Name: _____

Email: _____

Q1. Which of the following categories best describes you? You may indicate as many as you like, but if you identify with more than one category, please rank them, with 1 indicating the category that describes you best.

- ☐ public health official / government epidemiologist
- ☐ natural resource manager
- ☐ scientist working at a non-profit agency
- ☐ scientist working at or contracting for a government agency
- ☐ academic conservation biologist
- ☐ academic medical entomologist
- ☐ academic disease ecologist
- ☐ academic epidemiologist
- ☐ other (describe)

Q2. Are there others with substantial expertise on Lyme disease who you believe would add additional valuable information to this survey?

PLEASE READ THESE INSTRUCTIONS: Please answer each of the following questions, and if you answer a question, please provide at least one reference that supports your answer. If you do not believe there are sufficient data to answer the question, please indicate this by writing ID for "insufficient data". If you believe published or unpublished data exist to provide a preliminary answer but substantially more work needs to be done to be confident in that answer, please indicate this by adding NMS (needs more study) to the references you list. Please list as many references as you can reasonably provide, and feel free to refer to published papers that contain additional references. The goal is to assemble as much actual data as exist on a given question. In addition, if you would prefer to simply provide a reference that has data to answer a question (and save yourself the time of finding and entering the estimate), then I will extract the estimate/data from that reference. However, in doing so I may or may not extract the exact same data or in the same way you would, so providing an estimate will ensure I use the estimate you have in mind.

Q3. Rank the following factors influencing larval or nymphal tick survival from most influential (=1) to least influential (=9); indicate NE (no effect) or ID if insufficient data exists. References that explicitly compare the importance of multiple factors on tick survival are of greatest value.

Factor	Rank	Ref #s
Humidity		
Minimum temperature		
Maximum temperature		
Vegetation structure		
Amount of leaf litter		
Density of hosts		
Differential feeding/molting success		

Refs:

Q4. Where and at what stage does density dependence act to regulate populations of ticks? Put another way, what keeps tick populations from expanding to infinity? Rank the following between most influential (=1) to least influential (=7); indicate NE [no effect] or ID if insufficient data exists.

Factor	Rank	Ref #s
Larval stage density- dependent survival on hosts		
Nymphal stage density- dependent survival on hosts		
Adult stage density-dependent survival on hosts		
Larval stage density- dependent survival off hosts		
Nymphal stage density- dependent survival off hosts		
Adult stage density-dependent survival off hosts		
Adult stage density-dependent reproduction		

Refs:

Q4. Please fill in the following table with approximate estimates and either interquartile (25th percentile-75th percentile) range or ±1SE range to determine the contribution of hosts to the pool of infected nymphal ticks. If necessary, use these **bins: 0–15%, 16–25%, 26–50%, 51-75%, 76-100%, ID (insufficient data).** Sources of data on the fraction of larval ticks fed by each host could come from molecular identification of residual blood inside unfed nymphal ticks, or from relatively comprehensive estimates of tick burdens from hosts at a given site. Reservoir competence is defined here as the fraction of larval ticks feeding on an infected host of this species that would transmit *Borrelia burgdorferi* after surviving molting to the nymph stage (i.e., it does not include death during molting). Fraction of infected nymphs that were infected by feeding on this host can be derived from the product of these two variables. Enter NE [no effect] or ID if insufficient data exists. Note that questions in this table do not incorporate differential feeding success on different hosts or ticks that are killed by hosts which is part of Q3. Note also that this analysis doesn't take into account evidence for differential host competence of each species for different *Borrelia burgdorferi* genotypes, which may have different disease severity in humans.

Geographic Region (check one):

- ☐ Northeastern and Midwestern North America
- ☐ Europe
- ☐ Western North America

Species	**Approximate fraction of larval ticks fed (0-100%)**	**Ref #s**	**Reservoir competence (0-100%)**	**Ref #s**	**Fraction of all infected nymphs infected by host**	**Ref #s**
Mouse						
Chipmunk						
Deer						
Squirrels						
Raccoon						
Opossum						
Skunk						
Shrews						
Birds						
Lizards						
Other:						

Refs:

Q5. For each statement about how patterns of human Lyme disease infections have changed over time, please check the best answer.

Lyme disease was present in North America prior to colonization (pre-1500): ☐ true, ☐ likely, ☐ possible,☐ unlikely, ☐ false, ☐ insufficient data

Refs:

Lyme disease decreased in North America following settlement by Europeans because land was cleared for agriculture: ☐ true, ☐ likely, ☐ possible, ☐ unlikely, ☐ false, ☐ insufficient data

Refs:

Lyme disease increased in North America due to post-agricultural reforestation in the 20th century: ☐ true, ☐ likely, ☐ possible, ☐ unlikely, ☐ false, ☐ insufficient data

Refs:

Lyme disease has been present in Europe for hundreds of years: ☐ true, ☐ likely, ☐ possible,☐ unlikely, ☐ false, ☐ insufficient data

Refs:

Lyme disease has been present in Europe for hundreds of years: ☐ true, ☐ likely, ☐ possible,☐ unlikely, ☐ false, ☐ insufficient data

Refs:

The number of Lyme disease cases has been increasing in Europe over the past three decades: ☐ true, ☐ likely, ☐ possible,☐ unlikely, ☐ false, ☐ insufficient data

Refs:

Q6. Estimate the relative contribution, in % of total variance explained, of the following factors to the temporal changes in reported Lyme disease cases over the last four decades, and please indicate which region the results correspond to. Enter NE [no effect], ID if Insufficient Data exists, or NFS for Needs Further Study. References that examine multiple factors at once and do quantitatively are of greatest value.

- ☐ Northeastern and Midwestern North America
- ☐ Europe
- ☐ Western North America

Factor	**% of increase**	**Ref #s**
Better diagnosis/awareness		
Climate change		
Biodiversity loss		
Human development near forests		
Increased deer populations		
Increased mouse populations		
Change in human activities		

Refs:

Q7. Fill in the table to illustrate how deer density influences tick abundance. Specifically, if deer density in an intact forest in a mainland area such as Massachusetts (i.e., not on an island; also assume that raccoons, opossums, squirrels, and other mammals are at average densities for this region) was initially 100/km^2, questing larval tick density was 100/100m^2, and questing nymphal tick density was 10/100m^2 how would long-term average tick density change (i.e., excluding transient effects) if deer density was reduced to 50 deer/km^2, 5 deer/km^2, or 0 deer/km^2?

Deer density	Larval density	Refs	Nymph density	Ref #s
100	100		10	
50				
5				
0				

Refs:

Q8. Draw three curves/lines that describe (on a relative scale): (*i*) the expected number of human Lyme disease cases, (*ii*) the density of infected nymphs, (*iii*) total vertebrate species richness, across the following landscape gradient. Indicate which region you are depicting, and note that the rightmost part of the x-axis in this question refers to the current ecological state of host communities in the region, and not to pre-historic communities. Thus, in the northeast, assume a host community without wolves, or pumas, and in California, assume a community without grizzly bears or wolves. The impacts of these missing species are obviously difficult to accurately determine with currently available data.

- ☐ Northeastern and Midwestern North America
- ☐ Europe
- ☐ Western North America

What mechanisms give rise to the trends you drew?

(*i*) Mechanism for the pattern in the expected number of human Lyme disease cases:

Refs:

(*ii*) Mechanism for the pattern in the density of infected nymphs:

Refs:

(*iii*) Mechanism for the pattern in the total vertebrate species richness:

Refs:

Q9. You are tasked with reducing Lyme disease risk in a small area (e.g. a township) that is 25 km^2 in area, located in a Lyme-endemic area (e.g. upstate New York, Germany, N. California) . You have five years and an annual budget of $10,000. How would you allocate your budget? What would be the impact of your investment on the density of infected nymphs and the number of human Lyme disease cases in the fifth year (e.g. ↓ 25%)?

Control measure	**Annual investment ($)**	**Infected nymph density**	**Human Lyme cases**	**Ref #s**
Reduce deer density by 50% starting from 100/km^2				
Install feeding or salt-lick stations that spray acaricide on visiting deer				
Treat forested areas used by humans with acaricide				
Trap and kill mice or other rodents				
Distribution small mammal tubes with acaricide-laden cotton				
Launch an education campaign designed to increase personal protection behaviors (e.g., wearing long pants and long sleeves, checking for ticks after spending time outdoors)				
Identify high-risk areas and close public access during high risk periods				
Purchase land or easements to merge small forest fragments into large ones and restoring that land to a forested state				
Reduce the total amount of forested area in the township by clearing land				
Clear brush at the edges of private properties that border on forested area				
Increase rodent predator species richness by installing owl nest boxes and raptor perches and banning hunting of coyotes and foxes				
Other:				

Refs:

Q10. List the order in which the following taxa are usually found in communities as host diversity increases in forested areas and indicate the region you are describing. If the group of animals is not present in that region simply omit them from the order; similarly if there is a group of animals that you believe plays an important role in Lyme disease ecology that is not listed, please add them. If you want to split any of the groups into individual species (e.g. split shrews into *Sorex* and *Blarina* shrews), please feel free to do so.

- ☐ Northeastern and Midwestern North America
- ☐ Europe
- ☐ Western North America

Mice, rats, voles, chipmunks, shrews, squirrels, skunks, opossums, raccoons, foxes, deer, coyotes, bobcats, birds, lizards, wolves, owls, raptors, bears, pumas/cougars, mustelids (weasels)

Approximate Order:

Refs:

Q11. What would the impact be on mouse density (white-footed in the NE USA, the most important small mammal host in other regions) of adding the following species to a host community at their "average" density? With a check mark, indicate the column that most closely approximates your prediction for the effect on white-footed mouse density and provide references in the final column.

	Effect on white-footed mouse density							
Species	**Large reduction (> –50%)**	**Moderate reduction (–11-50%)**	**Little effect (±0–10%)**	**Moderate increase (+11–50%)**	**Large increase (+>50%)**	**Diffi-cult to predict**	**Insuff. data**	**Ref #s**
rats								
chipmunks								
squirrels								
foxes								
deer								
coyotes								
birds								
wolves								
raptors								
weasels								
other:								

Refs:

Q12. What is the approximate strength of the following factors for predicting spatial variation in Lyme disease incidence in humans at the township scale (~25 km^2) (i.e., in an analysis with these variables, what fraction of the variance would they explain in Lyme disease incidence). If there is insufficient data to provide an estimate put ID. If you provide an estimate, please provide at least one reference, and also if many studies exist, please indicate the approximate number of studies that exist that support this assessment. Also indicate which region you are describing.

- ☐ Northeastern and Midwestern North America
- ☐ Europe
- ☐ Western North America

Predictor	**Approximate Predictive power, partial R^2 (e.g. 30%)**	**Approx. # refs (0, 1-5, 6-10,>10)**	**Ref #s**
density of infected nymphs			
time humans spend outdoors recreating			
proportion of residential property perimeter abutting forest			
distance of residence to nearest forest fragment			
average forest fragment size in county			
proportion of county covered by forest			
density of deer			
density of small mammals			
density of competent hosts			
mammal species richness			
carnivore abundance			
predicted nymphal infection prevalence, based on host abundance, tick burden, competence, molting			
Other:			

Refs:

Q13. Finally, what other questions should be added to this questionnaire to: (*i*) demonstrate common ground about Lyme disease ecology, (*ii*) clarify issues of disagreement, or (*iii*) highlight areas needing further study.