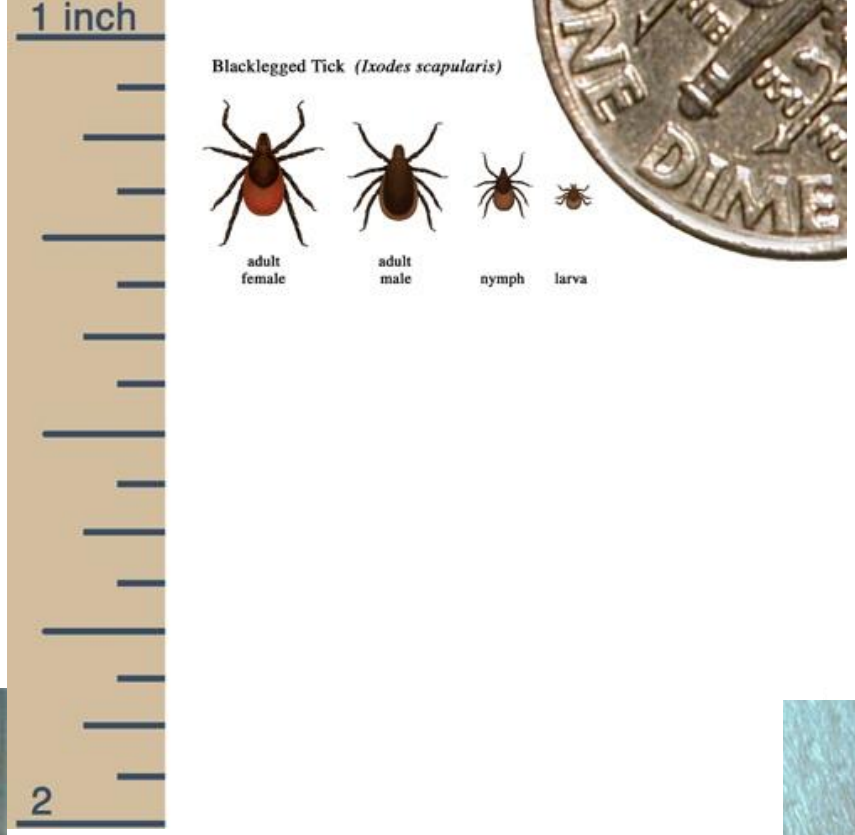
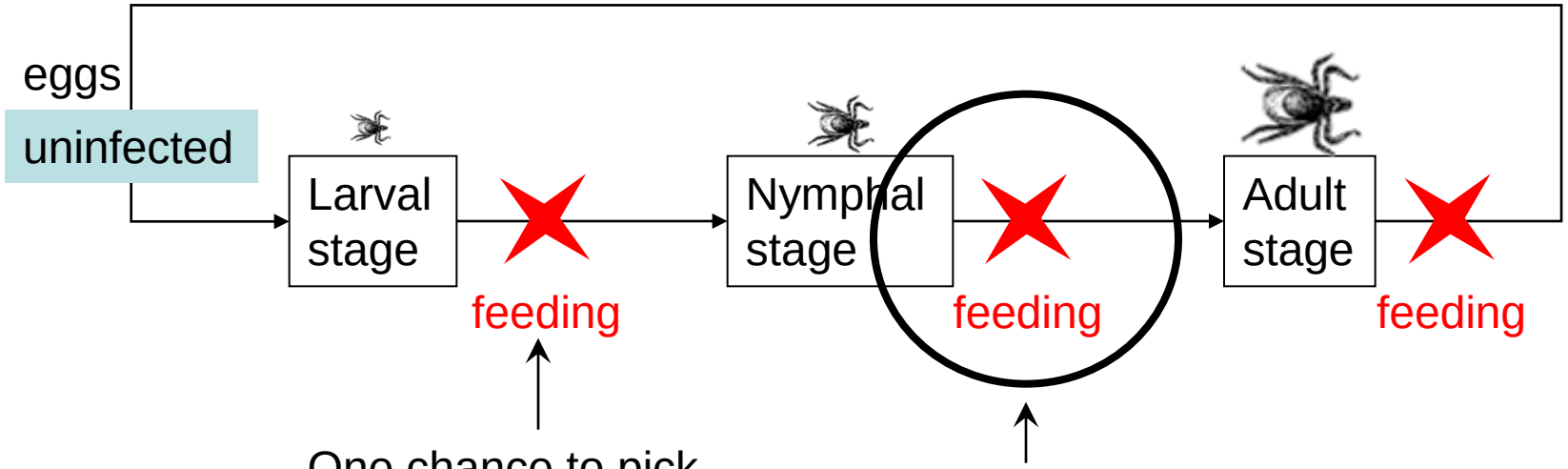
Lecture 8: Lyme Disease and Ecology

Questing


1 inch
2
Blacklegged Tick (Ixodes scapularis)
adult female
adult male
nymph
larva
ONE DIME

←Adult

Nymph→



One chance to pick up *Borrelia* infection before nymphal stage

Humans are at risk during this feeding

Host for tick larval stage determines ***nymphal infection prevalence***

Risk to humans determined by:

1. Density of nymphal ticks
2. Infection prevalence in nymphal ticks
3. Human behavior

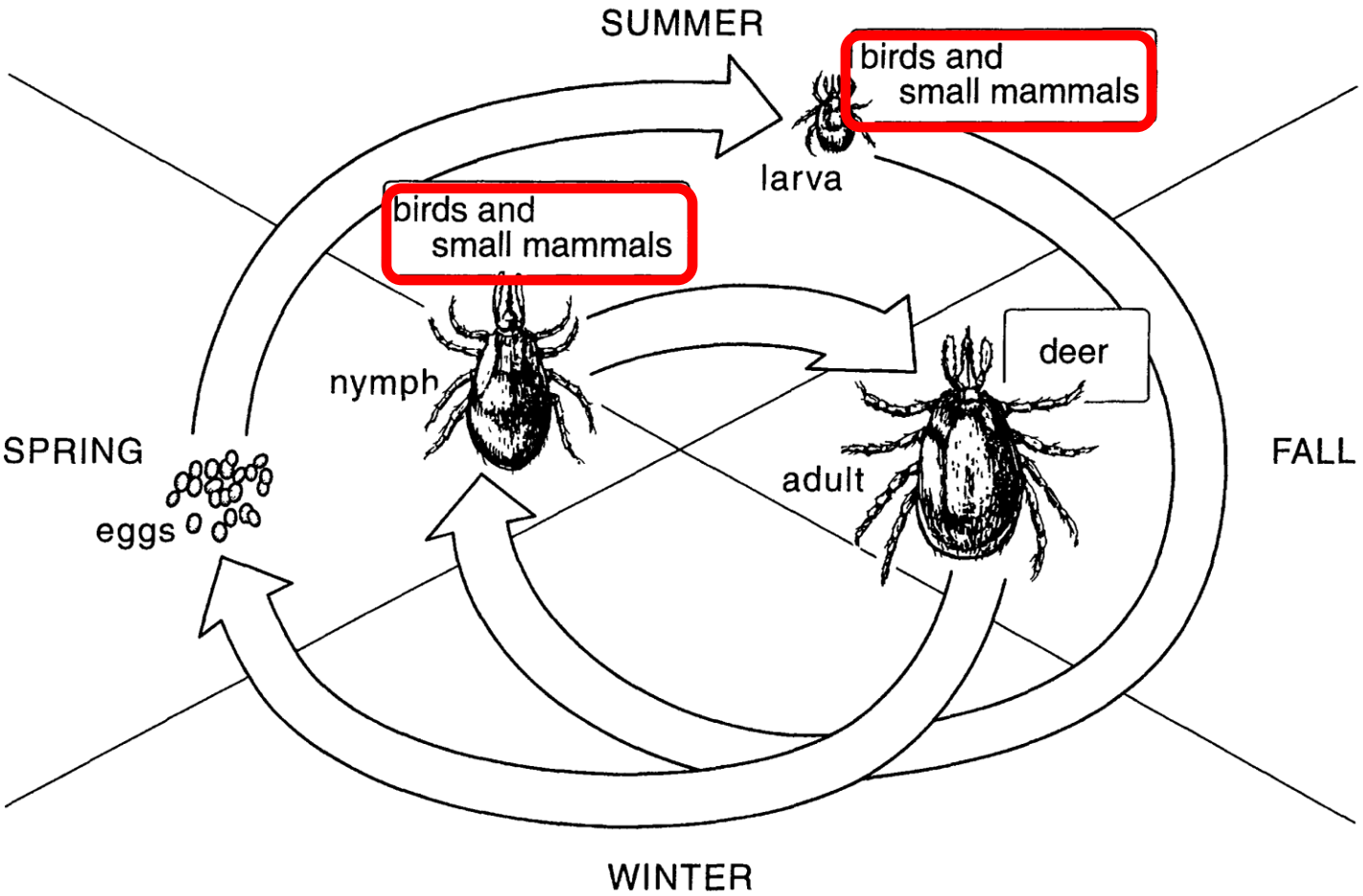
Tick life cycle:
East coast (*Ixodes scapularis*)

How does altering the host community affect disease risk?

Disease risk = cases in a target species

Increased disease risk

Decreased disease risk



How does altering the host community affect disease risk?

Disease risk = cases in a target species

Increased disease risk

Amplification

Adding a species to a community increases the total abundance of hosts for a pathogen, increasing the disease risk to the target host.

Decreased disease risk

Dilution

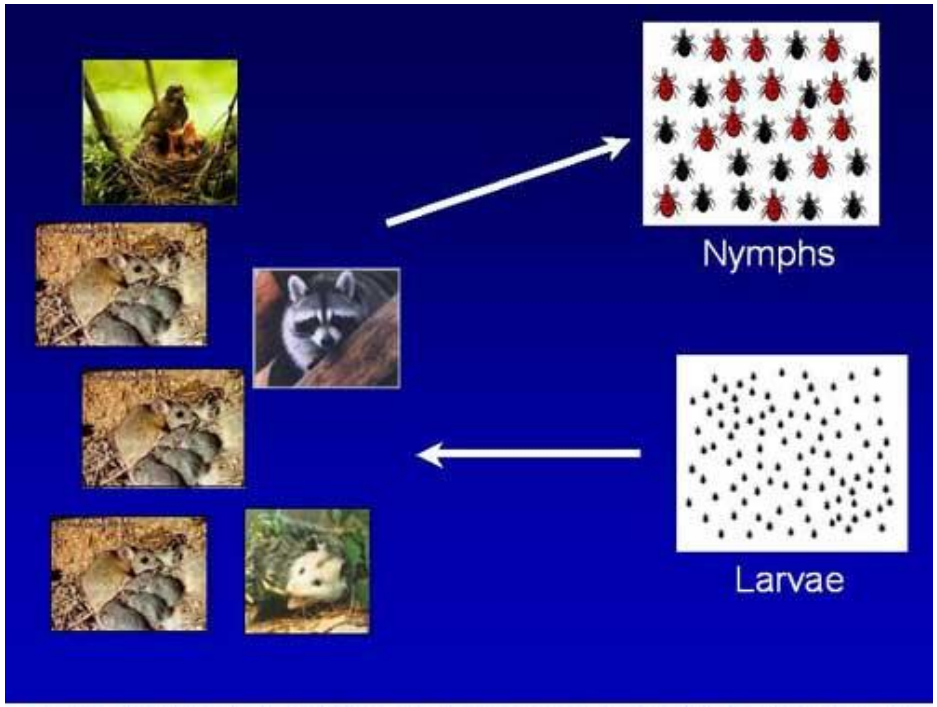
Adding a species to a community decreases the abundance of more competent hosts, decreasing the disease risk to the target host.

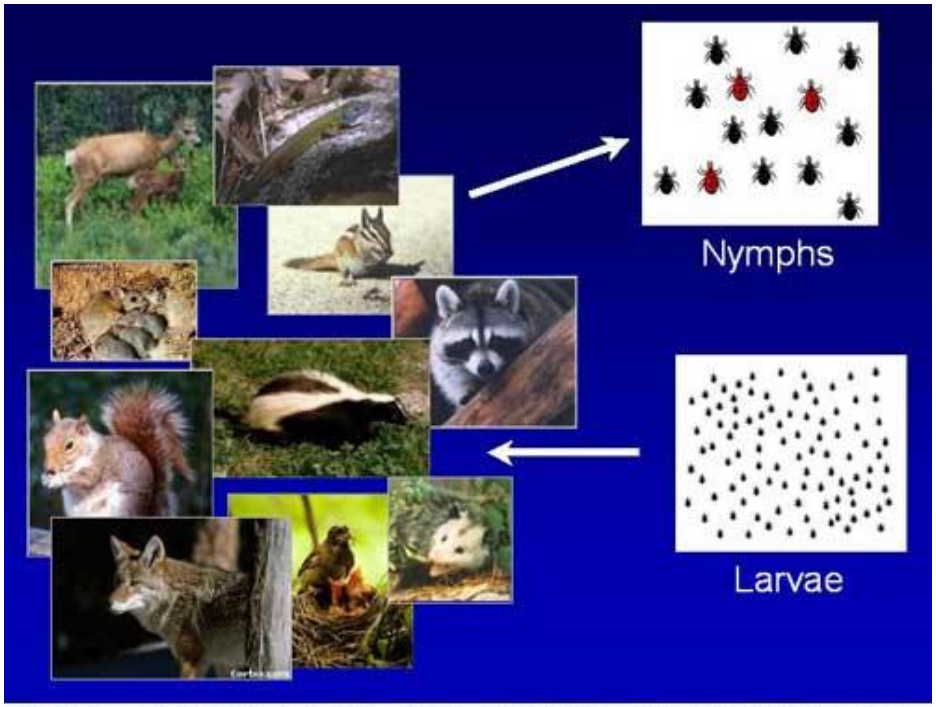
Each tick feeds only once per stage.

Feedings spent on poorly-competent hosts are “wasted” for the disease.

Competence (for hosts)

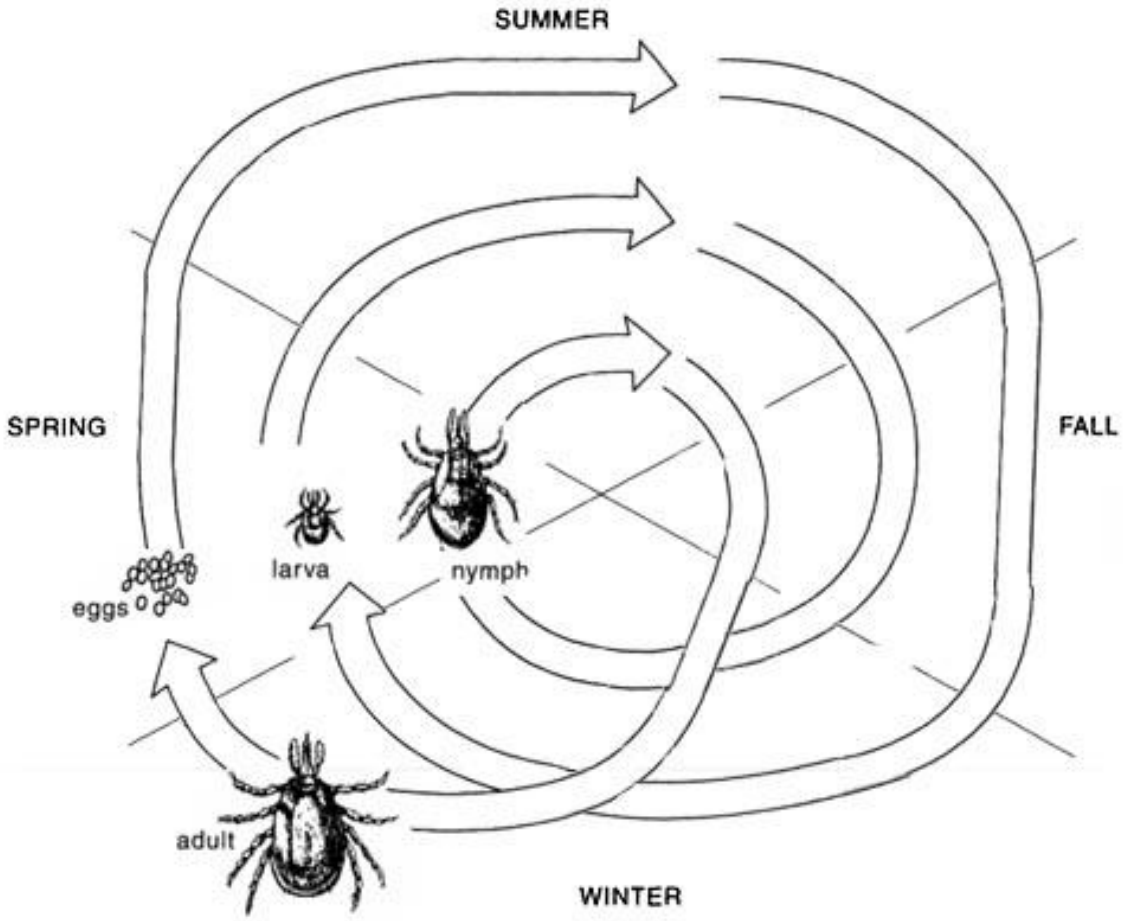
The efficiency with which a host acquires and spreads a pathogen.





- White footed mice do well as other species are lost
- White footed mice are a **preferred** host of the ticks → More ticks
- White footed mice are a **competent** host → more infected ticks

Tick life cycle:
California (*Ixodes pacificus*)



Reservoir competence

Hosts differ in their efficiency at acquiring and spreading the *Borrelia* spirochete

Highly competent

Dusky-footed woodrat
(*Neotoma fuscipes*)

Somewhat competent

Deer Mouse
(*Peromyscus maniculatus*)

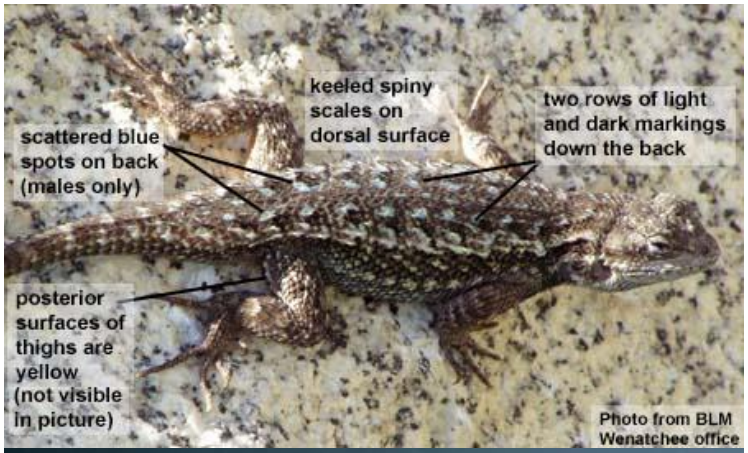
Totally incompetent

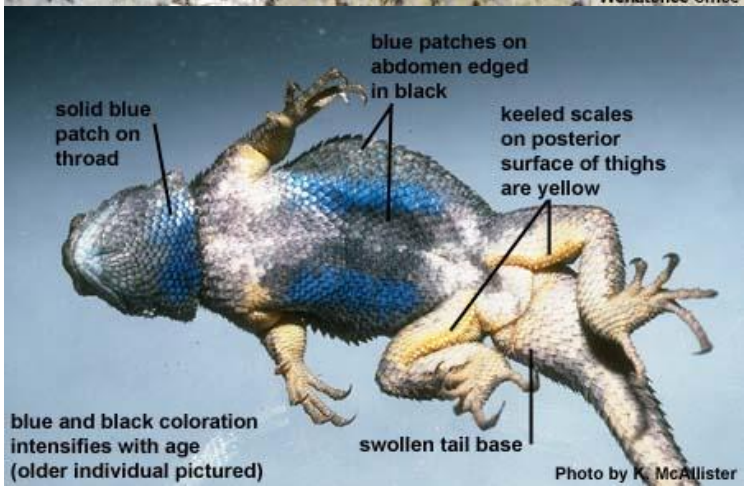
Western Fence Lizard
(*Sceloporus occidentalis*)

Lyme disease cases 1992-2006

California 0.3 cases per 100,000

Connecticut 74 cases per 100,000





Sudden Oak Death

↓

habitat characteristics

↓

vertebrate host community

↓

tick abundance & infection prevalence

↓

Lyme disease risk to humans

Risk to humans determined by:

1. Density of nymphal ticks
2. Infection prevalence in nymphal ticks

3. Human behavior

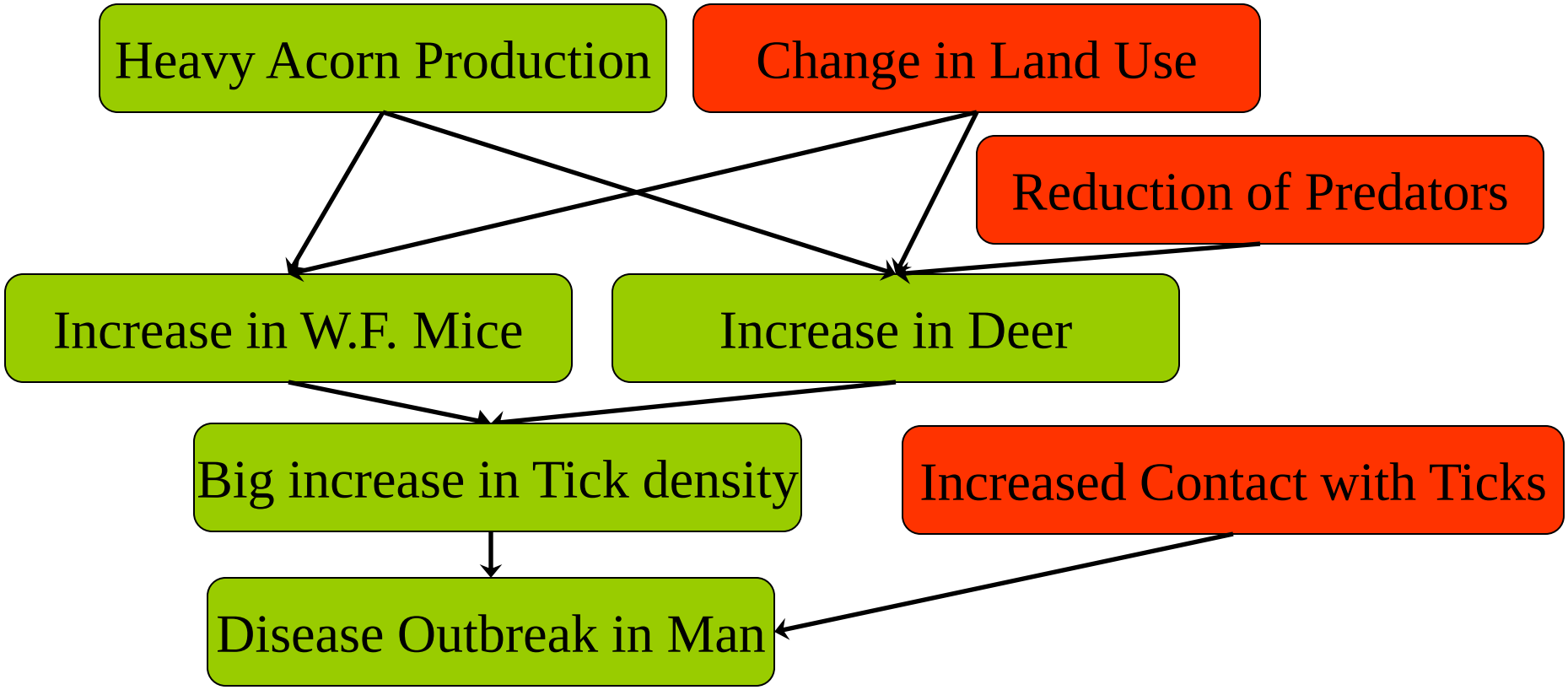
UC Berkeley researcher Denise Steinlein demonstrates the three actions found to be riskiest for acquiring ticks:

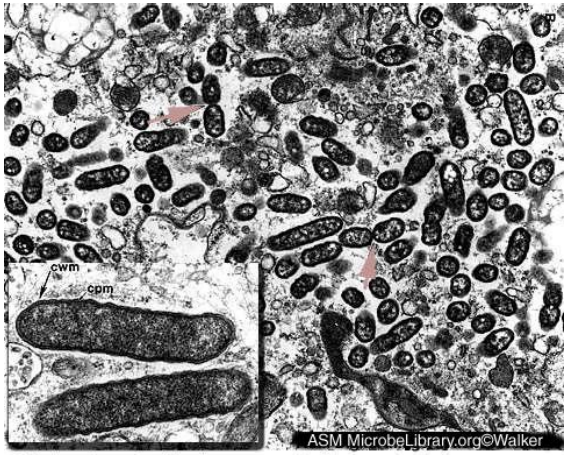
leaning against a tree,
carrying wood and
sitting on a log.

Anthropogenic factors

Natural factors or consequences

Lyme Disease





Following release from the phagosomes, rickettsiae grow free in the cytoplasm of cultured cells, dividing by binary fission (seen at arrows). Inset highlights the outer and inner membranes of rickettsia.

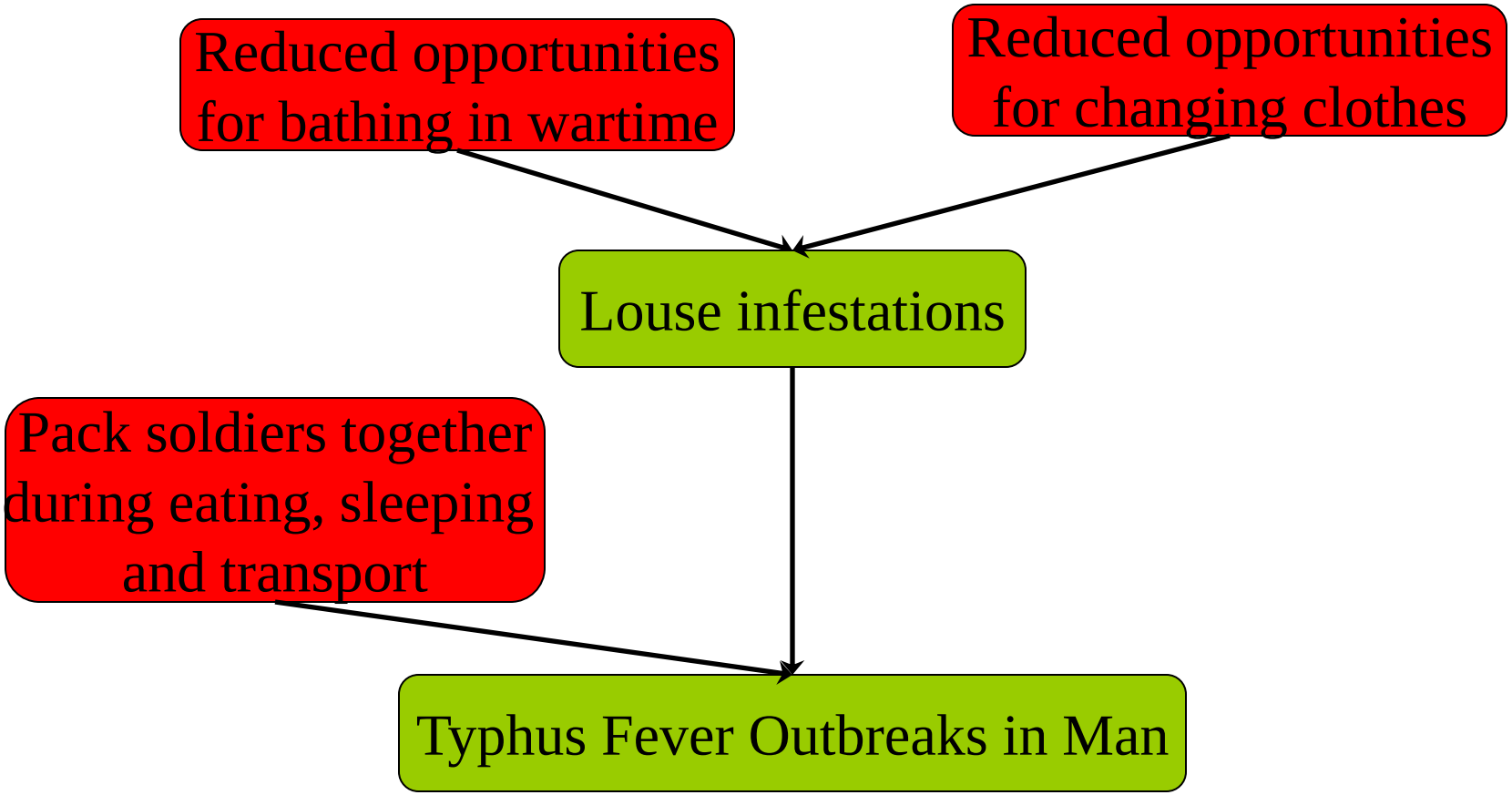
Rickettsia prowazekii

Human louse:
Pediculus humanus

Typhus Fever aka War Fever, Camp Fever, Famine Fever, Jail Fever, Ship Fever, Spotted Fever, Sharp Fever, Epidemic Fever, Putrid Fever, Fourteen Day Fever, Malignant Fever, Petechial Fever or Spotted Ague.

The Louse is a very inefficient vector with a very short range of movement.

Typhus Fever



Napoleon defeated by Typhus

Opponent	Year	Winner
Russia	1812	Typhus (300,000/600,000)
Austria/Prussia/Russia	1813	Typhus (219,000/500,000)

The Crusades

1190. Plague and famine reduced a Christian army from 100,000 to 5,000 soldiers.

Crimean War (1853-1856)

During the war, more than 70,000 French soldiers died of disease, 10,000 were killed in action and 20,000 died of wounds.

US Civil War (1861-1865)

Of the 650,000 soldiers who died, over 400,000 died of disease.

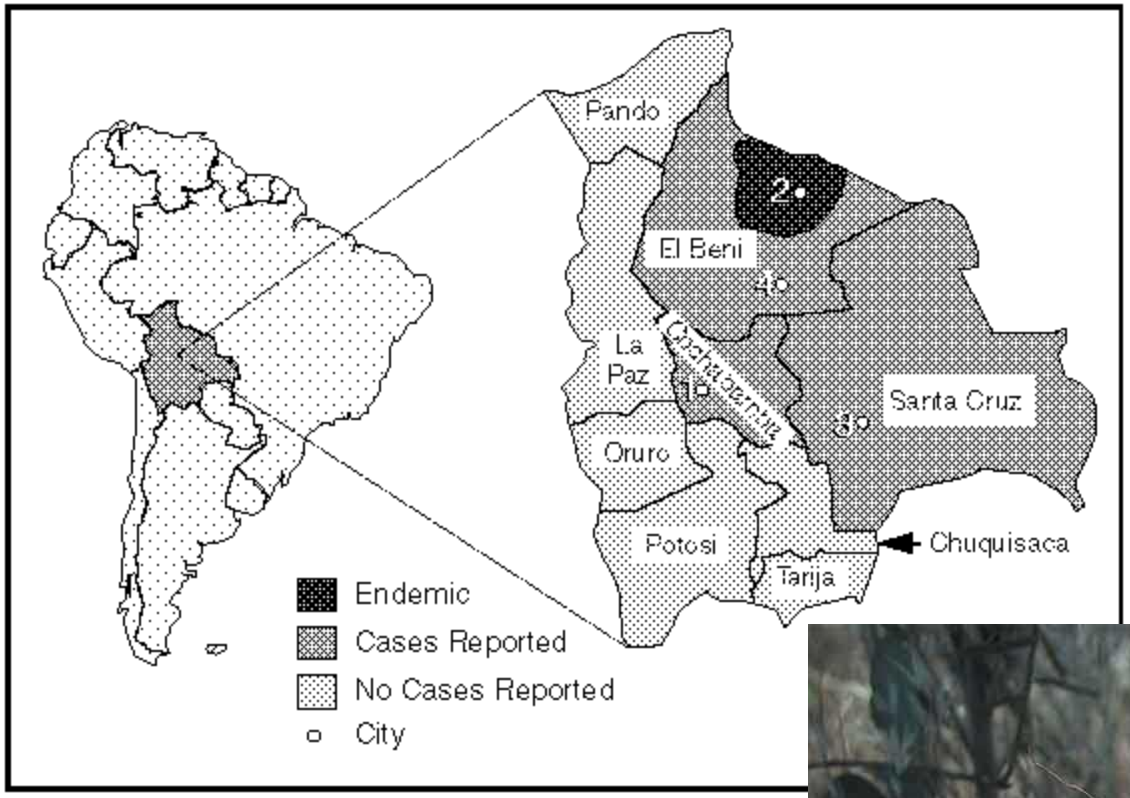
Spanish-American War (1898)

During this short war, almost 2,000 American soldiers died of disease while only 469 were killed in action or mortally wounded.

World War I (1914-1918)

As armies were returning home, a typhus epidemic raged. There were 30 million cases and 3 million deaths in European Russia alone.

FIGURE 1. Area in which Bolivian hemorrhagic fever is endemic and four cities* in which suspected cases were identified — Bolivia, July 1–September 30, 1994



* 1) Cochabamba, 2) Magdalena, 3) Santa Cruz, and 4) Trinidad.

Bolivian Hemorrhagic Fever

Bolivian Hemorrhagic Fever