

The Dilution Effect

By Jill Hahn / Special To The Tab
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Here's a story about a blacklegged tick, a white-footed mouse, an unpleasant bacterium, and how reducing biodiversity in our own backyards can literally make us sick.

Lyme disease, which now accounts for about 90 percent of the vector-borne disease (spread by an animal carrier) in the U.S., is caused by the bacterium *Borrelia burgdorferi*, transmitted by the bite of an infected blacklegged tick, *Ixodes scapularis*. A new-born tick does not carry the bacterium. In order to acquire the bacterium, the larval tick must take its blood meal from an infected animal. And here's where the *I. scapularis* larvae are the kind of eaters you wish your children were: they are not picky. They will feed on a wide variety of mammalian, bird, or even reptile hosts. The larva takes one blood meal from the host it happens to encounter, and then molts into its next stage, called a nymph.



Photo courtesy of Frontiers in Ecology and the Environment

Adult blacklegged ticks

Most people contract Lyme disease from the nymphal stage of the blacklegged tick, partly because the nymph is small and hard to spot, partly because it is active in June and July, when we're likely to be out enjoying the woods.

What determines whether the nymphal tick that just bit you is likely to give you Lyme disease? Dr. Richard Ostfeld, senior scientist at the Institute of Ecosystem Studies (Millbrook, NY), conducted a series of elegant, if messy, experiments to find out. Since a nymph can only acquire *B. burgdorferi* during its larval meal, Dr. Ostfeld's first task was to determine whether feeding on different animals resulted in differing proportions of infected nymphs. To do this, he and his colleagues trapped individuals from every potentially important bird and mammal species in his study site in Dutchess County, NY. This list included deer, robins and other songbirds, white-footed mice, chipmunks, raccoons, possums, skunks, shrews, and squirrels. The animals (deer excepted) were caged for 72 hours. Any tick larvae attached to them fell off into pans of water under the cages. They were collected (a dirty job, because more than just ticks dropped into those pans during the 72 hours) and tested for the presence of the Lyme disease bacteria.

Dr. Ostfeld discovered that over 90 percent of the ticks that fed on white-footed mice tested positive for *B. burgdorferi*. 40-55 percent of the ticks from shrews or chipmunks tested positive, and the proportion of positive ticks collected from the other species ranged from around 15 percent to less than 2 percent. So the host species a larval tick

fed on dramatically affected whether the resulting nymph would be able to transmit Lyme disease.

Since different species of animal have differing abilities to pass the Lyme disease bacterium to the tick, this suggests that increased host biodiversity might lower the prevalence of infected ticks. Dr. Ostfeld dubbed this hypothesis the Dilution Effect.

Ecologists know that, as you fragment forest into smaller and smaller pieces, the number of animal species found in those forested "islands" declines. If the Dilution Effect holds true, then the proportion of infected nymphal ticks should increase as forest area goes down and biodiversity decreases. Dr. Ostfeld and his colleagues set out to test that prediction.

They measured the density of nymphal ticks in forest fragments of different sizes (ranging from less than two acres to almost 19 acres) by dragging drop cloths through the forest and counting the number of nymphs collected. When Dr. Ostfeld tested the ticks, he discovered that, as the Dilution Effect predicted, the proportion of ticks infected with *B. burgdorferi* increased as the forested area decreased.

Why would this be? In the smaller forest fragments, many potential host species disappeared. One species, however, whose numbers conspicuously explode as forest area decreases is the white-footed mouse. White-footed mice, as Dr. Ostfeld had already shown, are incredibly efficient at infecting ticks with Lyme disease.

What does this mean for human health? Simply put, biodiversity protects us from Lyme disease. If you go hiking, say, in the White Mountains of New Hampshire, and you get bitten by a blacklegged tick nymph, you know that tick had a wide variety of species from which it could have taken its larval meal, and most of those wouldn't be likely to infect it with the Lyme disease bacterium. On the other hand, if you're out on a small plot of forested land in your suburban hometown - especially if it's smaller than about five acres - that nymph that bit you most likely got its last meal from a white-footed mouse, and most likely did contract the bacterium during that meal. So your chances of contracting Lyme disease from a tick bite are much higher in the forest fragment near your house than in the National Forest.

If those cute little white-footed mice are the problem, why not simply get rid of them? Attempts to eradicate rodents to a level at which they can no longer transmit disease are notoriously unsuccessful. Attempting to rid the woods of ticks is a similarly Sisyphean task. There is another solution: let the Dilution Effect work for us by changing the way we manage our landscape.

Dr. Ostfeld's work has shown that the loss of biodiversity through the fragmentation of our native forests has real health consequences. The Dilution Effect holds true for Lyme disease and may play a role in other vector-borne diseases as well. It's time to



Photo courtesy of Frontiers in Ecology and the Environment
White-footed mouse female and pups

stop thinking of biodiversity as something that would be nice to preserve, but of no practical value. The next time a local interest in your community wants to break up an existing parcel of forest into smaller pieces for the sake of development, think about the health consequences, and think twice.

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