Management of ticks and Lyme disease in protected natural areas

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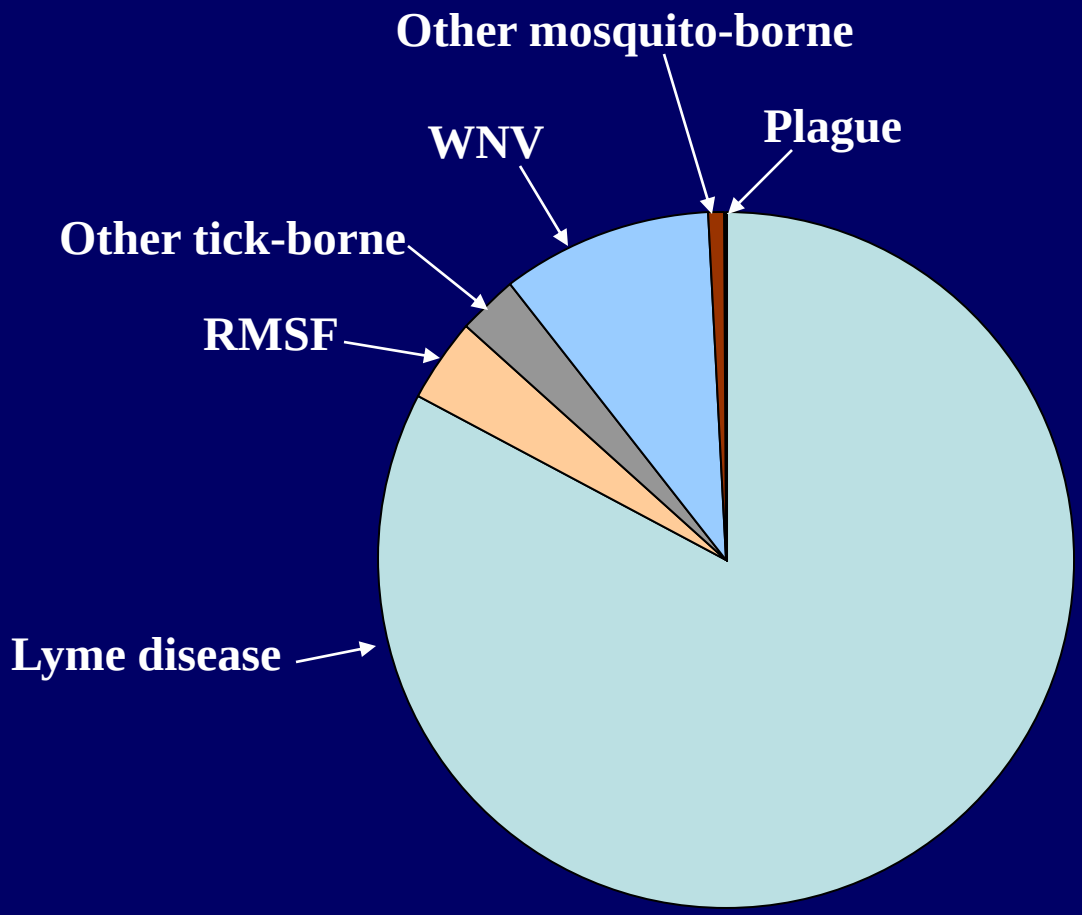
Human cases of vector-borne diseases, United States, 2002



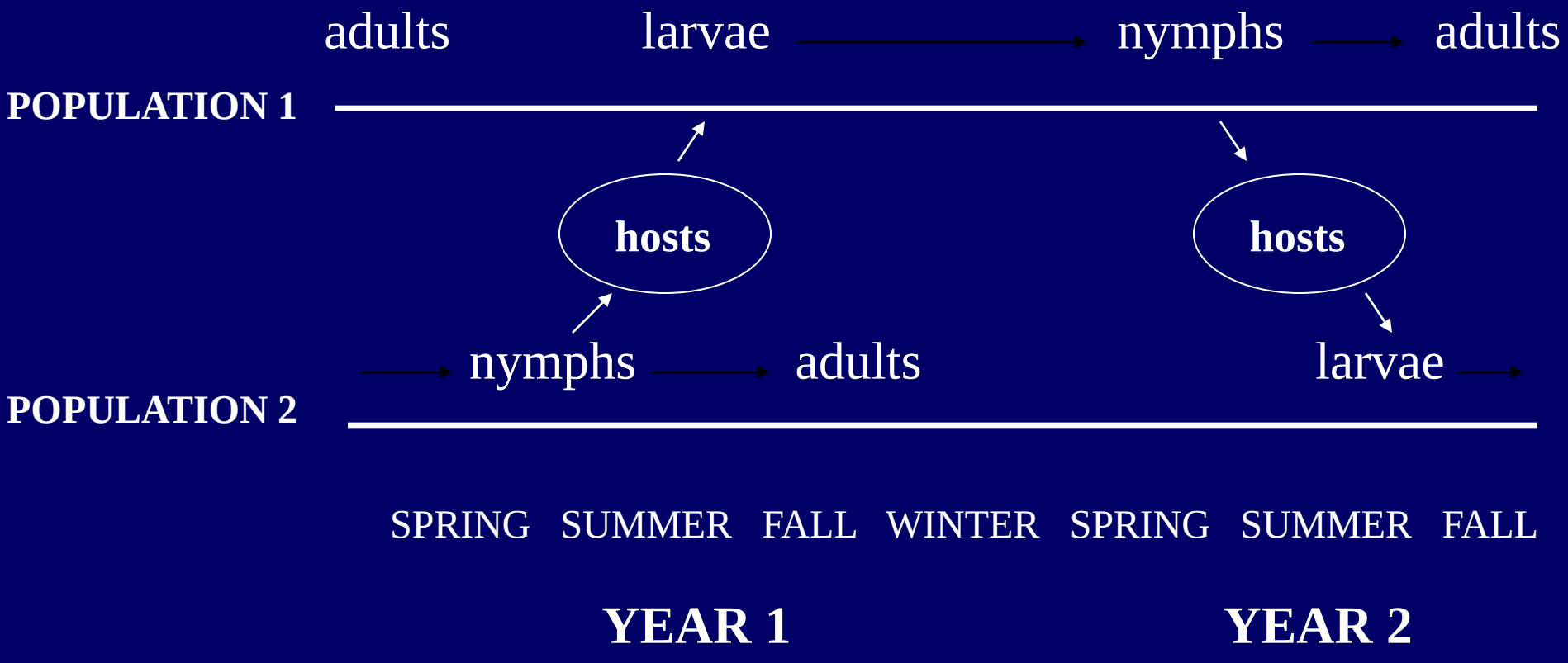
Lyme disease

pathogen

reservoirs

vector

Life cycle of *Ixodes scapularis*



Approaches to managing ticks and Lyme disease

- Self-protection precautions
- Habitat manipulation
- Manipulation of host populations
- Biological control
- Pesticide applications
  - broadcast
  - host-targeted

IPM for tick-borne diseases of humans

Integrate techniques so as to efficiently lower probability of exposure to pathogen

$$P_e = 1 - (1 - k_v)^n$$

P_e = probability of being bitten by at least one infected vector

k_v = proportion of vectors infected with pathogen (=prevalence)

n = number of vector bites

Probability of exposure to pathogen

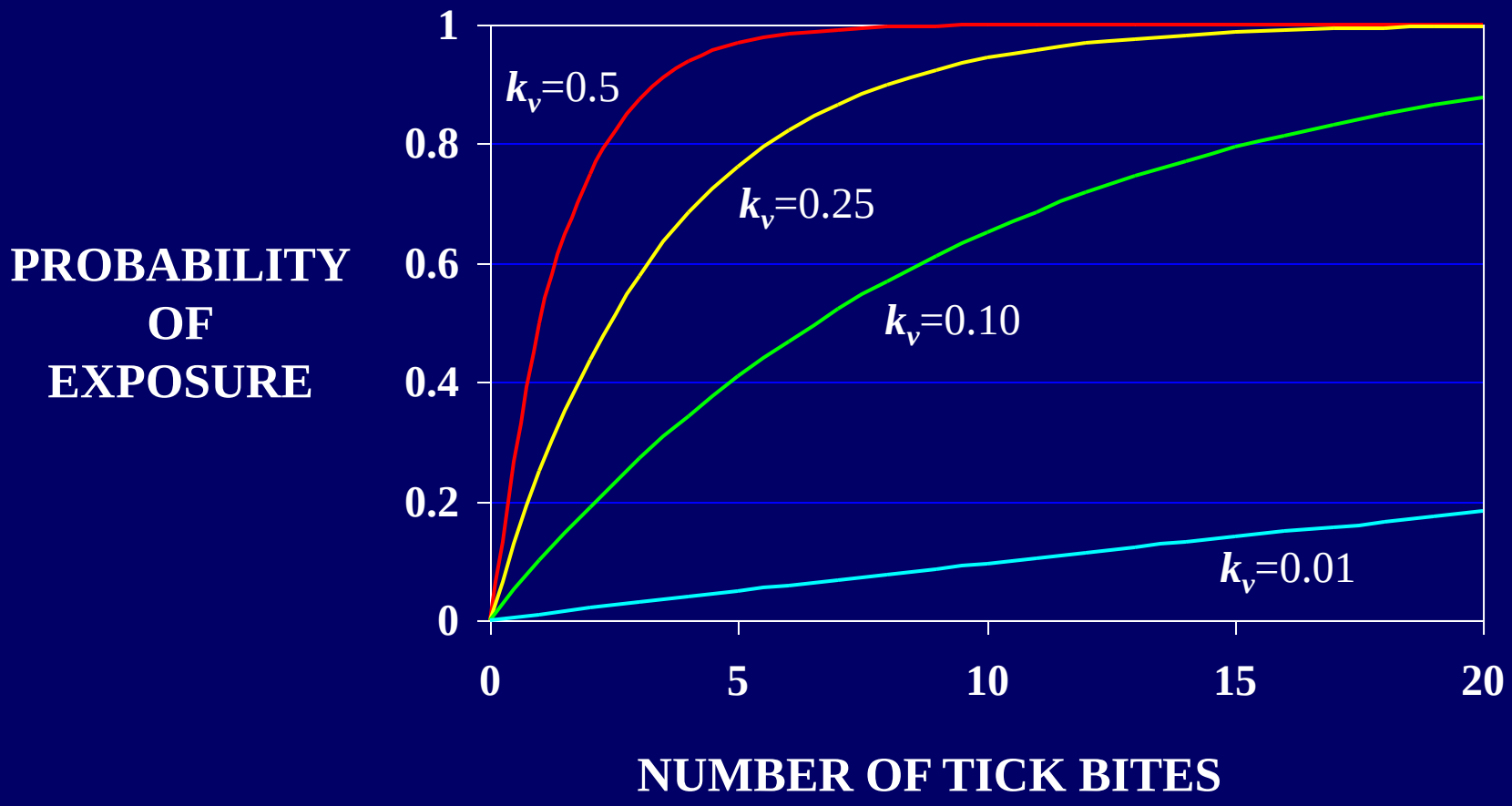


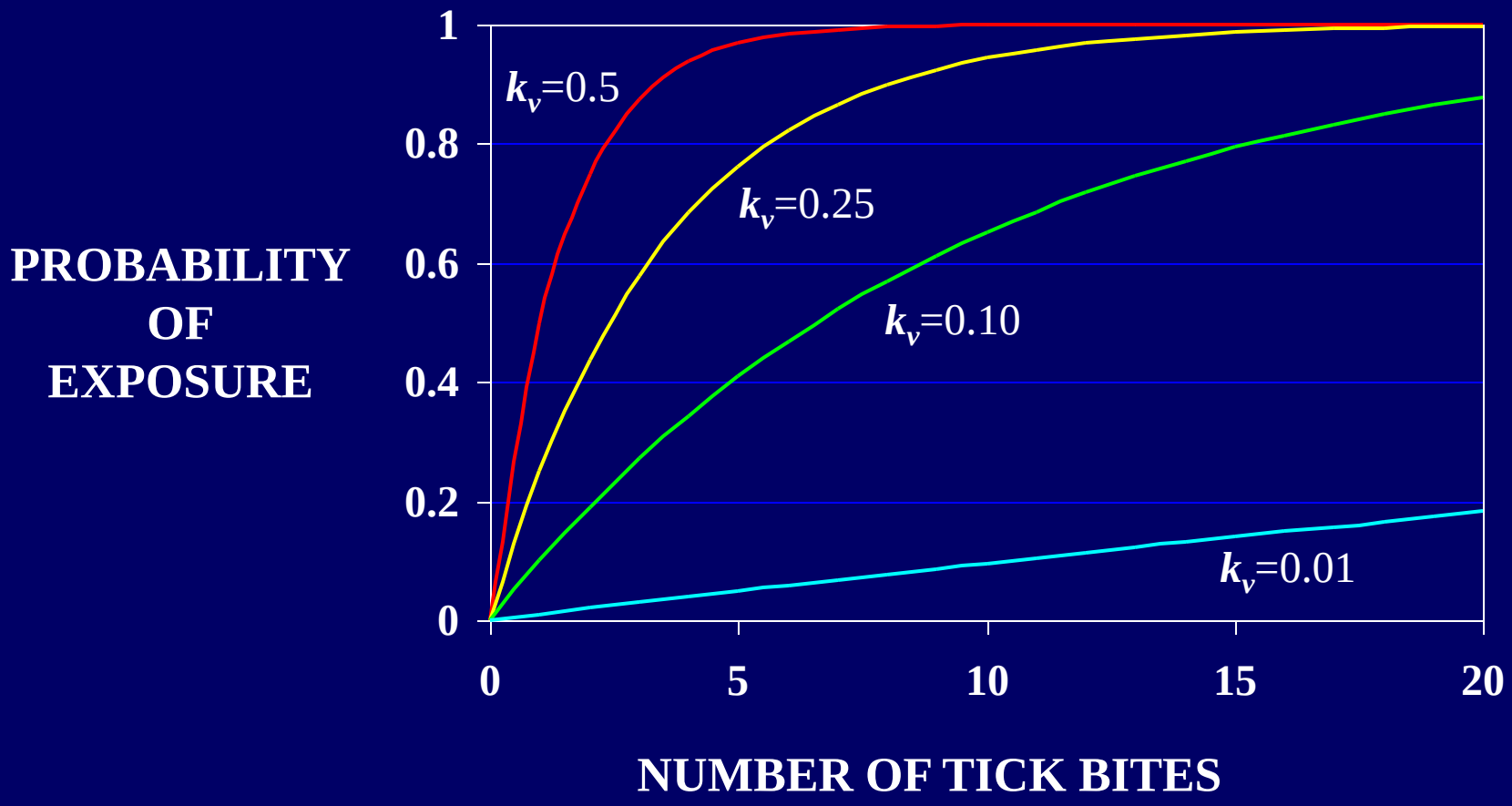
TABLE 1. Estimated numbers of effective tick bites in areas endemic for Lyme disease

Study (reference), site, and time period	Disease incidence	Estimated no. of effective tick bites*
Steere et al. (21), Great Island, MA		
Summer 1979	0.03	0.08–0.14
Summer 1983	0.02	0.05–0.09
1962–1983	0.24	0.69–1.23
Hanrahan et al. (22), Fire Island, NY		
Summer 1982	0.03	0.08–0.14
1977–1982	0.14	0.38–0.68
Lastavica et al. (23), Ipswich, MA		
Summer 1985	0.10	0.26–0.47
1980–1987 (overall)	0.35	1.08–1.93
1980–1987 (zone 1)	0.66	2.69–4.83

* Average number per person; range based on the range of spirochete prevalence in ticks from 0.33 to 0.20

from: Ginsberg. 1993. *American Journal Of Epidemiology* 138:65-73.

Probability of exposure to pathogen



Approaches to managing ticks and Lyme disease

Management technique	Lowers *n* or k_v	Environmental effects
- Self-protection precautions	*n*	Minimal effect
- Habitat manipulation	*n*	Substantial effect ( )
- Manipulation of host populations	*n* and/or k_v	Substantial effect ( )
- Biological control	*n*	Nontarget effects (-)
- Pesticide applications		Nontarget effects (-)
- broadcast	*n*	broad
- host-targeted	k_v	narrow

Habitat requirements of *Ixodes scapularis* nymphs

poor habitat

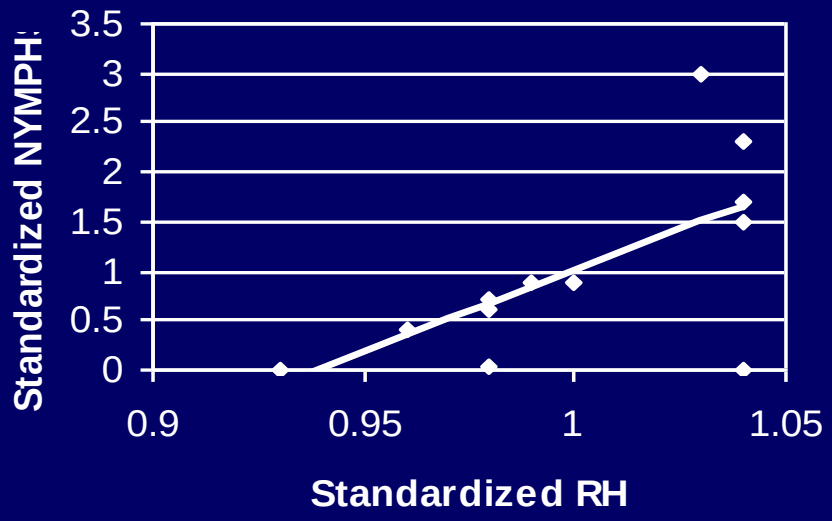
good habitat

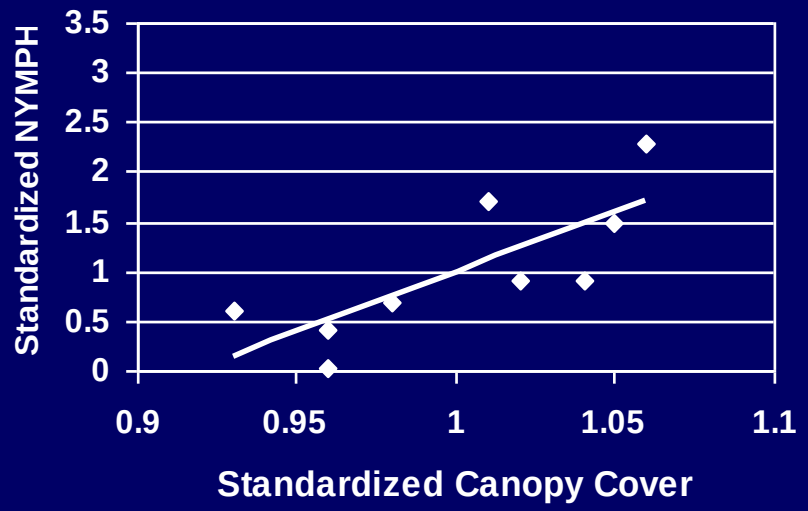
Habitat distribution of *Ixodes scapularis*

ADULTS PER SAMPLE

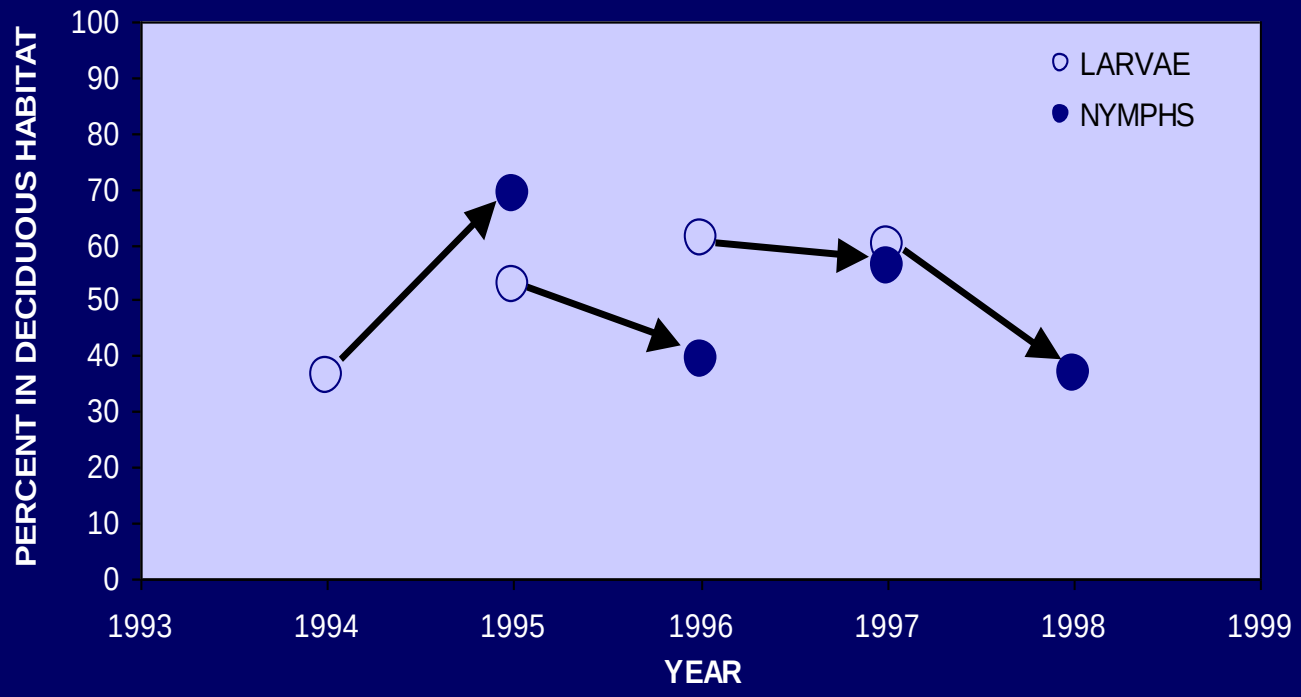
NYMPHS PER SAMPLE

Environmental factors affecting nymphal distribution



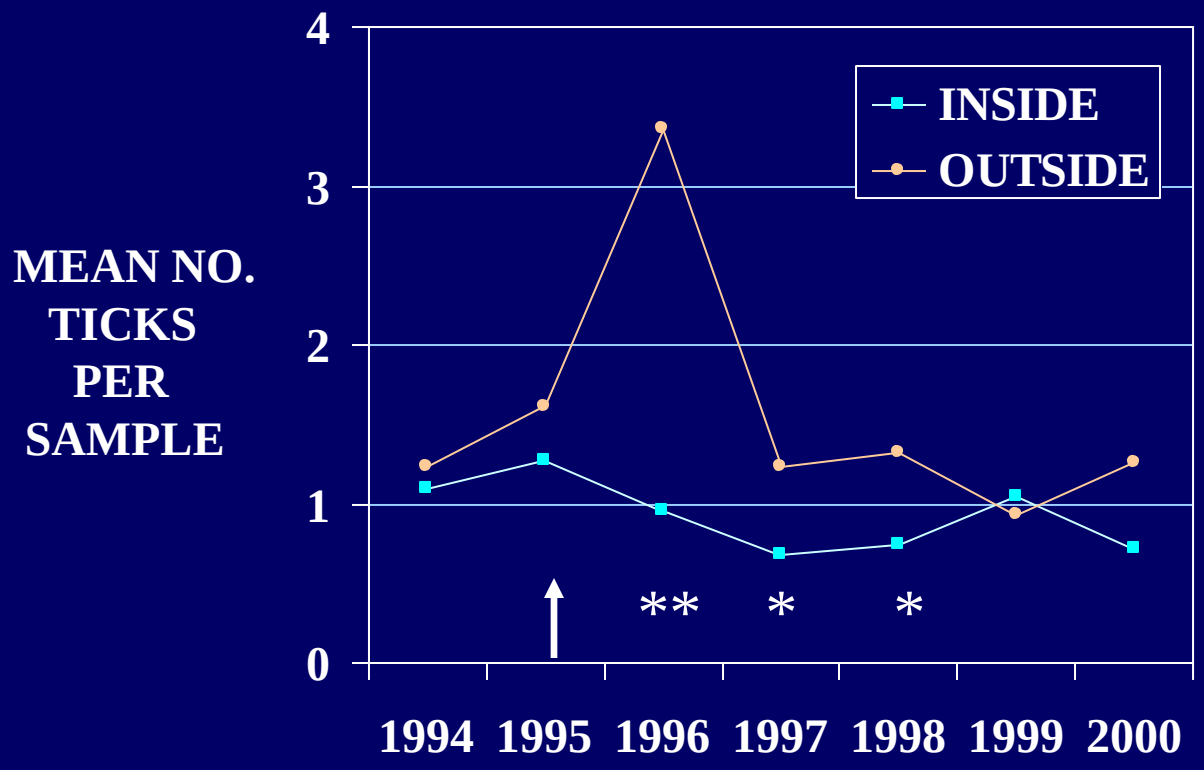


Habitat shifts from the larval to the nymphal stage, Fire Island, NY



From Ginsberg et al. 2004.*Environ. Entomol*.33:1266-1273.

Nymphal *Ixodes scapularis* inside and outside of deer exclosures, Fire Island National Seashore, NY



From Ginsberg et al. 2004.*Environ*. *Entomol*.33:1266-1273.

Landscape design works at three levels

1) Landscape design affects tick population size
   - likelihood of tick encounter
   - transmission dynamics of pathogen

2) Landscape design affects host abundance
   - reservoir competence of alternative host species
   - diversity of host species

3) Landscape design affects human encounter with ticks
   - probability of human exposure to pathogen

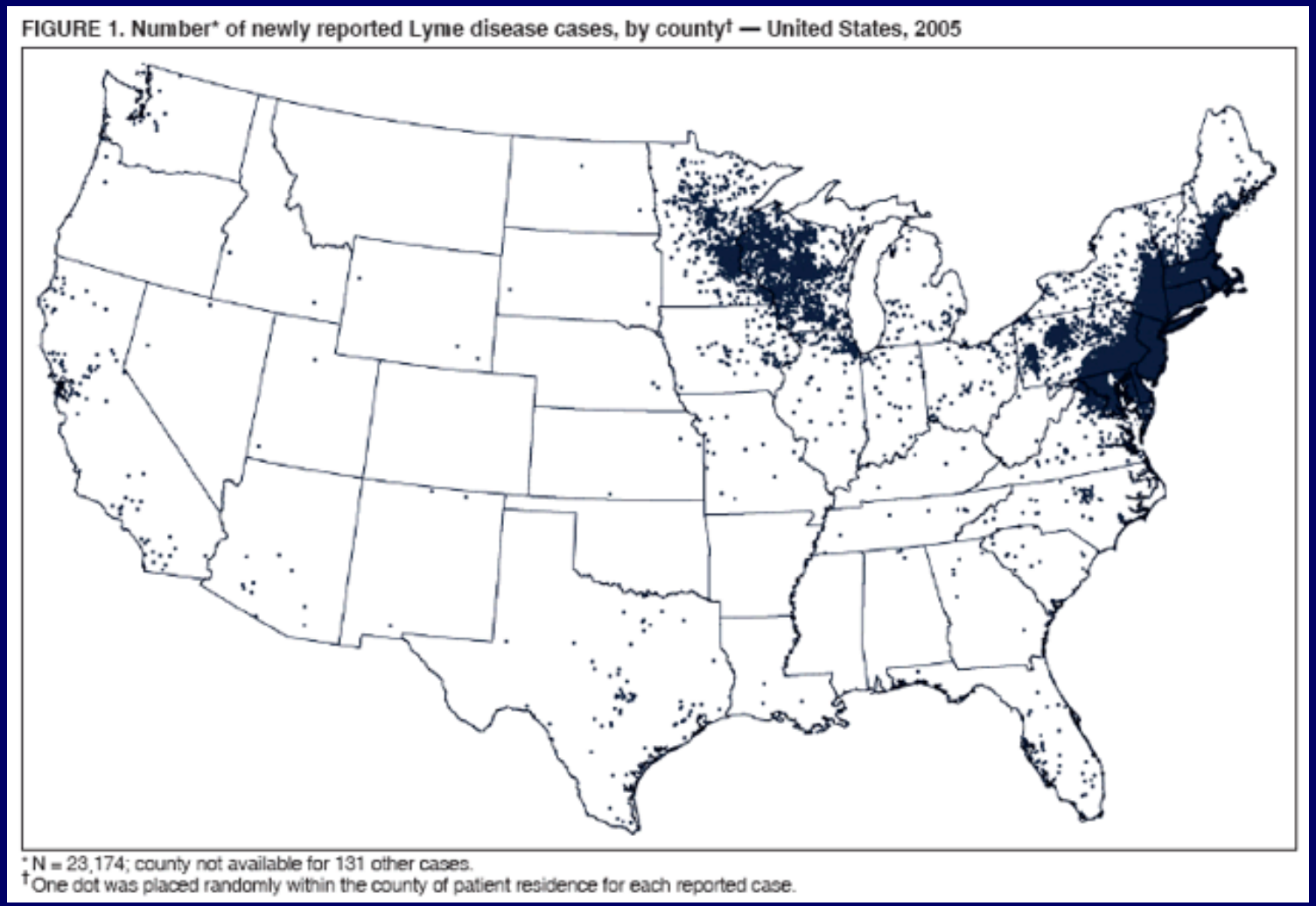
Habitat requirements for *Ixodes scapularis* nymphs

- moist leaf litter
- typically with forest canopy cover
- appropriate hosts present

Landscape features that lower tick abundance/number of tick bites

- dry at ground level
- open forest canopy
- appropriate hosts excluded (local? area-wide?)
- people discouraged or excluded from tick habitat

Lyme disease risk map – United States



Centers for Disease Control and Prevention

Barriers – various functions

Paths – separate people from tick habitat

Useful references

Bowman, AS & P Nuttall (eds.) 2008. *Ticks: Biology, Disease and Control*. Cambridge University Press, Cambridge, UK.

Ginsberg, HS & KC Stafford, III. 2005. Management of ticks and tick-borne diseases, pp. 65-86 *In* Goodman, JL, DT Dennis, & DE Sonenshine (eds.) *Tick-Borne Diseases of Humans*. ASM Press, Washington, DC.

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