



# Transmission dynamics of vector-borne pathogens

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# Lyme disease

**Vector:**

**tick**

*Ixodes scapularis*



**Reservoirs:**

**mammals**

*Peromyscus leucopus*

*Microtus pennsylvanicus*

*Tamias striatus*

**birds**

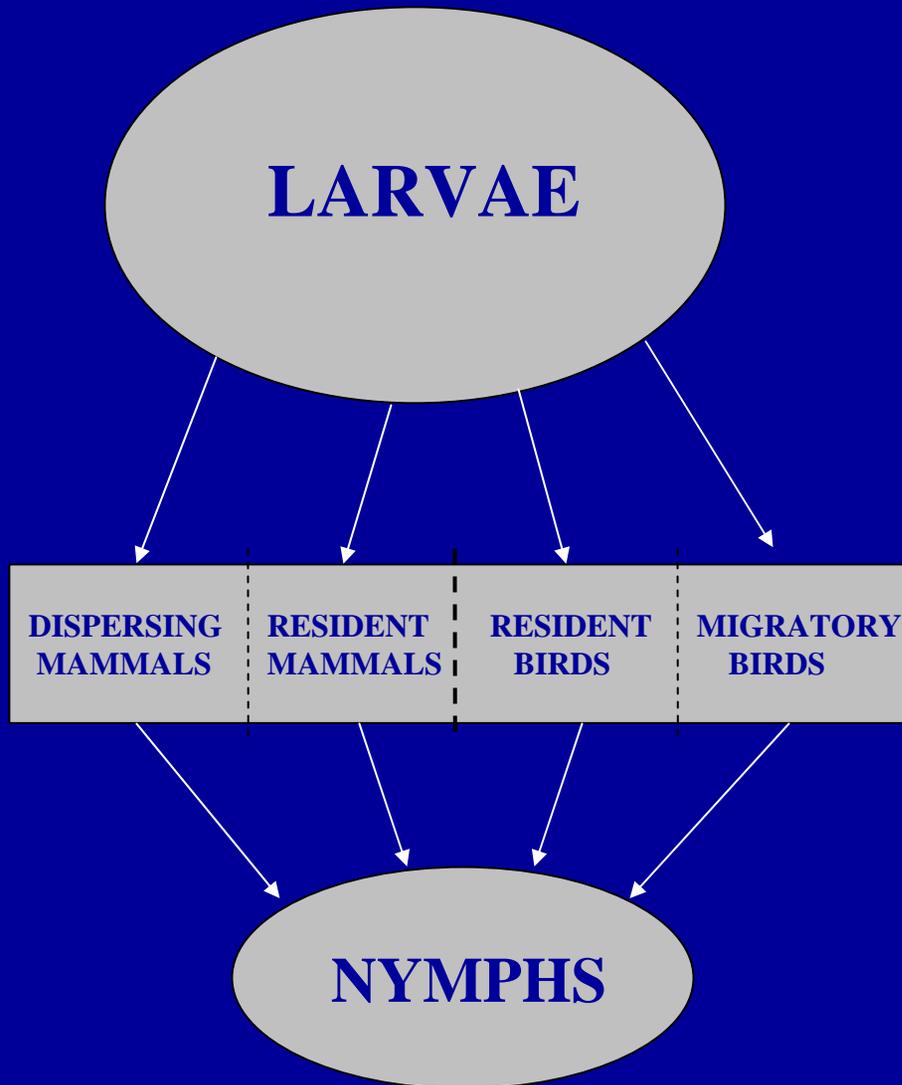
*Turdus migratorius*

*Melospiza melodia*

**Prevalence of *Borrelia burgdorferi* infection in nymphal  
*Ixodes scapularis*, Fire Island Lighthouse Tract**

**year                      # tested                      # infected                      % infected**

1994	233	39	16.7 %
1995	195	27	13.9
1996	290	13	4.5
1997	75	9	12.0
1998	120	0 (?)	0 (?)
1999	114	29	25.4



**Sources of infection for nymphal *Ixodes scapularis***

# **Factors influencing proportion of nymphal ticks infected with spirochetes**

- **Proportion of host animals infected**
- **Reservoir competence of each host species**
- **Distribution of larval ticks among host species**

# Probability of exposure

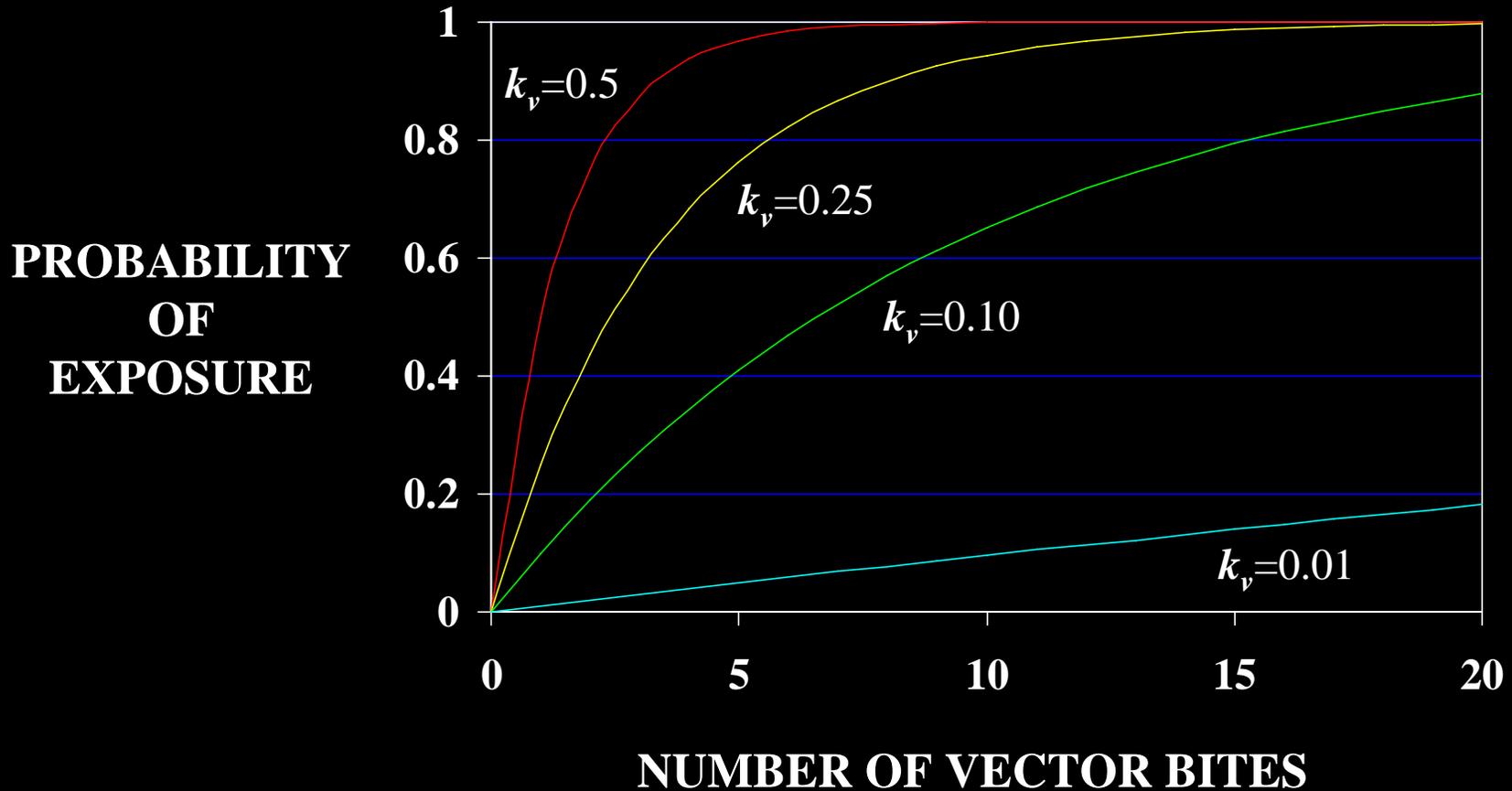
$$P_e = 1 - (1 - k_v)^n$$

$P_e$  = 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



# Estimated proportion of hosts exposed to *Borrelia burgdorferi*

<b>Host species</b>	<b>Locale</b>	<b>Source</b>	<b>Proportion</b>
<i>Peromyscus leucopus</i>	Fire Island NY	Ginsberg 1992	1.00
<i>Peromyscus leucopus</i>	East Haddam CT	Anderson & Magnarelli 1984	1.00
<i>Sciurus carolinensis</i>	East Haddam CT	Carey et al. 1981	1.00
<i>Tamias striatus</i>	East Haddam CT	Carey et al. 1981	1.00
<i>Geothlypis trichas</i>	Naushon Island MA	Mather et al. 1989	0.81
<i>Thryothorus ludovicianus</i>	Naushon Island MA	Mather et al. 1989	1.00

**Reservoir competence of vertebrate species for  
*Borrelia burgdorferi*, Fire Island, NY.**

**species            # larvae tested    # positive        % positive**

<b>robin</b>	<b>31</b>	<b>5</b>	<b>16.1 %</b>
<b>catbird</b>	<b>50</b>	<b>2</b>	<b>4.0</b>
<b>towhee</b>	<b>56</b>	<b>1</b>	<b>1.8</b>
<b>song sparrow</b>	<b>51</b>	<b>2</b>	<b>3.9</b>
<b>cardinal</b>	<b>23</b>	<b>2</b>	<b>8.7</b>
<b>brown thrasher</b>	<b>8</b>	<b>0</b>	<b>0</b>
<b>w.f. mouse (field)</b>	<b>372</b>	<b>207</b>	<b>55.6</b>
<b>w.f. mouse (control)</b>	<b>66</b>	<b>0</b>	<b>0</b>

## *Hosts of larval Ixodes scapularis*

### **Northeastern U.S.**

*Peromyscus leucopus*

*Tamias striatus*

*Turdus migratorius*

### **Southeastern U.S.**

*Scincella lateralis*

*Eumeces fasciatus*

*Ophisaurus* spp.

# West Nile Virus

## Enzootic vectors

*Culex pipiens*  
*Culex restuans*

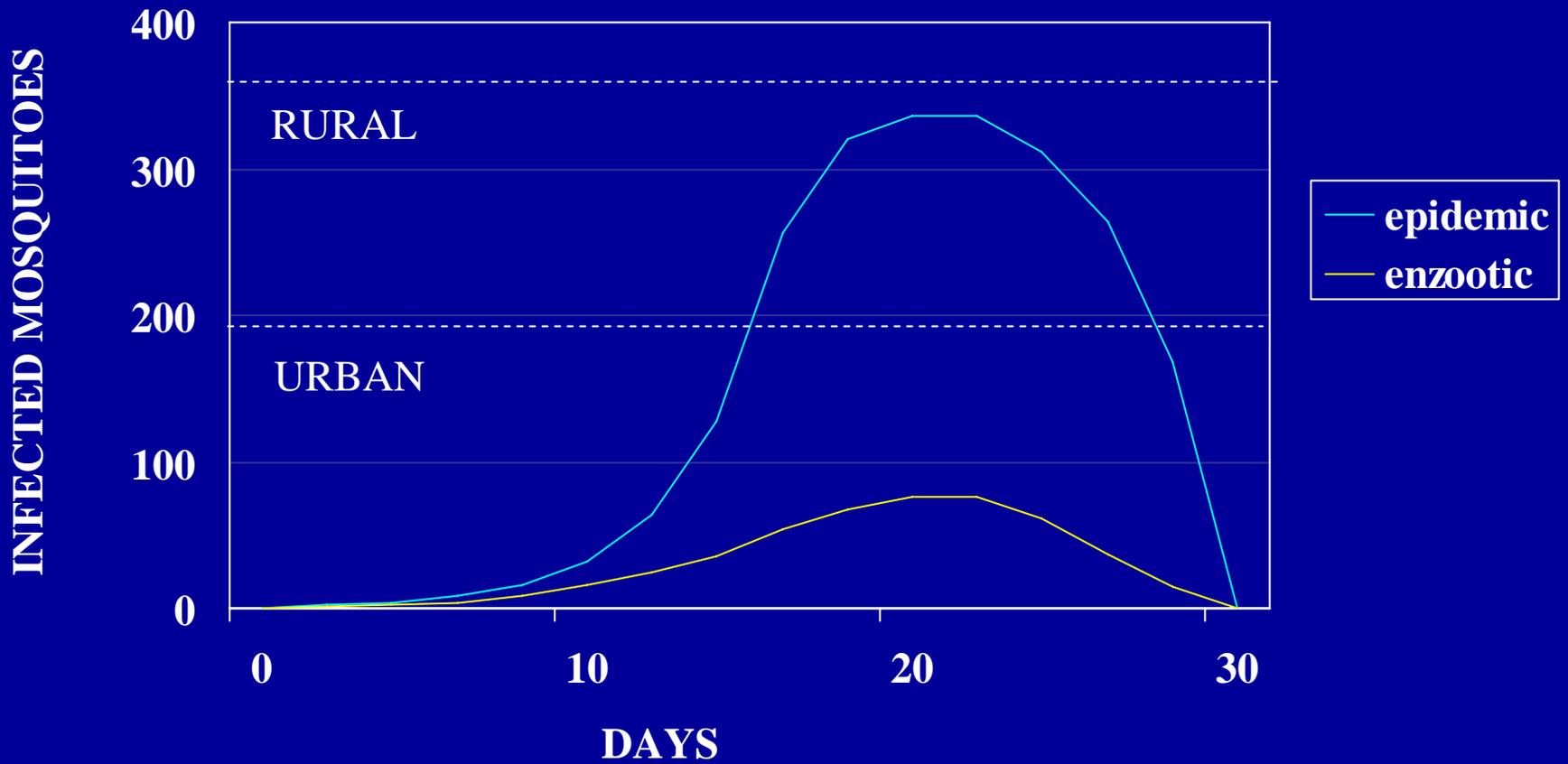
## Bridge vectors

*Culex salinarius*  
*Culex pipiens*  
*Aedes albopictus*  
*Aedes vexans*

## Reservoirs

*Turdus migratorius*  
*Passer domesticus*  
*Corvus brachyrhynchos*  
*Cyanocitta cristata*

# WNV epizootic activity



# Factors influencing WNV transmission

## Epizootiology

- WNV present
- Competent vectors
- Competent reservoirs
- Large vector population
- Densities of vectors and reservoirs
- Proximity of vectors and reservoirs

## Epidemiology

- Density of human-biting mosquitoes infected with WNV
- Density of humans
- Proximity of humans and infected mosquitoes

# Efficient management of vector-borne diseases

## Conservation

*Well-targeted interventions:*

Less need for large-scale, broad-spectrum control measures (minimizes nontarget effects)

## Public health

*Greater cost-effectiveness:*

Fewer people get sick

