



# ***THE COMPREHENSIVE DEER TICK CONTROL MANUAL***

Strategies and Techniques  
for the Control of Lyme Disease Carrying Ticks

An EcoHealth Publication




**ECOHEALTH, INC.**  
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Finally, we appreciate the cooperation of property owners throughout the Northeastern United States, for providing access to tick-infested properties where much of our research has been undertaken.



# Chapter 1

# What Is Lyme Disease Tick Management?

Fight Lyme disease! It's a cause that just about everyone can endorse. But who should do it, and how should they proceed? Just how prevalent is the Lyme disease problem? Can tick management help in suppressing Lyme disease?

In just the past decade, Lyme disease has emerged as the most significant vector-borne disease in the United States. Although rarely fatal, the disease can cause severely debilitating arthritic, neurologic and cardiologic symptoms, sometimes resulting in permanent damage. And it is not limited just to the U.S. Lyme disease is a serious problem worldwide throughout the north temperate zone in Europe, Russia and China.



Lyme disease is caused by a tick-transmitted bacterial infection. Lyme disease spirochetes (pronounced spiro'ketes) are a type of bacteria that are transmitted by the bite of ticks in the genus *Ixodes* (pronounced Ix'o'dees). Most of the *Ixodes* ticks that transmit Lyme disease are commonly called deer ticks and they are often abundant wherever there are deer. Deer ticks are basically wildlife parasites. Human populations continue to infringe on the habitat of wildlife at an ever escalating rate through development and recreation. The risk of exposure to deer ticks will only increase. Now, in many areas Lyme disease has become a "backyard" threat, and it is one that seems certain to become worse unless some action is taken.

But what can be done? Historically, ticks have proven difficult to control. The complex biologic and ecologic attributes of ticks have made it nearly impossible to significantly reduce any tick population using a single "magic bullet" approach. During the 1980's and 1990's, as deer ticks and their associated spirochetes have become such a serious threat to the public health, older tick control strategies are being reexamined, and novel strategies are being tested for their impact on these "new" important pests. In some cases, strategies that have been successfully applied in the past against ticks on rangeland or in more open areas are proving ineffective or impractical for controlling deer ticks in many of the suburban residential areas where they occur.

Fortunately, Lyme disease is preventable through vector control. But it is becoming clear that effective deer tick management requires that several environmental and personal protection strategies be integrated into a comprehensive program. Like opening a full box of tools, Integrated Tick Management (ITM) provides management specialists with appropriate options for developing the best biorational deer tick control strategy for any given situation. There is little value in killing the same tick twice, thus, the components of an effective ITM program should be complementary and should avoid having overlapping impact.

**I**ntegrated  
**T**ick  
**M**anagement

.....

The best integrated tick management program should include the following five strategies:

- **Surveillance**  
to detect tick infestations and identify tick habitat.
- **Landscape Management**  
To reduce the amount of tick habitat, and isolate it into manageable units.
- **Targetted Chemical Control**  
With host- and habitat-targetted insecticide applications.
- **Personal Protection**  
By using repellents, protective dress and daily tick checks.
- **Cultural Practices**  
To modify activities and practices in ways that reduce tick exposure.

■ **Controlling deer ticks to manage Lyme disease risks is usually not a one-time treatment.**

It is the job of the management specialist to mold these components into an effective plan aimed at reducing the probability that someone will be bitten by a Lyme disease-infected deer tick. But because it takes just one infectious tick bite to get Lyme disease, the most effective program will be the one that uses all of the necessary "tools" called for in a given situation (residential yard, parkland, etc.). Best results will be achieved only when (1) each selected component is applied properly or rigorously adhered to (especially the host- and habitat-targetted insecticides), and (2) the program is continued as recommended or needed. Controlling deer ticks to manage Lyme disease risks is usually not a one-time treatment.

This manual gives field professionals (pest management, landscapers, land use planners, etc) an explanation of the current state of knowledge in deer tick biology, ecology and management strategies. It is written as both a training manual for deer tick control, and as a reference guide. However, some of the methods and techniques described are best understood by example. Thus, wherever possible, information provided in this manual should be supplemented with actual training sessions conducted by deer tick management specialists.

# Chapter 2

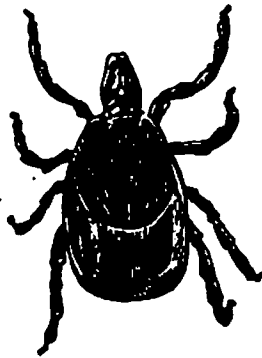
# Deer Tick Biology

## Understanding tick biology and ecology

### In this chapter:

- What are ticks —
- Recognizing deer ticks —
- Deer tick lifecycles —
- Patterns of seasonal abundance —
- Definitions of vectors, hosts and reservoirs —

### What Are Ticks?



Most people think of ticks as a kind of insect. They're not! Technically, they are classified as Arthropods and more specifically as Acarines (A'car'ines). That puts ticks in the same group of "bugs" as spiders and mites. But for all practical purposes, this distinction doesn't matter to the average homeowner plagued by these pests. It does mean that when we talk about the chemical pesticides used for killing ticks (acarines) we refer to them as acaricides. Otherwise, ticks are much like mosquitoes and other bloodsucking pests in that they are obliged to feed on blood to develop and reproduce. This is the reason that they bother us; the only way for ticks, flies, fleas and lice to get blood is to find and attach to hosts, which can include various animals as well as people. Some of these bloodsuckers are more than just pests. They can also be important as potential transmitters of disease agents. This is especially true for certain types of ticks. While some types (species) of ticks feed on a limited diet of hosts, others are less particular and feed on a wide variety of animals. Those that do can carry the parasites and other germs from one type of animal to others. The tick that carries Lyme disease feeds on a variety of wild and domestic animals, and man. Lyme disease bacteria may have come from one or more species of wild rodents where it apparently causes little harm, but may severely affect humans and some animals.

### More About Ticks

Most of the ticks that people encounter have certain biologic traits in common. For instance, they all progress through four life stages:

- egg
- larva
- nymph
- adult (male & female)

Except for the egg stage, all other stages feed on blood. The immature stages (larvae & nymphs) use blood to transform into the next stage (larvae - nymphs; nymphs - adults). Adult female ticks use blood to make thousands of eggs. The males of some species of ticks may require a small blood meal to produce sperm.

Ticks typically stay attached to hosts for just a few days in each stage. When they become fully blood-engorged they detach, leaving their host animal. Larvae usually take 2-3 days to engorge, nymphs may take a day longer and adult females may take a week or more. Nevertheless, all will detach and continue the lifecycle--either by transforming into the next life stage or by laying eggs.

**Recognizing Deer Ticks**

Despite certain basic similarities among ticks, all ticks are not the same. That may seem obvious or profound, depending on one's training and background, but in fact there are about 800 species of ticks in the world but only about 6 species are commonly encountered in the eastern part of the United States. A few additional species may be encountered in the southern and western U.S. But out of all of these ticks, only one closely related group of deer ticks appears responsible for infecting people with Lyme disease. As the tick "expert" you may be expected to distinguish deer ticks from the other ticks that you or your clients find. Once you know a few of the things to look for, you should be able to distinguish the most common ticks that attack people.

<b>The Ticks Most Commonly Found Biting People.</b>		
<b>Common Name</b>	<b>Scientific Name</b>	<b>Region</b>
Deer Ticks	<i>Ixodes dammini</i> <i>Ixodes pacificus</i> <i>Ixodes scapularis</i>	east, midwest west south
Dog Ticks (Wood)	<i>Dermacentor variabilis</i> <i>Dermacentor andersoni</i>	east, west midwest
LoneStar Tick	<i>Amblyomma americanum</i>	mid-atlantic, south
Pacific Coast Tick	<i>Dermacentor occidentalis</i>	west
Brown Dog Tick	<i>Rhipicephalus sanguineus</i>	entire US

In recognizing deer ticks, the striking coloration and size of the adult stages make them fairly easy to recognize while immature ticks are so small that it can be difficult to even see the distinguishing characteristics. At the very least you will need a hand lens to see specific characteristics on adult ticks, but you may need one just to see the immature stages. We recommend magnifying the tick 20-30 times its normal size in order to get a good look.

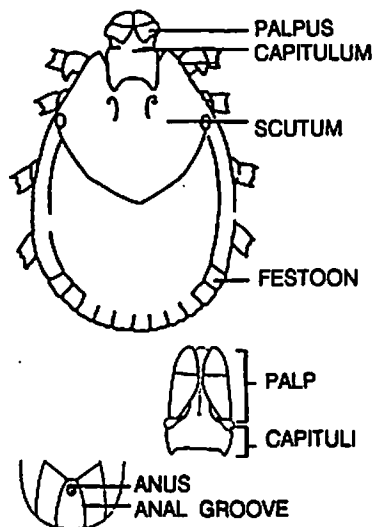
**Wood Tick**    **Deer Tick**



— larvae: 6 legs, translucent brown, nearly microscopic.

— nymphs: 8 legs, appears darker, size of poppy seed.

— adults: 8 legs, females are red/orange with shiny black scutum, males all black, slightly larger than sesame seed.



<b>Distinguishing Characters Of The Most Common Ticks</b>			
<b>Character</b>	<b>Deer Tick (Ixodes)</b>	<b>Dog Tick (Dermacentor)</b>	<b>LoneStar Tick (Amblyomma)</b>
<b>Scutum</b>	<i>black</i>	<i>whitish</i>	<i>white spot</i>
<b>Festoons</b>	<i>absent</i>	<i>present</i>	<i>present</i>
<b>Anal Groove</b>	<i>around anus</i>	<i>beneath anus</i>	<i>beneath anus</i>
<b>Mouthparts</b>	<i>longer than capitull</i>	<i>shorter than capituli</i>	<i>longer than capituli</i>

### **Deer Tick Lifecycles**

Deer ticks have a fairly complicated lifecycle involving bloodfeeding on multiple hosts and taking two years or longer. This lifecycle varies somewhat depending on the species or the region where the tick is found.

<b>Two-year Deer Tick Lifecycle</b>				
	<u>Spring</u>	<u>Summer</u>	<u>Fall</u>	<u>Winter</u>
<b>Year 1:</b>	<i>Eggs Laid/Hatch</i>	<i>Larvae Feed</i>		
<b>Year 2:</b>	<i>Nymphs Feed</i>		<i>Adults Feed</i>	

*Ixodes dammini* (Northeast, mid-Atlantic, mid-west U.S.): Adult female ticks lay about 2,000 to 3,000 eggs in the springtime, all in a single cluster at or close to the spot where she detached from her host. Larvae begin hatching in the early summer but do not aggressively attach to hosts until later in July and August. Larvae attach for 2-3 days, then detach, overwinter and emerge as nymphs the following spring. Nymphal activity begins in late April and reaches a peak by mid-June. Nymphs that find hosts stay attached for 3-4 days before detaching. Engorged nymphs transform into adult ticks which begin emerging in October. Some nymphs that fail to find hosts may survive until the following spring. Adult tick activity reaches its peak by mid- to late-November. Adult females take a week to 10 days to engorge, then detach, overwinter and lay eggs in the spring. Adult ticks remain active all winter and may be found whenever temperatures are mild (40°F).

*Ixodes pacificus* (Pacific northwestern U.S.): All stages closely resemble their eastern counterpart in appearance. Larvae and nymphs are active beginning in late spring and remain active well into the summer. The adults are active from November through May.



**Tick Vectors...  
Carriers Of Disease**

When used as a medical term, a vector is an organism that carries things from one place to another. Bloodsucking insects or ticks are potential vectors serving as the "vehicle" for transmitting a disease-causing germ from one host to another. In Lyme disease, deer ticks serve efficiently as vectors of Lyme disease-causing spirochetes. Even though people and animals may be bitten many times by many different "bugs" over the course of a summer, most of these bites are unlikely to result in Lyme disease. Instead, bites from deer ticks are how most people become infected with Lyme disease spirochetes. Several studies have now shown that bites from other species of ticks, including the common dog tick, as well as a host of biting flies, mosquitoes and fleas do not serve to transmit Lyme disease spirochetes. With few exceptions, even other ticks that bloodfeed on the same animals as deer ticks fail to become infectious. That is why deer ticks are called the main vectors of Lyme disease.

**Tick Hosts vs.  
Reservoirs**

Deer ticks obtain their bloodmeals from host animals. *Ixodes dammini* feed principally on warm-blooded hosts (mammals and birds); the type of animal depends on the stage of the tick. Immature ticks will feed to one degree or another on most types of animal (especially small rodents) while the adult stage prefers bloodfeeding on larger mammals (especially deer). *Ixodes pacificus* also bloodfeed on mammals and birds, but the immature stages of this tick also feed on cold-blooded reptiles, especially lizards. Deer ticks are said to have a very broad range of hosts on which they feed.

The maintenance of tick populations depend upon their host feeding success, but in trying to understand where infected ticks come from we have to subdivide the tick hosts into those that just provide blood-meals and those that also infect bloodfeeding ticks with Lyme disease bacteria. The term reservoir is used to describe host animals that both carry and transmit the bacteria to uninfected vectors, continuing the cycle of infection. Any animal that is bitten by an infected tick may become infected, but that doesn't automatically make that animal a reservoir. Animals that are infected but not infectious are often called dead-end hosts.

In Lyme disease, studies have been conducted which identify those species of animals that are reservoirs (infective) and those that are dead-end hosts (not infective).

- **A host is any animal that ticks feed on.**
- **A reservoir is a host that can also infect ticks.**

<b>Animals capable of infecting deer ticks.</b>	
<b>Infective To Ticks</b>	<b>Not infective To Ticks</b>
<ul style="list-style-type: none"> <li>■ white-footed mice</li> <li>■ short-tail shrews</li> <li>■ chipmunks</li> <li>■ squirrels</li> <li>■ foxes</li> </ul>	<ul style="list-style-type: none"> <li>■ white-tail deer</li> <li>■ raccoons</li> <li>■ catbirds</li> </ul>

In addition, of the animals that can infect ticks, **some will infect more than others**. This will depend on 3 factors:


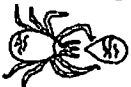

- The animals' infectivity
- The abundance of ticks bloodfeeding
- The density of each species of animal

That is why **more infected ticks are produced by reservoir animals that are abundant, and infested with many larval ticks than by animals that are rare, or rarely tick-infested**. Research comparing the potential for various animals to infect tick populations has shown that small rodents, and in particular white-footed mice, produce most (75%) of the ticks that are infected with Lyme disease spirochetes.

**Timing Of Transmission**

Once deer ticks become infected with Lyme disease bacteria, they may transmit the infection by injecting infectious saliva during their next bloodmeal. Most larval deer ticks are uninfected when they hatch from eggs. When larvae feed on reservoirs, they may become infected. The bacteria are then carried over as those larvae transform into nymphal ticks. Only after infected nymphs attach to hosts does the bacteria become active in those ticks' saliva. This activation period takes time, causing a delay of about 24 hours between the time of tick attachment and transmission. The same process occurs when nymphs bloodfeed and then transform into adult ticks. Results of studies confirmed that when infected nymphs were removed from hosts within 24 hours of their attachment, the animals did not become infected with Lyme disease. Because of this delay, we recommend (at least) daily checking for ticks and prompt tick removal as part of any personal protection strategy (Chapter 6).

■ Remember that it usually takes 24 hours before the tick can infect someone!

<b>Time Required for Disease Transmission.</b>	
<b>Tick attachment for:</b>	
	<b>24</b> hours ..... No hosts infected
	<b>48</b> hours ..... Some hosts infected
	<b>72</b> hours ..... All hosts infected

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## **Summary**

The knowledge gained through research on deer ticks and Lyme disease has permitted scientists to develop the effective tick management strategies discussed in this manual. Many of these strategies have been based on:

- recognizing key hosts and reservoirs
- identifying capable vectors
- understanding the transmission process
- knowledge of the deer tick lifecycle

Development of any new strategies for managing deer ticks will likely also be based on this type of knowledge.

# Chapter 3

# Tick Surveillance

## Detecting infestations and identifying tick habitat.

### In this chapter:

- How, when and where to sample ticks —
- How to protect yourself while sampling —
- How to produce a Lyme disease risk assessment —

With today's increased awareness of Lyme disease, most people who find a tick (any tick) imagine that they are at risk. Some truly are. Deer ticks are expanding their range but they are not the only ticks out there! Remember, there would be no risk from Lyme disease if the property just has a dog tick infestation. But even in the absence of deer ticks, a "ticky" property may indicate that conditions are suitable for a deer tick invasion. A good surveillance program can assist in many of the important action decisions you may be asked to make, and in fact, may help to sell the entire ITM program.

Before beginning any management action, it is probably a good idea to first determine whether a property is infested with deer ticks. Tick management certainly would be needed if deer ticks were found. ***But because the purpose of ITM is to prevent Lyme disease, some level of tick management may be called for even if no deer ticks were recovered in preliminary surveillance.***

■ ***Tick Management may be called for even if no deer ticks are found!***

<b><i>Deer Tick Management</i></b>	
If deer ticks were present.....	Recommend ITM program.
If none were found.....	Continue annual surveillance.
<b><i>BUT</i></b>	
If it is a Lyme disease area.....	Consider some level of preventative treatment.

However, before running off to collect a few ticks, read the rest of this entire section. First, you should arm yourself with the right equipment (see "Tick Collecting Equipment"), select the proper method for the time of year (and stage of tick), and determine where on the property ticks are most likely to be. You may also want to read Chapter 6, so that you know how to protect yourself. Taking these steps will both increase your chances for success and aid in your interpretation of surveillance results.

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## How, When, and Where To Collect Ticks

If deer ticks are abundant on a property, you or the owner will likely know it. In such a situation, it is likely that at least one family member already has been infected with Lyme disease or experienced a tick bite. Of greater concern is the more common situation where ticks are present but not all that abundant. In these situations, the property owners may not realize that their properties are infested and that they are at risk. For example, in one Connecticut community, only 4 out of 32 homeowners surveyed realized that their yards were infested with deer ticks, while in reality, infected ticks were found infesting each property.

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### How

- **Tick collecting typically involves "dragging" or "flagging".**

Tick collecting typically involves "dragging" or "flagging". Sometimes these terms are used interchangeably, but we make a distinction between these methods. Tick flags and drags are usually made of sturdy flannel cloth attached to a pole. Flags often are of standard size (1 meter square) but the size is not critical unless you are attempting to compare results with others. Then you will need to use the same methods and style of equipment.

The best method to use in collecting deer ticks will be determined largely by which stage of tick is being collected, and that will depend upon the time of year. Nymphal *Ixodes dammini* will be the likely target from May through July, while adult stages of this tick is most active during the late fall and early spring. In the western U.S., *Ixodes pacificus* nymphs are most active in April while adults seek hosts from November through April. The type and degree of vegetative cover may also influence the collecting method used.

**Deer ticks are not attracted to the flag, and only are "collected" following passive contact. Thus, the flag must reach to where the ticks are.**

When collecting:

- nymphs — keep flag (drag) low to ground. Flag must brush across top of leaf litter.
- adults — push flag across vegetation at knee-height. Be sure to check pants as well.

Inspect the flag (drag) every 30 seconds. Using a longer interval results in "collected" ticks falling off before being recovered. Shorter intervals result in spending too much time inspecting the flag relative to the time spent sampling.

To inspect the flag:

- Train your eye to search for the correct sized-image
- Lay the flag flat on the ground
- Inspect both sides carefully

Larval and nymphal deer ticks look smaller than you think they will. Inexperienced collectors often mistake aphids, mites, etc. for ticks.

#### Tick Collecting Equipment

- **Tick Flag (or Drag) —**  
Made of heavy white cotton flannel size may vary (usually 1m X 1m)
- **Flag Handle —**  
Standard wooden broom handle with means for attaching flag (velcro or staples work well)
- **Forceps —**  
Fine point
- **Humidified Sample Vials —**  
Plastic snap-cap vials with plaster of paris base (plaster is moistened just before use)
- **Timing Device —**  
Stop watch, preferably with a 30 second alarm
- **Record Sheet —**  
See example (Appendix)

If you find ticks on the flag, grasp them gently with the forceps and place them into the pre-moistened sample vial. In order to keep the tick alive for longer than a day, you will need to store the vials in a sealed plastic bag with a piece of damp toweling.

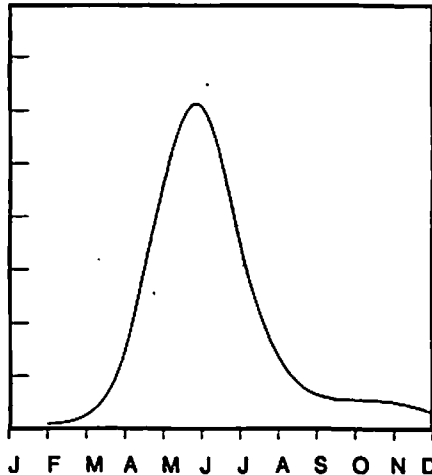
For any tick collected, be sure to note the suspected location of the tick. This information will be useful later when constructing a risk assessment for your client.

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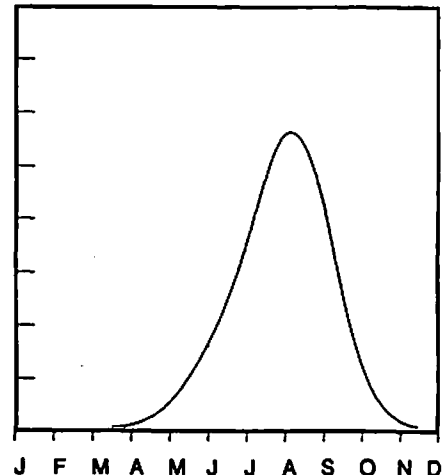
**When**

Wherever possible, arrange to conduct your initial tick sampling early in the season of risk (see ITM calendar) In the eastern U.S., sampling should begin in May. In the western U.S., sample from Fall through early Spring for adult ticks because these are most easily detected. If ticks are detected, immediate steps can be taken to minimize infection risk before the early summer when outdoor activity, and risk of tick exposure becomes greatest.

■ *In the eastern U.S., sampling should begin in May.*



**Seasonal Abundance of Nymphal Ticks**



**Seasonal Abundance of Larval Ticks**

It is possible to conduct an effective surveillance program at other times of the year. Sampling in August may turn up larvae, a sure sign of risk to come. Finding adult ticks during fall or spring sampling is also indicative of risk.

The best time of day to collect deer ticks is usually in the morning just after the dew has dried. However, they can be collected throughout the day; overcast days are usually better than bright sunny ones. If you are scheduling to sample on several properties, select the ones that are more open (and thus less humid) for sampling earlier in the day and leave those that retain higher humidity (such as low-lying wooded sites) for later. In general, ticks are not active on rainy days, and their activity appears to drop off just before a storm as well. From mid-October until mid April, adult deer ticks, if present, are active on days when temperatures are above 40°F. It is usually not worth sampling in colder temperatures or with snow cover.

**Where**

In order to detect deer tick infestations, it is best to first concentrate on sampling where ticks are likely to be found. Studies on residential properties indicate that deer ticks are not generally distributed but are more likely to be found in certain "habitats" (see drawing). Since deer ticks require high humidity, they seek out habitats that are heavily shaded, damp (but not flooded) and covered with leaf litter. Also remember that ticks are associated with wildlife, so sites that concentrate animal activity may also have concentrations of ticks.

- **Concentrate on sampling where ticks are likely to be found.**

**Specific Sites Likely To Harbor Deer Ticks**

- Areas in which deer are frequently observed (shaded)
- Brush pile perimeters
- Directly along the base of stone walls
- Wood piles
- In brushy edge plantings
- Wooded areas, especially near stumps or fallen logs
- Edge of lawns, under overhanging bushes

Studies in residential areas in New York, Connecticut, Massachusetts and Pennsylvania have shown that most immature and adult deer ticks are found in woodlots or the wooded buffers between yards, and along edge habitats (called ecotone), and especially in unmaintained borders. High risk areas are often found around rockwalls, woodpiles and brushpiles. All stages of deer ticks are extremely rare on maintained lawn, although ticks may occasionally be found on the lawn close (within 2-3 meters) to the ecotone.

Deer ticks are rarely found in open, sunny areas. In general, searching for ticks in open lawns and parkland is a poor use of time and is unlikely to yield results.

- **Deer ticks are rarely found in open, sunny areas.**

- Open Lawn — 2%
- Ornamentals — 9%
- Unmaintained Borders — 21%
- Woods — 68%



**Tick "flagging" vs. "dragging"**

Standard tick collecting methods often involve flagging or dragging a cloth sheet over vegetation, but technically speaking, these terms are not interchangeable. Both flagging and dragging usually employ flannel attached to a pole; the flag is usually pushed ahead of the collector but can be dragged behind, while the collector always "drags" a tick drag by pulling a rope attached to either end of the pole.

Properly used, the flag serves as an extension of the collector, reaching sites where the collector cannot conveniently reach. In dense brush (where deer ticks are often found), the cloth flag will readily fall between stems to reach the leaf litter on the ground. In the same habitat, drags are carried over the tops of the vegetation and fail to consistently reach the forest floor. In collecting deer ticks, the best technique will depend on which tick stage and habitat type is being sampled. In most cases, a tick flag will permit greater sampling flexibility. For example, it is easier to direct the cloth end of a tick flag under the drip-line of a brushy hedge than to pull a drag into the same area.

Use the following as a guide in selecting the most effective tool and technique for collecting nymphal or adult deer ticks in specific habitat types.

<i>Effective Tools for Tick Collection</i>		
<b>Nymphs</b>	woods . . . . .	flag—usually dragged behind
	ornamentals . . . . .	flag—worked between stems
	edge . . . . .	flag—pulled or pushed in & out of vegetation
	trails, lawns . . . . .	drag
<b>Adults</b>	all habitats . . . . .	flag—contact vegetation 1 - 3 ft above ground

**Protecting Yourself While Collecting**

■ **Whenever you enter tick habitat, you are at personal risk of being bitten by infected ticks.**

Whenever you enter tick habitat, you are at personal risk of being bitten by infected ticks. In ITM, you recommend the proper use of repellents for personal protection to your clients (Chapter 6). The same should go for you, right? But, there is a problem. When conducting tick surveillance your job is to find ticks if they are there, not repel them. Unfortunately, the use of some repellents (especially products containing DEET) may adversely affect collecting efficiencies.

Protective dress (Chapter 6) can serve as a first line of defense against host-seeking ticks. Tucking in as many entry portals as possible (cuffs, shirt-tail) will help to keep attacking ticks on the outside of clothing. Treating boots and pants with permethrin-based repellents (Permanone®) also helps; in preliminary experiments, Permanone treatment (of collectors) did not appear to negatively affect tick collecting efficiencies. However, if you plan on keeping any of your sampled ticks alive, never let them contact Permanone-treated surfaces (or anything that has contacted treated surfaces).



**Lyme Disease Risk Assessment**

Risk is a relative term; there are degrees of risk in anything, including Lyme disease. As you will likely find when you show your client the ticks collected from his yard, the presence of deer ticks on a property is certainly a compelling indicator of risk. But without extensive sampling and a complete understanding of how your client uses the property, the tick management specialist will be unable to precisely determine a property owner's risk of encountering ticks or contracting Lyme disease. Even with extensive sampling, precise estimates of risk are difficult to obtain.

However it is possible to measure some of the indicators of risk — your tick surveillance results are just one of these. Other significant risk indices include the frequency of deer sightings (more deer = more ticks); human and animal use-patterns on and off the property (pets, especially may pick up ticks and bring them to people); and the amount of suitable small mammal and tick habitat (areas where ticks may be concentrated).

First let's deal with the tick surveillance information. The number of ticks collected during a specified unit of exposure time or space can serve as a useful index of risk. In practice, we assess risk by determining the abundance of infected, host seeking ticks collected per man-hour of flagging. Without access to sophisticated testing procedures, you may not be able to determine how many of your ticks are infected. But just the number of ticks present can serve as a useful relative indicator of risk. As a general rule, we use the following guidelines:

Nympha per hour	Adults per hour	Infestation is	Recommended sampling time (min) to detect
1-3	<1	very light	>90
3-10	1-4	light	60
10-15	4-6	moderate	45
over 15	over 6	high	30

***If you made notes while collecting the ticks, you can now pinpoint the areas on the property where ticks, and risk are likely to occur.***

After flagging ticks on the property, your next job in making a risk assessment is to ask the property owner some questions. Ask how often deer are sighted on the property and where. Where do children play? Are there pets? Where do pets go when they are outside? Do the pets come inside the house? Do certain areas get used just on special occasions (ie. an annual stacking of wood on a pile, or a wild area only used by grandchildren when they visit)? These are just some of the questions you should ask to help ascertain how your client uses his property. When coupled with your tick findings, this information will help you to more completely evaluate his Lyme disease risk. You will also want to use this to guide your treatment recommendations.

# Chapter 4

# Landscape Management

## Isolating and reducing the amount of suitable tick habitat

### In this chapter:

■ ***Landscape decisions can greatly impact the degree of wildlife activity in both residential yards and parkland as well as influence the amount and "quality" of tick habitat.***

- Landscaping to manipulate wildlife activity patterns —
- Methods for lowering humidity in the tick's micro-habitat —
- Pushing back the "danger zone" by edging and mulching borders —
- Handy yard maintenance tips to reduce exposure to ticks —

Bringing a little bit of nature into the lives of those not able to spend their days in the "great outdoors" is usually considered one of the benefits of the suburban and rural living experience. Over the past three decades in much of the United States, and especially along the East and West Coasts, rampant human development has expanded into areas formerly reserved as haunts for all kinds of wildlife. When housing developments and building lots intrude into woodlots inhabited by deer, wild rodents and birds, the human "intruders" either displace or end up co-habiting with the natural fauna. More recently, certain wildlife species, including deer, are refusing to move away, instead adapting to life with the human species. All of these changes have served to bring humans into closer and more constant proximity with wildlife. Unfortunately, it has also greatly increased human exposure to their parasites and pests. Ticks and the infections that they carry are just unwanted, and potentially dangerous "little bits of nature" that tag along with the rest of the package.

Most people thrill to the first sighting of deer in their yard, and only later realize that these same animals have been attracted to (and are eating) their expensive ornamental plantings. The antics of playful chipmunks running along picturesque rockwalls tend to obscure the fact that the rockwall is a rodent condo, potentially festering with Lyme disease-infected ticks. Landscaping decisions can greatly impact the degree of wildlife activity in both residential yards and parkland. They can also influence the amount and "quality" of tick habitat. Because of this, landscape manipulation and management can be a natural means for reducing the abundance of infected deer ticks and thus, risk for Lyme disease. Moreover, landscape practitioners that keep an eye towards tick problems can provide their clients with sustained tick population reduction that will save both monetary and environmental costs over the long-term.

### Basic Strategies

Because ticks and the risk they present are only brought onto properties by animals (ticks don't really crawl in), and they only survive under certain conditions once they are brought in, landscape management presents a real opportunity for tick reduction. To manage deer ticks through landscape manipulation, the two overriding rules to remember are **(1) create an environment that does not attract tick hosts, and (2) make the habitat inhospitable for long-term tick survival.**

Keeping these simple rules in mind, basic landscape manipulations will fall into just a few categories that we mention here and discuss below.

- Trimming, pruning, clearing
- Thinning existing canopies
- Plant selection
- Separating more dangerous from less dangerous areas

Although it sounds simple, it becomes more complicated when you keep in mind the need to end up with an aesthetically pleasing landscape plan as well as one that doesn't promote ticks. However, if done correctly, the effect will be to reduce the number of ticks coming onto the property, make the property less supportive of ticks when they are there, and present physical barriers to prevent human exposure to ticks in the remaining tick habitat.

### ***Landscaping and Wildlife Activity***

Your tick surveillance may have revealed tick "hot spots" on the property. Recent research suggests that these hot spots can be directly correlated with activity patterns of the animals that are tick hosts and reservoirs. The animals were likely attracted to these particular areas because the type of vegetation provided a favored source of food or special cover, or the landscape feature provided preferred protection or nest-building sites. Unless you do something to change that, these areas will continue to be tick hot spots. Several potential causes of tick hot spots:

- ***Anything that you can do to keep deer away will have a major impact on tick densities throughout the property.***

<b><i>Deer Tick "Hot Spots"</i></b>	
▪ protected grassy or leafy areas .....	deer bedding area
▪ overgrown fruit tree "orchards" .....	deer feeding area
▪ brush piles .....	rodent nesting habitat
▪ rockwalls .....	rodent nesting habitat
▪ woodpiles .....	rodent nesting habitat
▪ rotting stumps or logs .....	rodent nesting habitat
▪ close vegetation near birdfeeder .....	rodent feeding habitat
▪ compost pile .....	rodent feeding habitat

On the west coast, where *Ixodes pacificus* is the vector of Lyme disease bacteria, wood rat (*Neotoma*) nests (often a loose conglomeration of sticks up to 2 feet high) serve as habitat to a diverse animal fauna, and can also be tick hot spots.

These tick hot spots require special attention, as often they also are a focus for human activity (filling the birdfeeder, stacking firewood, discarding brush, etc.). Problems can be compounded where rodent nesting and feeding habitats are combined (birdfeeder positioned over rockwall or dense vegetation). Some of these situations are likely to be hard to modify -- you have to put discarded brush someplace; and what would you do with all of those stones if you dismantle the rockwall? Thus, in some cases around specific landscape features supporting tick hot spots, you may end up resorting to chemical tick

control (Chapter 5), but before you do, perhaps you can make landscape changes that either disrupt the existing animal activity pattern or make the habitat less suitable for tick survival.

In addition to tick hot spots, there is the rest of the tick habitat to manage. Anything that you can do to keep deer away will have a major impact on tick densities throughout the property. Studies have shown that immature ticks are most abundant in areas where deer are abundant, and ticks are not likely to be abundant if deer are not abundant. The client who regularly sees deer on his property is definitely one who needs your help.

### ***Disrupting Animal Activity***

■ *Today, there are more than 13 million white tail deer alone.*

■ *Deer may deposit blood-engorged ticks wherever they frequent. The more frequently they come into a person's yard, the more ticks that are likely to be found.*

■ *Avoid landscaping with such deer favorites as Japanese yews, honeysuckle and most fruit trees especially crab apple.*

In dealing with deer ticks, one animal—the white tail deer—will largely determine the abundance of ticks in an area. But remember, deer only produce uninfected ticks. Mice and occasionally a few other rodents found around the yard are to blame for infecting the ticks with Lyme disease bacteria. Still, deer are viewed by most as villainous when it comes to discussing Lyme disease. And the number of these "villains" has been increasing tremendously throughout this century. In the early 1900's the entire U.S. deer population was estimated at 500,000 animals. Today, there are more than 13 million white tail deer alone, while a similar abundance of mule and black tail deer further swell this number. Whereas before, deer were often killed for food, suburban zoning and a general decline in the necessity for hunting has changed all this. Now, safety issues and social pressures leave deer unfettered and increasing in many of their haunts.

Not only are deer more abundant than they used to be, but human and deer activity coincide now more than ever before. Both of these facts are due largely to the human population increase and shift to suburban living. Homes are now adjacent to or nestled within forests or open tracts, with the landscaped areas we call "yards" appearing very attractive to hungry deer. But deer feeding injury to plants is not the only concern. Deer may deposit blood-engorged ticks wherever they frequent. The more frequently they come into a person's yard, the more ticks that are likely to be found.

#### ***Plants Less Attractive To Deer***

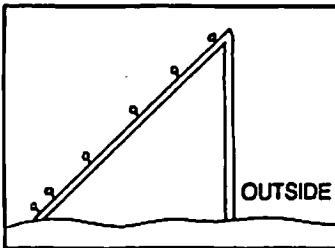
<b><u>Ground Shrubs</u></b>	<b><u>Deciduous Trees</u></b>	<b><u>Conifer Trees</u></b>
Juniper	Hickory	Leyland cypress
Rose	Horse Chestnut	American holly
Barberry	Catalpa	Colorado spruce
Forsythia	Black Alder	White spruce
Hydrangea	Black gum	Blue atlas cedar
Inkberry	Sassafras	Black pine
Rose of Sharon	Sourwood	Austrian pine
Viburnum	Sweetgum	Umbrella pine
Mountain laurel	Yellowwood	Red pine
Rhododendron		Pitch pine

One way to discourage deer activity on properties is to landscape with plant material less attractive to deer such as those listed on the preceding page. However, note that under conditions of high population stress, deer will eat almost anything.

In addition to listing those plants that deer do not like, you should particularly stay away from some of their favorites. These include Japanese yews, honeysuckle and most fruit trees (esp. crabapple).

### **Deer Fencing and Repellents**

Fencing is another way to reduce or even eliminate deer activity on a property. Moreover, new fence designs have made fencing a more feasible option than in the past. High tensile angled fences now replace the more unsightly 12' mesh fencing. A 7-wire electric fence built in a slanted style can effectively reduce deer intrusion even under heavy deer pressure. The wires are spaced at 12-inch intervals along a rail slanting up at a 45 (o) angle from the ground and away from the yard to an outside height of 4 feet. The fence covers about 6 feet of horizontal space presenting deer with a perplexing obstacle as well as a shock upon contact. To stop other small mammal intruders (raccoons, groundhogs, rabbits), add 2 more wires near ground level (one between the ground and wire 1, and one between wire 1 and 2).



#### **Installing a deer fence**

- Make the fenced area as square as possible
- Prepare the fence line by removing brush
- Use either treated wood or fiberglass posts
- Use smooth 11-14 gauge wire with 200,000 psi tensile strength

■ **Deer repellents may have a place in reducing deer frequency in particular locations.**

<b>Some Deer Repellents</b>		
<b>Product</b>	<b>Action</b>	<b>Manufacturer</b>
Deer Away	Odor	Integra (800) 468-2472
Miller Hot Sauce	Taste	Miller Chemical (717) 632-8921
Magic Circle	Odor	State College Labs (215) 921-0641 or 372-9700
Chaperone	Taste	Sudbury Lawn & Garden (602) 285-1660 x 2289
Hinder	Odor	UniRoyal Chemical Co. (800) 635-6950
Human hair	Odor	non-commercial
Tankage (dried feces)	Odor	non-commercial

Finally, deer repellents may have a place in reducing deer frequency in particular locations. By eliminating certain individual food plants in the environment from their daily diet, deer may simply seek their dinner elsewhere. Then they become someone else's problem. Some deer repellents work by creating an odor obnoxious to deer while others produce an offensive taste when deer eat treated vegetation. Both types have limitations; how much plant material must be eaten before deer get the idea and what is the sphere of influence of odor-based repellents. In addition, both types wash off so that repeated applications are necessary. For these reasons, repellents are not likely to work as effectively as fencing or as simply removing the plants attracting deer in. Moreover, you may want to consult experts in the most effective use of various deer repellent products.

### ***Discouraging Small Mammals***

In addition to discouraging deer on a property, it ***is also good to discourage high densities of certain small mammals***. Having 10 - 20 mice and 4 - 6 chipmunks is about average for the typical suburban one acre property. Of course, these densities fluctuate seasonally and vary greatly from property to property. However, the more small mammal reservoirs that are present on a property the greater the opportunity for larval ticks to become infected. Any landscape feature or condition that promotes high densities of these small rodents will only increase Lyme disease risk if deer ticks are also present.

■ ***Any landscape feature or condition that promotes high densities of small rodents will increase Lyme disease risk if deer ticks are also present.***

By thinning vegetative cover and creating "openings" in the upper and lower vegetative canopy, these animals will feel less secure whenever they come out of their burrow sites (they live in constant fear of being eaten!!).

They also prefer the security of moving along side of something (foundation, rockwall, fallen tree). Opening up the canopy in such areas and removing whatever rodent cover you can will serve to keep the little varmints moving along to "safer" environs elsewhere. A well shaded, brush-enclosed rockwall is a secure haven that will support high densities of mice, chipmunks and other small rodents. Opening the vegetative canopy can only help!

■ ***The narrower the wooded buffer or the greater degree to which it is cleared in the understory, the less it will support animal activity and tick survival.***

From the discussion so far, it may sound like the only tick-safe yard is one that is paved over or that is stuck in the middle of a football field. In order to reduce suitable tick habitat, some people do choose to renovate large portions of the wooded or brush-covered habitat, changing it into open lawn. This will certainly discourage animal activity and reduce tick survival. Much of this brush-clearing work is best done in the winter months, when tick activity is normally low. However, if the temperature is above about 40°F, remember to check for ticks at the end of the day.

Property borders with wooded buffer zones are another problem area. In most suburban areas, it is usually desirable to have a vegetative screen between neighboring properties, but these areas often support all kinds of animal activity. Vegetative buffers also produce the leaf-litter and vegetative cover required by ticks for their survival. The narrower the wooded buffer or the greater degree to which it is cleared in

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the understory, the less it will support animal activity and tick survival. Pushing the buffer to the property line and replacing it with lawn will definitely reduce the amount of tick habitat. To maintain an effective screen, you may want to consider evergreen hedges (pine, spruce or other plants not attractive to deer) that are pruned at the base to give about one foot or so clearance above the ground. This type of border will provide the most privacy and the least tick habitat while still using vegetation.

Large open expanses of lawn can be broken up by planting individual shade trees (remember to avoid those most attractive to animals). Small clusters of shrubs or vegetative islands are OK (smaller is better). These vegetative islands should be small enough or arranged in such a way as to discourage rodent "colonization" or other activity. An isolated patch that doesn't meet the animals' every need for food and cover will support only limited activity. That is why it is best to select shrubs that are not too compact and that do not grow close to the ground. The spacing of plantings within vegetative patches is also important. The more open you can leave it, the less suitable it will be for ticks as well as animal hosts.

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### ***Plant Selection***

Unfortunately there is no list of plants that would repel ticks or their animal hosts. This is one aspect of deer tick management requiring much more research. Even though our suggestions here are based more on anecdotal field observations than on scientific data, the reader may find this somewhat helpful as a general guide.

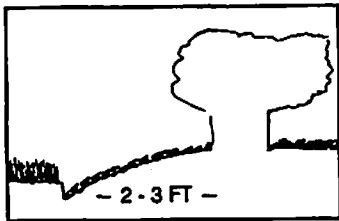
Evaluating plants and plantings for their growth form, their degree of maintenance required (most of us do not do enough maintenance) and their attractiveness as deer food, will be the best bet in selecting plants for the tick-managed yard. In considering plants for use in the landscape, it is probably best to choose those that can be pruned away from the ground or those that grow in a more upright manner (as opposed to being bushy). As an example, clumps of ferns rarely have many ticks or much animal activity. The same cannot be said for clumps of day lilies; ticks have often been collected along the edges of gardens brimming with these perennials (probably due to the way the leaves bend over onto the ground, providing close animal cover and humidity for ticks). Rhododendron beds free of leaf litter rarely are ticky whereas overgrown rockgardens and plantings along rock walls are more likely to harbor ticks.

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### ***Edging and Mulching***

On a baseball field, when the outfielder crosses the warning track he becomes aware that he might soon crash into the outfield wall. The track warns him that he is moving from the safety of the playing field into an area where he may get hurt if he is not careful. We can do something similar in Lyme disease prevention. Here, the open lawn is relatively tick-free while ticks are much more abundant at the lawn edge where shrubs, or brush, or woods begin. We can create a "warning track" using the basic landscaping technique of edging and mulching.

When planning to use this strategy, you must discuss with your client that the warning track is there as a constant reminder to him that his property is divided into two types of areas when it comes to deer ticks; zones of relative tick safety and tick-dangerous areas. Use edging and mulching wherever possible to demarcate the tick danger areas. Then, whenever family members cross this boundary, they need to remember to check for ticks (Chapter 6). This system is not foolproof by any means; people will still get ticks — from wandering pets, from the occasional stray tick, or by incidentally crossing the barrier without realizing it.



**Mulching**

Cutting an edge will define the line between the lawn and the shrub bed, flower garden or woods. Edges can be cut either by hand or by using a power edger. The distance that the edge is cut away from the brush line depends somewhat on the nature of the adjacent vegetation. As a general rule, cut the edge about 2-3 feet from the drip-line of the closest vegetation.

Next, pull out the grass and the grass roots in the direction of the shrubs. While you are down on your hands and knees, consider clearing other leaf debris from under shrubs and bushes. Discard all debris in a compost pile or better yet, carry it off of the property.

After clearing the bed, you are ready to rake it smooth and put down the mulch. The type of mulch used and the way it is applied may be determined by what plant material is being used, and it may have an impact on how tick-free your border will become. The standard mulching materials used in landscaping include a variety of woodchips (oak, pitch pine, cedar) or different grades of bark mulch. Wood chips tend to tie up nitrogen as they decompose and so may not be suitable in flower gardens or areas where plants have shallow roots. Try to use a mulch that is of uniform size and one that provides good air circulation to the top layer of soil. Small-sized chunks may be better than oversized pieces, mainly to avoid adding cover for small mammals.

The type of mulch selected may also depend on whether you intend to apply any of the recommended habitat-targetted acaricides (Chapter 5). With appropriate application the mulched bed can become a relatively "tick-free" zone buffering the perimeter of lawns or open spaces. Again, a uniform-sized mulch will permit a more even and thorough application of either liquid or granular acaricide. Give some consideration to how much of the active ingredient will adsorb to the organic matter in the mulch. This may also influence your selection of materials -- both of the mulch and the acaricide.

We recommend using no more than 1.5 to 2 inches of mulch on top of garden soil. This amount is also ideal for most shrubbery. Remember not to bury lower branches of shrubs; it's harmful to the plants and can create micro-environments for rodents.

Finally, instead of using mulch, some people like the earth look and that is ok, too. If you decide to go with bare soil, maintaining the edge and keeping the bed free of weeds and leaf debris is very important. However, you may have to water more often to keep the plants healthy.



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## **Other Landscape Management Tips**

- ***When mowing lawn edges, direct discharge into shrubbery rather than lawn.***
- ***Clean up old wood storage and junk piles.***
- ***When using power blowers, blow leaf litter and other plant debris out from under shrubs, then rake and remove.***
- ***Position bird feeders away from rodent habitat.***
- ***Keep large beds of weeds or fallow areas mowed,***

When mowing lawn edges, always direct the discharge into the shrubbery rather than into the lawn. Ticks lurking along unmaintained edges can be displaced into the lawn where an unsuspecting family member may be more likely to contact it. An even better suggestion is to bag all clippings and discard them into a compost pile well away from family activities.

Clean up old wood storage and junk piles. These areas are not only unsightly in the yard but they provide excellent cover for rodents. Moreover, neatly stacked piles will be easier to treat with either host-targetted or sprayed acaricides (but we don't recommend spraying firewood).

When using power blowers to blow material from the lawn, the tendency is to accumulate more leaf litter on or near the lawn edge. Better to blow material (leaf litter and other plant debris) out from under shrubs, then rake and remove. When disposing of yard wastes, consider composting or complete removal from the property. It is never a good idea to just shift tick habitat from one place to another, unless you are moving it well away from all human and pet activity.

Bird feeders should be positioned away from rodent habitat. Loose seed should be cleaned up. Cease feeding birds by April and don't start again until after larval tick activity has died down (October/November).

Keep large beds of weeds or fallow areas mowed, at least roughly. If you plan to reclaim areas left fallow for longer than a year, be sure to apply an acaricide to that habitat during the first tick season. You may have removed the cover, but probably did not remove all of the ticks that were there.

# Chapter 5

# Targetted Chemical Control

## Host- and habitat-targetted applications of acaricides

### In this chapter:

- Defining host- and habitat-targeting of acaricides —
- The Damminix<sup>®</sup> system —
- Proper application techniques for host-targetted acaricides —
- What, when and where to spray —
- Safety issues —

**■ To provide the most comprehensive, and most effective prevention against Lyme disease, we recommend the careful use of selected acaricide formulations in most deer tick management programs.**

Since the advent of DDT, man has relied on synthetic pesticides to rid himself of all types of pests. And despite all of the negative publicity we hear about these compounds, they can and do work. But when misused or overused, problems can and do develop.

Borrowing concepts from Integrated Pest Management theory, Integrated Tick Management, attempts to get away from widely broadcast acaricide applications, instead attempting to find alternative means for limiting tick populations in the backyard landscape. Still, to provide the most comprehensive, and most effective prevention against Lyme disease, we do recommend the careful use of selected acaricide formulations in most deer tick management programs.

There is a growing reluctance on the part of homeowners to resort to wholesale drenching of lawns and shrubs with pesticides, including tick killers. Studies have shown that spraying alone is not the best way to substantially reduce deer ticks throughout the entire yard; methods are now available that increase efficacy and are more acceptable to clients. Some people at risk for Lyme disease are totally opposed to the use of broadcast insecticides. Integrated Tick Management can save the day and your business. Tick surveillance (Chapter 3) can tell you where the ticks most likely occur on a property. For the most part, whole lawn treatments are not even necessary (there are virtually no ticks in the middle of a lawn). Limiting acaricide spraying to edge and border treatments in selected habitats will allow you to greatly reduce the amount of active ingredient applied. This should be a big selling point. Even better, a new acaricide has been formulated so that you can direct even smaller amounts of tick toxicant right onto those wild animals which produce most of the Lyme disease-infected ticks--white-footed mice. Now you can get those varmints to work for you. Combining host- and habitat-targetted strategies allows you to sell both the most effective and environmentally-compatible chemical control of deer ticks to your clients. But efficacy is application-sensitive. This means that you have to do the applications correctly in order to get the results your client will expect.

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## **What Is Host- and Habitat-Targeting**

- ***By habitat-targeting your spray or granular application, you are making educated decisions as to where your efforts and the active ingredient will be best spent.***

The theory of directing insecticides onto particular hosts for the purpose of killing their "bugs" is not all that new. Impregnated ear tags have been used on cattle, flea collars on dogs and cats and baited dust tubes for wild rodents to control plague-carrying fleas. The first requirement in designing a host-targeted strategy is to determine if there is a key host that warrants such special attention. Luckily, in Lyme disease there is! We have already discussed how white-footed mice serve both as important sources of tick bloodmeals and as principal reservoirs for the Lyme disease bacteria (Chapter 2). By killing the immature ticks feeding on mice, overall tick abundance will be somewhat lowered. But more significantly, the abundance of ticks infected with the Lyme bacteria will be reduced to an even greater extent.

Habitat-targeted applications of acaricides for controlling deer ticks is an idea that comes directly from Integrated Pest Management theory. In IPM, surveillance (monitoring) identifies particular plants at risk, and then appropriate treatment is directed to those plants when it is needed. The same holds true in ITM.

Using your tick surveillance information, and discussions with your clients, you should have a good idea where on the property people will be exposed to deer ticks. Most likely the risky "habitat" will be on the perimeter of lawns, along trails through the woods to brush piles or neighbors, in garden plantings, rock gardens, rock walls, etc. "Habitat" refers to either tick or animal habitat.

If you know that deer bed down in a particular area, that may be a target for treatment. Rockwalls and woodpiles harbor rodents and are other habitats that should be targeted (you may choose to use host-targeted products in some of these particular habitats, especially firewood piles). Instead of treating everything in sight, by habitat-targeting your spray or granular application, you are making educated decisions as to where your efforts and the active ingredient will be best spent.

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## **DAMMINIX® — Host-Targeted Deer Tick Control**

Damminix® is a host-targeted acaricide that is active against larval and nymphal ticks associated with rodents. Developed by scientists working at the Harvard School of Public Health, it consists of cardboard tubes filled with cotton that has been impregnated with permethrin (7.4%) Damminix is patented and marketed by EcoHealth, Inc.





**Likely Tick Production  
From Mice On  
Untreated Property**

15 ticks/day  
X 120 days  
X 18 mice/acre =

**32,400 mouse-derived  
ticks/acre\***

\*ticks are not distributed evenly  
across the acre

Although mice are the source of Lyme disease, by using Damminix they can also become part of the solution. Remember that deer ticks are not infected with Lyme bacteria when they hatch from eggs, but become infected by bloodfeeding on infective small rodents (principally mice). Damminix works by killing ticks feeding on these rodents, especially mice. Normally, ticks derived from mice pose the greatest Lyme disease risk to humans.

Mice find the cotton in Damminix tubes to be superior to their natural nest-making materials. When they find a tube full of cotton, they greedily collect the fluffy balls and line their nests with it. In many of the regions where Lyme disease is a problem, each mouse, on average, is infested with 10-20 ticks daily (May-September). But all of those ticks that infest mice with Damminix-lined nests will be killed. Considering that an average 1 acre residential property may have 15-20 mice, if they all have treated nests, it can add up to a lot of dead ticks. In addition, Damminix does not harm the mice or predators of mice.

One additional note. Because mice are fairly territorial, they forage over a limited range. Applying Damminix in one yard will serve to expose all of the mice frequenting that area to treated cotton, even if they live in adjacent yards. By treating individual yards, you begin to reduce the number of mouse-derived ticks in the entire area even if neighboring properties have not used Damminix. However, much like an out-of-town relative with a cold coming to visit, tick-infested neighboring mice may occasionally frequent the treated yard and leave some ticks behind. However, if they take treated cotton back home as a souvenir, eventually many of the mice even 1 or 2 properties away will be tick-free as well. In selling this type of treatment you should stress that the best results will be achieved (for everyone), and will be achieved sooner, if neighboring property owners would participate in this part of the ITM program. Studies have shown how effective community-wide programs with host-targetted control can be.

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## **Proper Damminix Application Techniques**

**As with most things, if you expect them to work you have to do them right.** That goes for applying Damminix to control deer ticks. Product efficacy is application sensitive. If the mice do not find the cotton, no ticks will be killed. In order to apply Damminix correctly, pay special attention to the next few paragraphs. Basically, to apply it right you have to start to think like a mouse.

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## **Timing and Rate of Application**

■ **For best results, make 2 Damminix applications annually—Spring and Summer!!**

■ **If 100% of an acre is suitable mouse habitat, then Damminix is applied at a rate of 48 tubes per acre. This means that less than one ounce of active ingredient (0.6 oz) is applied per acre when using Damminix.**

In the northeastern and midwestern U.S., it is recommended to apply Damminix twice per tick season; once in the spring or early summer, when nymphal ticks are actively bloodfeeding on hosts, and once in the late summer, when larvae are active. We recommend that the spring application be made between April 1 and June 15. Applicators in the more southern latitudes (ie. MD, DE, PA, NJ) should aim for the early end of this spectrum, while further north (ie. RI, MA, WI, MN) applications could safely be delayed until early May. The summer application can be done between July 15 and September 15. Again, make the application on the early end of the range the further south you are. The summer application is crucial to the success of this tick-control strategy. Mice are more plentiful by late summer and much nest-building takes place. In addition, larvae are at their feeding peak during August and it is these larvae that become the next year's nymphs.

Applications of Damminix to control the Western Black-Legged Deer Tick (*Ixodes pacificus*) should also be made at least twice a year. Because the activity periods for immature stages (larvae and nymphs) of this tick overlap it is probably best to make the Spring application in March or April and the Summer application in July.

The proper number of tubes to apply depends upon the amount of suitable mouse habitat. If 100% of an acre is suitable mouse habitat, then Damminix is applied at a rate of 48 tubes per acre. This means that less than one ounce of active ingredient (0.6 oz) is applied per acre when using Damminix. To determine how much is needed for a given property, start with the total acreage but remember to reduce the number of tubes used depending on how much of the habitat is not suitable for mice (see below.) If the property is full of rockwalls, woodpiles or other features supporting dense rodent populations, plan to use 10-20% more tubes on that particular job.

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## **How Much Damminix To Apply**

If the property is one (1) acre total, the area taken up by the house, driveway, other paved areas, lawn, etc. should be excluded from the total area of mouse habitat. In general, the average one (1) acre residential site has about one half an acre (0.5) of mouse habitat. Thus, you would need about 24 tubes for each application or a total of 48 tubes annually (two applications).

Larger properties often have more mouse habitat; two (2) acre residential sites may have 1.25 - 1.5 acres of treatable area. On properties much larger than two acres, help your client decide on specific areas to protect and then treat around this area thoroughly. (Remember to include a 20 - 30 yard treated "buffer" zone around the protected area). You can also recommend reducing or isolating "excess" habitat.

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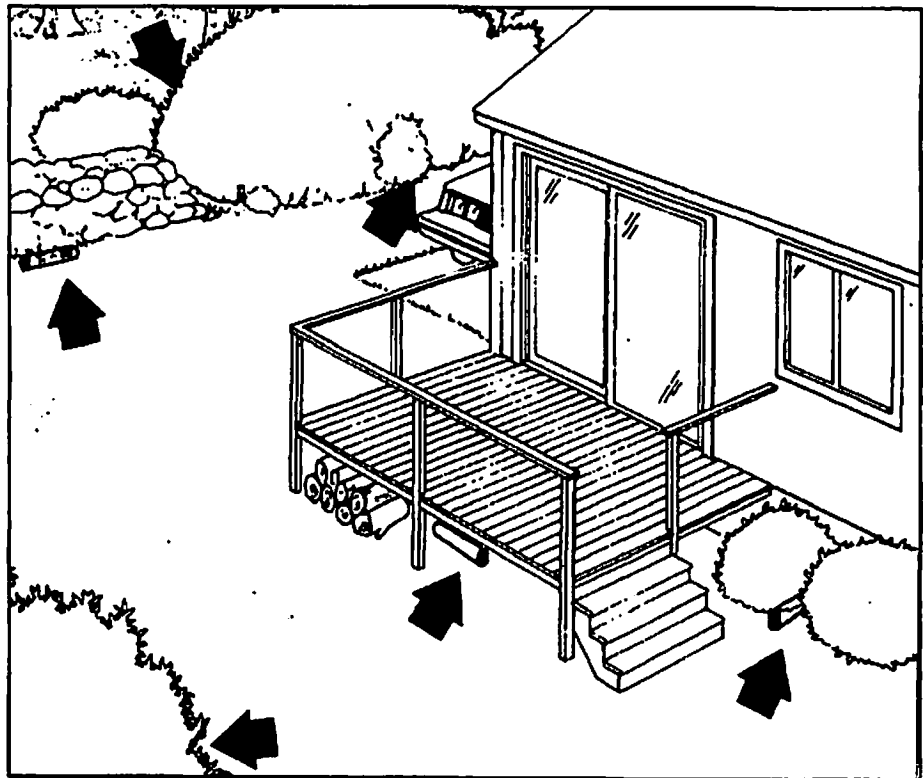
## Applying Damminix

"Think like a mouse!" That's the rule for applying Damminix. Proper application of Damminix is based on the habits of white-footed mice. For the product to work, mice must find the cotton. They will only find it if you put the tubes in areas that they frequent. How often will you drive miles out of your way for special treats? In addition, there is no "magic" attractant to the tubes, so you must also place them in settings where mice will feel secure about investigating them.

Place the tubes in mouse habitat. That includes woods, brush, under bushes, in flower gardens, along rockwalls, in woodpiles, brushpiles, near compost, garden sheds, etc. Mice rarely go into open areas, lawns, sparse planting beds and the like. When placing the tubes, you want every mouse to find at least one. Space the tubes 10 yards on center and that should be close enough. Exact measurements are not important. In some settings, making a grid design may be helpful. Unless the ground cover is very sparse (such as under pine plantings), it is not a good idea to leave much more than a 10 yard distance between tubes; you risk missing the normal travel routes of some of the mice. However, you can put them a little closer than 10 yards, especially if the habitat looks like it supports more mice (rockwalls, etc.)

■ "Think like a mouse!"

■ For the product to work, mice must find the cotton.



**Damminix Placement Chart**

In deciding where to place a tube at each 10 yard interval, consider where a mouse would feel most secure. Because they must continuously hide from predators, select sites that are a few inches from the base of trees, walls, foundations, fallen logs, etc. as opposed to areas without such cover. The tubes should lie flat on the ground and at the base of things like brushpiles, rockwalls, woodpiles, etc.

.....

■ **Remember, if tubes are empty, place the new tube in the same spot; if full or nearly so, reapply fresh tubes, but shift the location or placement slightly.**

Because mice like their bedding dry (who doesn't?), select sites out of rain gullies, marshy areas or particularly low spots that flood after heavy rains.

One particular aspect of applying Damminix has been confusing to many past users. When re-applying Damminix, if tubes from previous applications still have cotton in them, always place the new tube at a slightly different location but in the same vicinity. A tube full of cotton indicates that mice did not find the tube. This may be because mice were not abundant at the time, or because of poor tube placement. Conversely, an empty tube indicates mouse activity; replace an empty tube whenever it is noticed, or at least at the time of the next application. Remember, if tubes are empty, place the new tube in the same spot; if full or nearly so, reapply fresh tubes, but shift the location or placement slightly. ***A complete Damminix specimen label is provided in the Appendix.***

***Damminix Application Summary***

- Think like a mouse when placing tubes.
- Apply in spring and summer.
- Use enough to buffer the area to be protected by 20-30 yards.
- Reapply (in a different spot) even if old tube still has cotton.

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***Habitat-Targetted Acaricides***

On some properties it may be desirable to spray portions of the lawn edge or planting beds to achieve rapid reductions in tick abundance in those high exposure areas. Although ticks on lawn areas represent just a small (about 2%) portion of the ticks infesting most properties, human exposure to deer ticks in those settings may be higher than to ticks found back in the woods. As with any pest control program, it is best to consult with the client to discuss control objectives and methods as well as the materials to be used.

There are a variety of insecticides that can be used against deer ticks. Moreover, they come in both liquid or granular formulations. Among the most popular are carbaryl, chlorpyrifos, and diazinon as well as several pyrethroids, including permethrin, cyfluthrin and fenvalerate. Liquid formulations may give a quicker knockdown than granular, but granules penetrate better through foliage and leaf litter placing the acaricide closer to where deer ticks are lurking. The applicator's choice will depend on factors including:

- The type of habitat to be treated
- Environmental impact
- Regulatory issues (is a product registered for use in a particular location or habitat)
- User familiarity and experience with the compound

Two recommendable products are a pyrethroid called **Tempo2 Insecticide** (cyfluthrin) marketed by Miles and **Dursban\* Insecticides** (chlorpyrifos) marketed by DowElanco. The product descriptions and guidelines for use are those recommended by the manufacturers. However, in an ITM program where the product is being targetted in space and time, it should be possible or even desirable to apply these chemicals less often. Accordingly, we also make suggested use patterns for these products in an ITM program. Specimen labels are included in the Appendix.

**TEMPO2®  
Description**

Tempo® is an advanced generation pyrethroid insecticide which is highly effective against a wide range of pests at extremely low application rates. Tempo2 is a liquid formulation containing 2 lbs. of active ingredient per gallon. It is designed to be mixed with water and to be applied using conventional spray equipment. ***The product will give quick tick knockdown on lawns, lawn edges and along trails, and has proven effective against deer ticks in such settings.***

**DURSBAN\*  
Insecticides**

Dursban\* insecticides contain the organophosphate chlorpyrifos, which also controls a very broad spectrum of insects and ticks. Dursban insecticides are available as emulsifiable concentrates, wettable powders, dry flowables and granular formulations. The various formulations allow for treating a number of different habitats, such as turfgrass, shrubs and heavily vegetated areas. ***Liquid, WP and DF formulations give rapid knockdown of ticks on turfgrass while granular formulations penetrate denser vegetation on the perimeter of lawn edges and walking trails.***

**When and  
Where To Spray**

- **First Application—  
Mid- to late May**
- **Second Application—  
Late June or early July**

***Timing of the application is critical when using liquid and granular acaricide formulations to control deer ticks.*** Manufacturer recommendations suggest making four applications per year -- Spring, Early Summer, Late Summer and Fall -- to coincide with the activity periods of each stage of the deer tick. In ITM, we recommend just two applications of habitat-targetted spray or granular insecticide.

In your ITM program, the first habitat-targetted application should be made in mid- to late May, to coincide with the season when hungry nymphal-stage deer ticks are rapidly increasing their activity. Moreover, in May people begin spending more time outdoors in their yards increasing exposure of themselves and their pets to ticks.

A second application should be made in late June, or at least by early July. Nymphal tick activity as well as human exposure to nymphs reach a peak in late June. Moreover, the killing effect of the first application will be waning by this time.

Tempo® is a registered trademark of Miles, Inc.  
Dursban® is a trademark of DowElanco.



.....  
■ **Spray until wet—  
shaded lawns and  
lawn edges surrounded  
by bushy vegetation  
or woods.**

■ **Spray until drip—  
lower branches of  
ornamental plantings.**

In ITM, both Tempo2 and Dursban\* are to be used in specific habitats. Tempo2 is applied at a rate of 4 ml per 1,000 square feet. To treat 1,000 square feet, mix 4 ml of Tempo2 with about 4 gal of water. Apply the mixture to tick-infested habitats or tick-free zones including: mulched or unmaintained edges, trails and beneath bushes. On shaded lawns and lawn edges surrounded by brushy vegetation or woods, spray until wet. On lower branches of ornamental plantings, spray just until drip. Do not spray acaricides onto firewood (use host-targetted tick control in this setting). Moreover, insecticide applications may not be needed in areas where the lawn is wide open and exposed to full sunlight. Such habitat is less hospitable to deer ticks and their hosts.

When using Dursban\*, apply EC, WP or granular formulation to lawns and lawn edges, and granules to denser vegetation where foliage or leaf litter would block penetration of a liquid spray. **Cover thoroughly.**

Remember that in ITM you are only applying these sprays to certain habitats. If the total property size is one acre, the total volume used should be much less!

In the first year of any tick management program, you may want to add a third application in October or early November (preferably after a frost or two) to hit adult ticks questing on brushy vegetation. Ideally, you want to spray after leaves have dropped from bushes so that questing adult ticks will be exposed. However, there is a trade-off between the risk of exposure to adult ticks (which begins about mid-October) and waiting for the time to make the most effective spray application (early November). In making this application, it is best to spray on a day where temperatures are above 40 (o)F (ticks will be active). **Liquid formulations (Tempo2, Dursban\* EC or WP) should be directed to shrubs and lower vegetation on lawn perimeters, gardens or along trails, and to a height of about 3 - 4 feet.** This application should not be needed in subsequent years, since your other strategies (both host- and habitat-targetted products) should have reduced the number of successfully blood-fed nymphal ticks on the property.

When applying Tempo2 or Dursban\*, use conventional spray equipment with moderate pressure. **Make sure that the area being treated is covered thoroughly.** Because the ticks you are trying to kill with this strategy are likely to be within 3-4 ft. of an edge (see description of edge-Chapter 3), we recommend limiting spray applications to those areas. The deer ticks in wooded habitat are largely protected from sprayed-on acaricides because they hide beneath leaf litter.

When spraying any insecticide, remember to:

- **AVOID DRIFT, ESPECIALLY AROUND WATER.**
- **ALWAYS READ AND FOLLOW LABEL DIRECTIONS CAREFULLY.**

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## **Safety Issues**

- ***With ITM, you are recommending less chemical and you are using it in a very targeted manner. Of course, proper application is still required to minimize danger to humans.***

Applying any pesticide to the home environment usually raises client concern. But here is where the ITM program can save a sale. With ITM, you are recommending less chemical and you are using it in a very targeted manner. Of course, proper application is still required to minimize danger to humans and the environment. Here's what you should know about the products:

Host-targeted Damminix has an extremely low mammalian toxicity. The oral LD(50) is greater than 5,000 mg/kg. and it is completely metabolized and excreted so there is no chance of contaminating the food chain. Small children or pets would need to eat more than 1800 cotton balls in a single dose to reach 5,000 mg/kg. Because it is targeted, it has little to no impact on non-target organisms. Moreover, because the active ingredient is bound to cotton fibers and is not water-soluble, there is no potential for contamination of groundwater or other water supplies.

When applying Damminix, there is no special protective clothing required. Tests for skin irritation placed Damminix as a non-irritant. The product may cause minimal eye irritation, but due mainly to the abrasive nature of the cotton balls. Nevertheless, always wash your hands immediately after applying any pesticide.

The Damminix cardboard dispenser tube and cotton is completely biodegradable making it unnecessary to pick up and discard used tubes. However, for greater client satisfaction, remove any empty tubes and discard them in the trash.

Applying any liquid or granular pesticide requires a degree more caution. With liquid applications, always allow them to dry thoroughly before re-entry into the area. Be especially careful if applying near open bodies of water—including decorative fish ponds. Wear gloves and eye protection when mixing the chemical with water. It is a good idea to wear the gloves and goggles while applying the acaricide, too. Never eat, drink or smoke while applying pesticides, and remember to wash skin and clothing after applying them.



The next step is to make sure that the ticks stay on the outside of your clothing for as long as possible, where they will either be brushed off by normal activity or can be seen and removed. The best way to do this is to tuck your pant cuff into your socks. If you don't, any attacking tick is likely to move up your leg on the inside of your clothing, attaching in less than obvious spots (often behind the knee or in the groin or waistband area). Keeping your shirt-tail tucked in as well is also helpful. The best clothes for children will be those with elasticized cuffs on ankles and wrists.

Continually monitor (every few minutes) legs, torso, arms, etc. for ticks (or little specks of dirt) that are crawling upwards and remove them when first spotted. If you wait even a few minutes, you may find that the tick has disappeared and the next time you see it may be after it has attached. Keeping a small roll of sticky tape in your pocket for removing crawling ticks keeps you from having to deal with the same tick a second time and may be useful in monitoring tick activity on a property (to the client--"...see, I removed 3 ticks just walking around your property").

## Repellents

Insect repellents, if applied properly, can enhance the effect of protective dressing and help prevent tick bites. Several active ingredients are useful as repellents against deer ticks; the most widely used are DEET (found at various concentrations in Off products, Cutters, Tick-Guard, etc) and PERMETHRIN (found in Permanone® Products containing about 38% Deet or 2% Permethrin are recommended. In the case of tick repellents, more of the active ingredient than this is unnecessary, and can even lead to chemical overexposure.

- Always use chemicals, even repellents, according to directions on the label.

<u>Chemical Name</u>	<u>Action</u>
PERMETHRIN	rapid knockdown/tick mortality
DEET	repels ticks
M-1960	"
DIMETHYL CARBATE	"
DIMETHYL PHTHALATE	"
INDALONE	"
BENZYL BENZOATE	"

## How To Use Repellents Against Ticks

- Spray clothing, shoes, socks and pants.

As already stated, repellents do work against deer ticks but they work best if used correctly. To repel ticks, spray clothing, especially shoes, socks and pants. Even though products containing DEET (such as Deep Woods Off, TickGuard, Cutters) can be applied to skin, **those containing permethrin (Permanone) should only be applied to clothing (read the label!)**. Nevertheless, all formulations of repellents work best and longer to fend off ticks when they are applied to clothing. And Permanone can remain active through several clothes washings (so constant reapplication to the same clothes is not recommended). New, microencapsulated formulations (Skeedaddle)

not only may extend the length of protection, and according to the manufacturer may be milder for use on skin.

Many people have the idea that if a little repellent works, a lot will work better. This kind of thinking is wrong and can cause health problems. Repellents are not completely benign--some even melt plastic. ***So never use more than a lightly-applied spray, and always wash hands after applying.***

### ***Become Tick-Aware***

Sure, you could avoid deer ticks by becoming a couch potato or by never leaving your deck or driveway. However, we do not advocate giving up gardening, hiking or other activities just because you may pick up a tick. We do advocate adopting new habits that will help you to live with the deer tick plague.

Learn to classify the landscape and your homescape in terms of their degree of tick exposure risk; start to recognize areas of lower and higher tick exposure risk, and adopt an appropriate behavior and pattern of habits for each type of area. For example, when you carry brush back into the woods, check for ticks when you come back out. When weeding the flower garden, check your arms and legs every few minutes for ticks. Keep children out in open areas of the lawn and discourage activities in the wooded or brushy edges. Institute careful tick checks of all family members after outdoor activities. Make these habitual:

- Perform regular tick checks.
- Plan major activities involving tick habitat (clearing, etc.) for tick-free times of the year.
- Do activities in ticky areas during the driest parts of day.
- Restrict childrens' activities to managed areas or those less likely to harbor ticks.

We can't all move away from deer ticks, but we can change our way of thinking and acting to include dealing with them!

### ***Protecting Pets***

Pets, especially dogs and cats, can be an added source of risk for human exposure to deer ticks. Even if family members never go into tick-infested areas, pets may; and they can also carry ticks back into the home environment. Questing ticks have difficulty in penetrating the thick fur of cats and dogs when finding a place to bite. That means that the ticks will walk around for longer periods on the outer fur, and may happily crawl onto some other smoother surface if presented the opportunity. Who's at risk? The cat owner who picks up Muffy after she has just come in from stalking mice (in edge habitat) could be the unwitting recipient of any deer ticks Muffy carried in. Or the dog owner who sits down to watch TV with Buster after he has romped in the park.

Fortunately, there are a several strategies to employ that will neutralize the impact that pets may add to the risk of tick exposure.

- Keep pets either inside or outside during tick season.
- Use pet products to reduce tick exposure (collars, dips, sprays).
- Groom pets carefully after exposure.
- Limit pet to confined outdoor space and reduce tick abundance in and near that space (see Chapter 5).
- Adjust your habits regarding pets (keep out of human living, sleeping areas; make tick check after pet exposure).

### **Daily Monitoring (Tick Checks)**

We have already mentioned about conducting daily tick checks. As described in Chapter 2, the Lyme disease bacteria is not usually transmitted from tick to host during the first 24 hours after tick attachment. That means that prompt tick discovery and removal can minimize risk for infection.

The best time to do a tick check is right after ending outdoor activities. Remove all clothes and either seal them in a plastic bag or throw them directly into the dryer. Ticks cannot survive a 15-20 minute tumble in dry heat. (It is best not to mix field clothes with the rest of the family laundry unless they have been run through the dryer first). Then check all over for ticks — or have someone else help you check. It is best to stand in a well-lighted area for this activity. With some practice and strategic use of a mirror, it is possible to check yourself.

■ **Prompt tick discovery and removal can minimize risk for infection.**

<b>Where To Especially Check For Attached Ticks</b>	
■ Behind knees	■ Back and shoulders
■ Under arms	■ Hairline
■ Groin area	■ Head (particularly with children)
■ Waistband on trunk	

These are the most common areas where deer ticks are found. However, remember that ticks can be (and have been) found anywhere, so be sure to check the entire body.

### **How To Remove Deer Ticks**

■ **When removing deer ticks, there really is only one "best" way to take them off — PULL THEM OUT.**

Despite all of the precautions, there may come a time when you or your client finds an attached tick. And just about everyone has their own special way for removing biting ticks. Many of the most common "folk" methods for tick removal, such as touching the tick's back with a hot match or suffocating the tick under a layer of vaseline, seem to seek a degree of revenge against this unwanted parasite. Unfortunately, none of these "get even" methods work well against deer ticks. With deer ticks and Lyme disease, you just may become infected while trying to get even.

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***When removing deer ticks, there really is only one "best" way to take them off—that is to PULL THEM OUT.*** Simple enough, but let's go back a step and do the "job" right.

Research has shown that prompt removal of infected deer ticks can prevent transmission and infection. In these studies, prompt removal seems to mean about 24 hours in the case of nymphal ticks and 36 hours in the case of the adult stages. When removing the tick however, remember three points:

- The biting tick has made a hole in your skin.
- If the tick is infected, ripping it open could spill bacteria onto the skin and into that hole.
- The longer you wait to get it off, the better the chances of becoming infected.

Keeping these points in mind, we recommend following the procedure listed below each time you remove a deer tick:

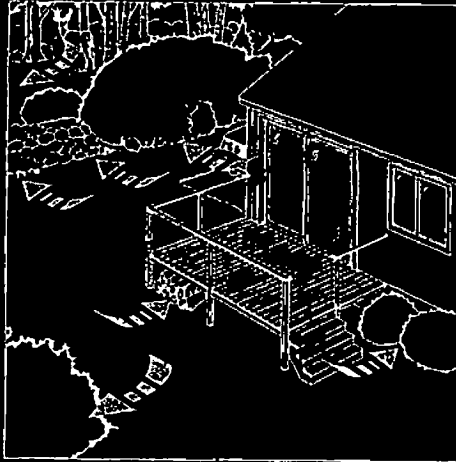
- Wipe area around tick with alcohol swab.
- Grasp tick firmly with fine-pointed tweezers as close to skin as possible.
- Pull straight out in one single motion.
- Rewipe the bite site with alcohol swab.

We also recommend saving the tick and noting down on a calendar the day and location of the bite. This information could come in useful at some later time. Many people save their ticks by attaching them to an index card with clear adhesive tape. All of the pertinent information can be recorded on the card for later reference. You may want to suggest that your clients save ticks that they find. This will serve as a means of passive surveillance. Also, a person with a tick is likely to be a motivated ITM client. You can offer to have the tick tested to see if it was infected.

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### ***Testing Ticks For Infection***

Since we advocate saving all of those biting ticks, we also need to tell you what you can do with them. Few people or groups have the expertise or equipment needed to identify nymphal and adult deer ticks. However, there is a commercial service that will identify and test ticks—even dead ticks—to determine whether they are infected with the Lyme disease bacteria. Much like performing a radon test, you or your client can purchase mail-in kits and submit tick samples to a professional tick-testing laboratory for identification and analysis. The test is based on new technology that detects the presence of bacterial DNA in the tick, even in tiny amounts. Studies have shown that this method is very accurate and results are usually returned within 7 to 10 days. In a few areas, state or local health departments also may offer similar services, but be wary of lengthy reporting delays. Just as if it were your own, once you take someone's tick for testing, they want to know right away if it was infected.



# Tick Tubes



**Easy to use.**  
Apply once in the spring  
and once in the summer.

*Place in brush, woodpiles, rock walls and flower-beds.  
Do not treat lawns - most ticks do not live on lawns.*

## USE AS AN AID IN THE CONTROL OF LYME DISEASE CARRYING TICKS.

**DAMNEXIN® A TICK TOXICANT** As an aid in the control of ticks (that may carry Lyme Disease) that infest mice and nests of mice found around yards, play areas, parks, brush, packs, and in woodlands.

EPA Reg. No. 56783-1

EPA Est. No. 5693 MA1

**ACTIVE INGREDIENT:**

+\* Permethrin ..... 7.4%

**INERT INGREDIENTS:**

..... 92.6%

**Total 100.0%**

\* O-phenylphenyl methyl (+A) cis/trans 2-2,2-dichloroethoxy, 2,4-dimethylcyclopropane carboxylates.

† Cis/trans ratio: Min. 35% (+A) cis and max. 65% (+A) trans.

### CAUTION: KEEP OUT OF REACH OF CHILDREN

Statement of Practical Treatment

**IF SWALLOWED** - Contact a physician or Poison Control Center immediately.

**IF ON SKIN** - Remove contaminated clothing and wash affected areas with soap and water.

**IF IN EYES** - Flush with plenty of water. Call a physician if irritation persists.

### DIRECTIONS FOR USE:

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

**FOR OUTDOOR APPLICATION ONLY.** For the reduction of ticks associated with the mice that serve as reservoirs for pathogens causing Lyme disease and babesiosis. Ticks feeding on these animals become infected and may transmit disease to humans, dogs, and horses.

For best results, place tubes flat on the ground in all brush-covered and wooded areas to be treated. The maximum distance between tubes should not exceed 10 yards in any direction.

Treatment should be limited to areas inhabited by mice, and need not include mown lawns

or open grasslands. Tubes should be positioned so that mice have access to the open ends. Product works best if not covered by leaves or other material.

**FOR TREATMENT AROUND YARDS:** Place tubes within 1 yard of the edge of mown lawns, in flower gardens, under bushes and along fences, wherever mice may reside. For complete coverage, all brush-covered or wooded areas within 50 yards surrounding the yard area to be protected should be treated.

**FOR TREATMENT OF WOODLOTS:** Tubes should be placed in a continuous array (such as a grid design), with no more than 10 yards between tubes in any direction. For complete coverage, apply tubes up to the brush-covered edge surrounding the woodlot. Tubes placed near thickets or rotting logs within the woodlot will be more effective than those placed in more open woodland terrain.

Tubes may be applied anytime between April 1 and mid-September, but should be applied at least twice a year. For best results, apply just prior to the feeding activity periods for nymphal (May-June) and larval (August-September) ticks. Tubes may also be replaced when nesting material is completely removed.

### STORAGE AND DISPOSAL:

Store at room temperature. Do not contaminate water, food or feed by storage and disposal.

Do not reuse empty tubes. The tubes and unused cation are biodegradable and may be left in the application site. If disposal is desired, wrap tube and put in trash collection.

### PRECAUTIONARY STATEMENTS

#### HAZARDS TO HUMANS & DOMESTIC ANIMALS

Avoid contact with eyes and skin. Contact with skin may result in temporary numbness and tingling sensations. Wash thoroughly with soap after handling.

#### ENVIRONMENTAL HAZARDS

This product is extremely toxic to fish and other aquatic organisms. Do not apply directly to water, or to areas where surface water is present or to terrestrial areas below the mean high water mark. Do not contaminate water by disposal of wastes or equipment washwaters.