Tick Safety in Schools

Integrated Pest Management for Protecting Children from Tick-Borne Diseases

Center of Expertise for School IPM

EPA
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Environmental Protection
Agency

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Because public awareness of ticks and the pathogens associated with them have increased during the last ten years, integrated pest management (IPM) strategies are critical to reduce and prevent exposure to ticks on school grounds. This document will identify and describe in some detail the different IPM techniques available for implementation. Specifically, tick species, their biology, and the pathogens they carry are identified. Recommended IPM tactics are discussed including landscaping practices, plant selection to deter and resist deer browsing, and direct tick control methods.

Tick Presence and Tick-Borne Disease Prevalence

The following tick species found in the United States include: blacklegged tick (*Ixodes scapularis* – also known as the deer tick), Western blacklegged tick (*Ixodes pacificus*), lone star tick (*Amblyomma americanum*), Gulf Coast tick (*A. maculatum*), brown dog tick (*Rhipicephalus sanguineus*), American dog tick (*Dermacentor variabilis*), and the Rocky Mountain wood tick (*Dermacentor andersoni*) (http://www.cdc.gov/ticks/geographic_distribution.html).

Brown Dog Tick

American Dog Tick

Rocky Mountain Wood Tick

Gulf Coast Tick

Western Blacklegged Tick

Blacklegged (Deer) Tick

Lone Star Tick

Depending on the tick species and pathogens found in the tick, the following diseases could result from tick exposure and are reportable to the Centers for Disease Control and Prevention (CDC): Lyme, Rocky Mountain spotted fever), babesiosis, ehrlichiosis, anaplasmosis, tularemia and Powassan virus (Figure 2).

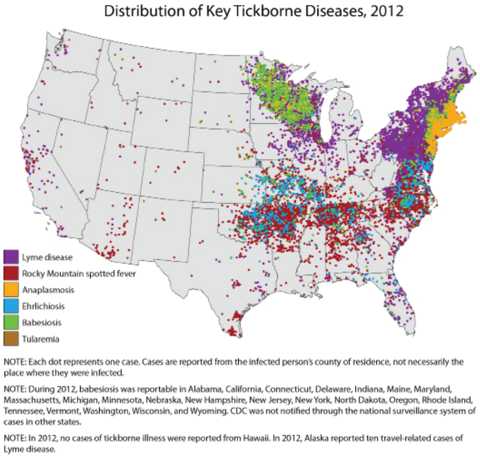


Figure 2. Distribution of tick-borne diseases in the United States, 2010 (CDC 2013).

Tick Biology

Climate: Ticks prefer cool, humid arboreal and deciduous forests. Some species, however, can adapt to arid habitats (Goodman 2005). Tick development is tied to temperature as their developmental phases shorten with increasing temperatures (Ogden 2006). Cold temperatures impact them less than many people realize. It is surprising to many to learn that 99% of all ticks will seek hosts once temperatures exceed four (4) degrees centigrade (or 39 degrees Fahrenheit). A New York study indicated that, regardless of winter conditions, more than 80% of ticks survived and that winter conditions do not necessarily restrict tick populations or, correspondingly, the risk from tick-borne diseases (Brunner et al. 2012).

Hosts: Brunner (2008) indicated that host competence for *I. scapularis* varies by species with ticks demonstrating a preference for hosts in the following order: white-footed mouse, eastern chipmunk, white-tailed deer, raccoon, opossum, striped skunk, short-tailed shrew, and masked shrew.

Rabbits also serve as a host for ticks. Cooney (2005) examined ticks on eastern cottontail rabbits and found that of the nearly 4,000 ticks collected, 80% were *Haemaphysalis leporispalustris* (rabbit tick), 9% *Amblyomma americanum* (lone star tick), 8% *Ixodes dentatus* , and 2% *Dermacentor variabilis* (American dog tick).

Birds also act as a host for *Ixodes scapularis* (formerly *Ixodes dammini*) and may contribute to the spread of ticks. Stafford et al. (1995) reported that 15.2% of the 36 bird species examined in Lyme, CT were parasitized by ticks and the blacklegged tick accounted for 94% of them. Most birds do not appear capable of infecting feeding ticks with the Lyme disease spirochete, *Borrelia burgdorferi*, but the American robin, house wren, Carolina wren, common grackle, and veery have been found to be reservoir competent hosts, and therefore may contribute to the prevalence of infected ticks in the environment. Nevertheless, there is little or no evidence that feeding birds increases the risk for tick exposure or tick-borne disease.

Deer are not affected by *B. burgdorferi*, and do not transmit the Lyme disease spirochete, but they are the primary host that allows ticks to multiply. This results in more ticks within a given area available to pick up and transmit the pathogen from reservoir animals to future hosts. Excluding deer by fencing has been shown to reduce both lone star and blacklegged tick numbers inside the fenced area. It is believed that controlling deer populations in an area in which ticks carrying disease pathogens are endemic would result in a reduction in risk for tick-borne diseases. However, the few successful deer reduction studies to date have generally been conducted on geographically isolated areas like islands or peninsulas (Ginsberg and Stafford 1995).

Other hosts may provide a means for ticks to migrate into an area with a depleted deer population. This theory was confirmed by a study conducted on Monhegan Island, ME. There, white-tailed deer were extirpated in 1999, but *Ixodes scapularis* ticks were discovered only three (3) years later, indicating a bird-derived reintroduction. (Elias et al. 2011).

Tick-Life Cycle: Within the tick life-cycle, depicted in Figure 3, the immature or nymph stage is of most concern because its small size (head of a pin) that allows it to be easily overlooked during tick checks.

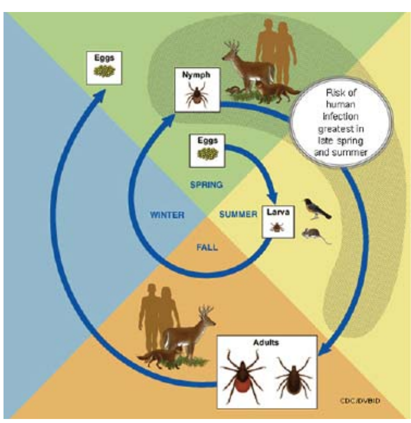


Figure 3. Tick life-cycle (CDC 2013)

IPM Strategies for Reducing Tick Populations

Recommended Landscape Management Practices for Schools

The following landscape practices are recommended as ways to reduce the exposure to you and your family of ticks. Figure 4 demonstrates how these practices can be integrated to create a backyard tick safe zone similar to school grounds.

Remove leaf litter, brush, and weeds at the edge of the lawn. Removal of leaf litter in forested areas of a residential community significantly reduced the abundance of questing blacklegged tick (Ixodes scapularis) nymphs throughout their peak activity period. Removal of leaf litter in early spring (March) and early summer (June) resulted in reductions in nymphal tick density ranging from 73% to 100%. Subsequent sampling of the *I. scapularis* population during the summer revealed similar rates of suppression of larvae (Schulze 1995).

Keep grass mowed (less than 3") on all school grounds including sports fields (soccer, baseball, football).

Create a nine foot (9') buffer zone between vegetation and all grounds used for school activities (soccer, baseball, football fields) (Stafford 2005).

Clear ground cover and vegetation around stonewalls and wood piles. The ground cover pachysandra is deer resistant but is also known to harbor ticks. Trim tree branches and shrubs around the lawn edge to let in more sunlight. Clear and widen woodland trails to avoid exposure to questing ticks.

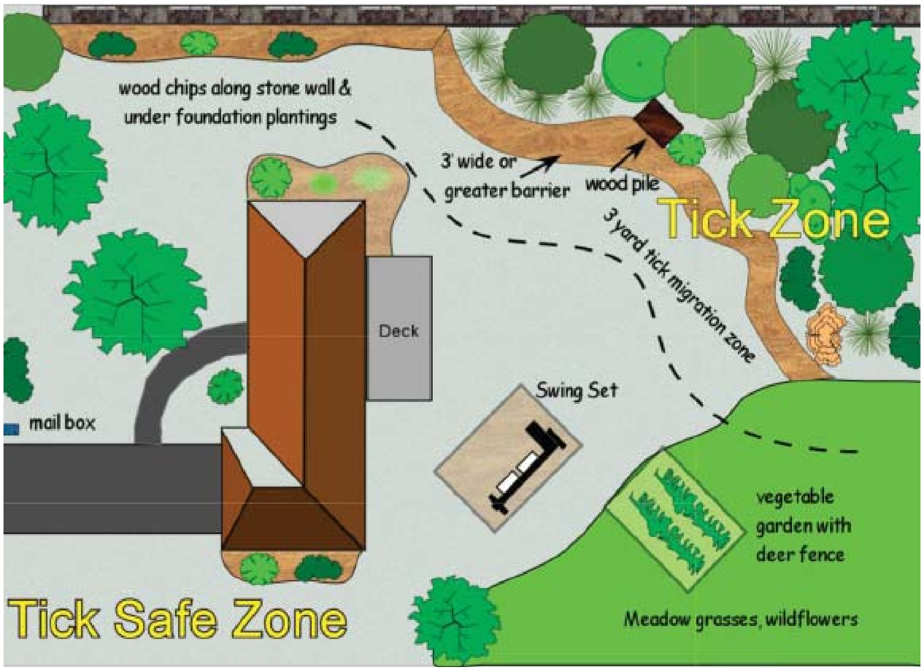


Figure 4. Creating a backyard tick safe zone (Stafford 2007)

Adopt hardscape and xeriscape landscaping techniques with gravel pathways and mulches. These dryer or less water demanding landscapes are environmentally friendly and reduce tick exposure. Create a 3-foot or wider wood chip, mulch, or gravel pathway surrounding landscaped areas.

Keep paths frequented by students (short cuts to their homes) clear from vegetation to a width of at least one sidewalk (54 inches). The Americans with Disabilities Act (ADA) requires a 60 inch clearance to allow for passing every 200 feet under normal pedestrian use.

Exclude deer - installing and maintaining an eight foot (8') high fence surrounding a property is effective in excluding deer.

Special Considerations for School Gardens and Landscaping

The selection of plants for developing and/or maintaing school gardens and landscape can directly impact the attractiveness to deer. Deer demonstrate preferences for certain plants just as humans prefer some foods over others. Those living near deer habitat can take advantage of this fact by using deer-resistant plants in their landscapes. However, when they are hungry they will resort to plants that are not a preferred species.

Deer Resistant Plant Varieties

The following plants, identified as being resistant to deer browse damage (Ward 2000), can be grown where browse damage is expected.

Annuals and Perennials Grown as Annuals

Spiderflower (*Cleome*), Marigold (*Tagetes*), Forget-me-not (*Myosotis*), Vinca (*Catharanthus*), Alyssum (*Lobularia*), and Dusty miller (*Senecio*)

Groundcovers

Myrtle (*Vinca*), Dead nettle (*Lamium*), Pachysandra (*Pachysandra*), ferns (most species), Liriope Bugleweed (*Ajuga*), Sweet woodruff (*Galium*), and Wild ginger (*Asarum*)

Bulbs and Corms

Hen & chicks (*Sempervivum*), Star of Bethlehem (*Ornithogalum*), Snowdrop (*Galanthus*), Ornamental chives (*Allium*), Daffodil (*Narcissus*)

Herbaceous Perennials

Lily of the valley (*Convallaria*), Lamb's ears (*Stachys*), Lavender (*Lavandula*),Yarrow (*Achillea*), Foxglove (*Digitalis*), Mint (*Mentha*), Russian sage (*Perovskia*), Oregano (*Origanum*), Silvermound (*Artemisia*), Lady's mantle (*Alchemilla*), Thyme (*Thymus*), Poppy (*Papaver*), Catmint (*Nepeta*), Goldenrod (*Solidago*), Rubarb (*Rheum*), Monkshood (*Aconitum*), and Mayapple (*Podophyllum*)

Vines

Wisteria (*Wisteria*), and Virginia creeper (*Parthenocissus*)

Shrubs and Trees

Leucothoe (*Leucothoe*), flowering quince (*Chaenomeles*), weigela (*Weigela*), butterfly bush (*Buddleia*), deutzia (*Deutzia*), spruce (*Picea*), cotoneaster (*Cotoneaster*) boxwood (*Buxus*), and spirea (*Spiraea*), honeysuckle (*Lonicera*), heather (*Calluna*), goldenbells (*Forsythia*), and andromeda (*Pieris*).

Figure 5: Honeysuckle (University of Texas, 2013)

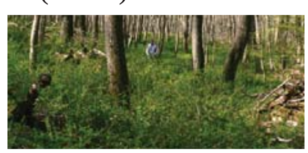


Figure 6: Japanese barberry (Williams et. al. 2010)

Ticks infected with human pathogens have been reported more abundant in areas with certain invasive plants, such as honeysuckle (Figure 5) and Japanese barberry (Figure 6), than areas with native vegetation or where these plants are absent (Allan et al., 2010, Elias et al. 2006, Lubelczyk et al. 2004, Williams et. al. 2009, 2010). These studies have shown that the control or eradication of these invasive plants reduced the number of infected ticks and the potential for tick-borne disease risk by altering habitat microclimate and host dynamics. There was a ten times greater chance for exposure to lone star ticks carrying *E. chaffeensis* (agent human ehrlichiosis) in honeysuckle plots compared to native vegetation and the removal of Japanese barberry reduced the number of adult blacklegged ticks with *B. burgdorferi* by 60% in comparison with unmanaged plots.

Plants Susceptible to Deer Browsing: The following plants are susceptible to deer browsing based on a survey of Connecticut gardeners (Ward 2000):

Annuals and Perennials Grown as Annuals
Impatiens (*Impatiens*), sunflower (*Helianthus*), English daisy (*Bellis*), dahlia (*Dahlia*), and fibrous begonia (*Begonia*)

Bulbs and Corms
Tulip (*Tulipa*), daylily (*Hemerocallis*), lilies (*Lilium*), and spring-flowering crocus (*Crocus*)

Herbaceous Perennials
Hosta (*Hosta*), garden phlox (*P. paniculata*), hollyhock (*Alcea*), daisy (*Chrysanthenum*), black-eyed susan (*Rudbeckia*), Jerusalem artichoke (*Helianthus*), candytuft (*Iberis*), shasta daisy (*Leucanthemum*), coneflower (*Echinacea*), cardinal flower (*Lobelia*), hibiscus (*Hibiscus*), and rose mallow (*Malva*).

Shrubs and Trees
Yew (*Taxus*), euonymus (*Euonymus*), arborvitae (*Thuja*), deciduous azalea (*Rhododendron*), rhododendron (*Rhododendron*) evergreen azalea (*Rhododendron*), rose (*Rosa*), hydrangea (*Hydrangea*), American holly (*Ilex*), evergreen holly (*Ilex*), yucca (*Yucca*), eastern red cedar (*Juniperus*), juniper (*Juniperus*), mountain laurel (*Kalmia*), hemlock (*Tsuga*), and apple (*Malus sp*.).

Tick Prevention and Control Recommendations

The following prevention and control recommendations may be implemented in accordance with local school guidelines and regulations:

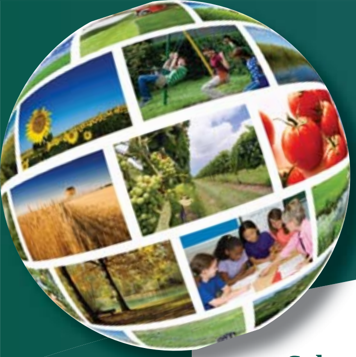
Personal Protection: Initiate personal protection by wearing long pants, long shirt, hat, gloves, and boots (covering lacings). Daily tick checks (personal inspection), and showering immediately with a washcloth is also important. The CDC (2013) recommends the use of a repellent with DEET (N, N-diethyl-m-toluamide) to be applied on skin, depending on the age of the person, and application according to label directions. Repellents containing 20% or more DEET can protect up to several hours. Always follow product label instructions when applying any repellent. The US Environmental Protection Agency (EPA) provides approved protection times for skin applied insect repellents at http://cfpub.epa.gov/oppref/insect/.

Clothing: Products containing permethrin kill ticks. Permethrin can be used to treat boots, clothing, and camping gear; it remains protective through several washings (CDC 2013).

Pesticide Treatment : A single springtime application of an acaracide (tick pesticide) can reduce the number of ticks in a yard or playing field (CDC 2013). If you are considering applying an acaracide to your school property:

- Check with local health officials about the best time to apply an acaricide in your area.
- Identify rules and regulations related to pesticide application on school grounds. Read the label and follow state and local posting guidelines and the district's school IPM policy and plan.

School IPM Administrators: Contact local and state governments to determine the policies associated with IPM in schools and in particular with supporting Tick IPM. For information on Integrated Pest Management in Schools initiative in EPA's Office of Pesticides Program please refer to: www.epa.gov/pesp/ipminschools/



Communication Strategies

School Maintenance/Groundskeepers: Ticks are usually more active in the months of April through October and peak in the summer months of June through August. The time of year when ticks are active may vary with the geographic region and climate. School groundskeepers should take care to protect themselves in the late spring and summer when immature ticks are most active (www.cdc.gov/niosh/topics/tick-borne).

Communication Tools For Schools: Communication tool kits are available for parents and school personnel at: www.cdc.gov/lyme/toolkit/index.html.The recommendations provided will reduce the risk from all tick-borne diseases including Lyme disease.

Resources for Registered Pesticides: EPA registered product labels are supported by the data submitted to satisfy data requirements and support registration. Efficacy, human health, and environmental exposure data are required to be evaluated and found acceptable to support the product label. Information on product labeling can be found at: www.epa.gov/pesticides/regulating/labels/product-labels.htm.

EPA also supports the following website which provides labels for each registered product: http://iaspub.epa.gov/apex/pesticides/f?p=PPLS:1.

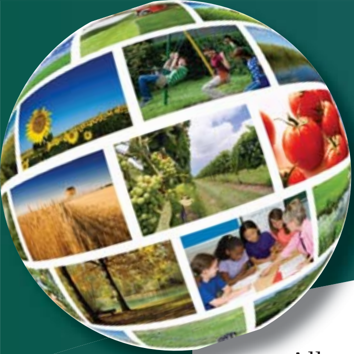
The National Pesticide Information Retrieval System provides a list of products registered to control ticks: http://npirspublic.ceris.purdue.edu/public.html.

Measuring the Effectiveness of Tick IPM Methods

The following table summarizes the current research on tick IPM tools that may be appropriate for the school environment.

Tick IPM Tools	*Effectiveness of IPM tools Under Study Conditions Evaluated*
Landscape Management Practices	
Clear vegetation on school grounds to allow for a 9 foot border	82% of nymphs are found within 3 meters of lawn edge with woods, stone walls, ecotone, etc. (Stafford 2013)
Keep paths (short-cuts to home) clear from vegetation to a sidewalk width (54') to accommodate two students walking abreast	ADA recommends 60" clear pathway every 200 feet to allow pedestrian passing.

Tick IPM Tools	*Effectiveness of IPM tools Under Study Conditions Evaluated*
Clear ground cover and reduce vegetation (e.g., honeysuckle, Japanese barberry)	For example, 10 times greater chance of exposure to the lone star tick (*Amblyomma americanum*), possibly carrying *Erlichia chaffeensis*, in honeysuckle plots compared to native vegetation. Study indicated white-tailed deer (*Odocoileus virginianus*), a preeminent tick host and pathogen reservoir, more frequently used areas invaded by honeysuckle (Allan et al. 2010). Research indicates a strong correlation between ticks and the invasive species, barberry (Stafford 2013) (Stafford 2013) and (Lubelczyk et al. 2004) indicate the shrub layer has a highest incidence of *Ixodes scapularis*, with the remaining, in order of importance, being: barberry, holly, honeysuckle, ferns, deciduous litter composition, grasses, and hemlock springs.
8' fencing around property to prevent deer migration	Arias (2012) indicated this method is effective.
Other Control Methods	
School administration and nurses detection of early tick attachment to students	Personal tick checks was protective against Lyme disease (Connally et al. 2009)
Educational outreach	71% participants who spent 1+ days in tick areas take some tick-prevention precautions. Residents who have a higher educational background and higher income are willing to use tick environmental controls (Gould 2008).
Personal protection / Clothing	Personal protection proven to be 20-40% effective in preventing tick attachment (Vázquez et al. 2008)
Outdoor area treatment with pesticides (conventional or biopesticides)	Efficacy varies with the pesticide selected and circumstance of application.
Host-targeted acaracides	Rodent bait boxes containing acaricides are 77% effective in reducing tick populations (Dolan et al. 2004)
4-poster device with acaracide to treat deer	The device is 68% effective in reducing the incidence of Lyme disease (Garnett et al. 2011)



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