme Disease is almost 5 times greater in these smaller forest patches than in larger forested areas.* [16] [17]



- **Wet June:** Year-to-year, the incidence of Lyme Disease can vary immensely (as much as 30%) in a region where Lyme Disease is established. 'In the US Northeast, approximately two thirds of human Lyme Disease infections are transmitted during the months of June and July by infected nymphs in the second year of the tick life cycle, rather than by larvae or adults.' Young tick larvae are particularly vulnerable to dry weather, so wet weather in June helps high survival rates of nymphs into their adult stage, creating a larger tick population two years later, with corresponding higher count of Lyme Disease cases. [18]
- **Warmer Winters:** Deer mice are vulnerable to cold winters, thus warmer winters may cause increased survival for deer mice and also associated deer ticks. Also, since adult ticks are not active when temperature is below 32°F, warmer winters and more frequent thaws predicted by climate-change scientists suggest an accelerated life-cycle for ticks [18]
- **High Humidity:** Since ticks can't drink water, they must absorb water from humidity in the air. Humidity above 85% is beneficial to ticks. Drought is a problem for ticks. [19]

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