


Lesson 9. Vector Control



Zoonotic Diseases

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Lesson Overview

- ❖ Definitions
- ❖ The Problem
- ❖ Causal Factors
- ❖ Control Measures
- ❖ Example

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Definitions

- ❖ **Pest:** Serious or fatal disease (archaic)
- ❖ **Pestilence:** Any, usually fatal, epidemic disease
- ❖ **Zoonotic Disease:** Diseases transmitted from vertebrate animals to humans through various routes
 - > Pets
 - > Livestock
 - > Wildlife

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Definitions *Continued*

- ❖ **Vector:**
 - An arthropod which carries a pathogen to a new host
 - Any organism which helps a pathogen reach a new host
 - An animate vehicle
- ❖ **Vectorborne Disease:** Diseases transmitted by a vector

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Zoonotic Diseases

Table 3.2 Number of Diseases that Human Populations Share with Domesticated Animals

Poultry	26
Rodents	32
Horse	35
Pig	42
Sheep/Goats	46
Cattle	50
Dog	65

Source: McNeil WH. *Plagues and People*, 1977

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Zoonotic Disease Transmission

- ❖ Direct Contact
- ❖ Transmission by Vectors

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Direct Animal Contact

- ❖ Disease agent found in saliva, blood, other body tissues
- ❖ Bites, scratches
- ❖ Contact with animal tissues or fluids (open cuts or on mucous membranes)
 - livestock - veterinarians, farmers
 - wildlife - handling dead or ill animals, field specimen collections

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Direct Animal Contact

- ❖ **Anthrax** - Handling sheep, other animals
- ❖ **Plague** - trappers skinning animals, blood or tissue contact, also flea bites
- ❖ **Brucellosis** - livestock tissue contact
- ❖ **Ringworm** - fungal infection (young kittens, puppies)
- ❖ **Rabies** - bites, scratches (virus found in saliva, salivary glands, nerve tissue only)
- ❖ **Rat bite fever** - (Streptococcal bacterial infection)
- ❖ **Tularemia** - rabbits, hares, rodents (also transmitted via other routes)

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For Example

- ❖ -900 Salmonella cases reported annually in Washington
 - Difficult to identify source of exposure for every case
 - Most probably are foodborne
 - Unknown percentage due to animal contact
 - Some waterborne, some person-to person
 - Need good thorough investigations
 - Consider animal exposure

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Salmonella Sources

- ❖ High percentage of reptiles (snakes, lizards, turtles) naturally carry *Salmonella* without signs of illness
- ❖ Serious cases in infants, immunocompromised, elderly
- ❖ Any animal food product may harbor *Salmonella*
- ❖ Outbreaks: Denver Zoo, Oregon infant cases, petting zoos

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Transmission by Vectors

- ❖ Ticks, mosquitoes, fleas, flies acquire disease agent from animal reservoir and transmit it to another host
- ❖ Natural host is not affected by the agent
- ❖ Accidental host may be severely ill or die
- ❖ Washington - low incidence of reported vector-borne diseases

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The Vector Problem

- ❖ Nuisance
- ❖ Property damage
 - Crops
 - Structures
 - Goods
- ❖ Human disease

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Nuisance

- ❖ Each year . . .
 - American consumers spend \$600,000,000 on pest control
 - 60% is spent in the residential market
 - \$2.9 Billion is spent on professional pest control

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Economic Impact

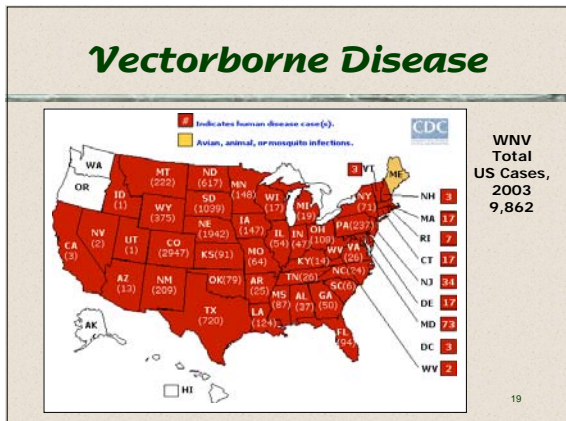
- ❖ Each year . . .
 - 1/3 of the world's crops are destroyed during growth, harvesting and storage
 - 25% of home gardener's crops destroyed
 - \$20 Billion in crop loss/damage
 - Residential damage = ???

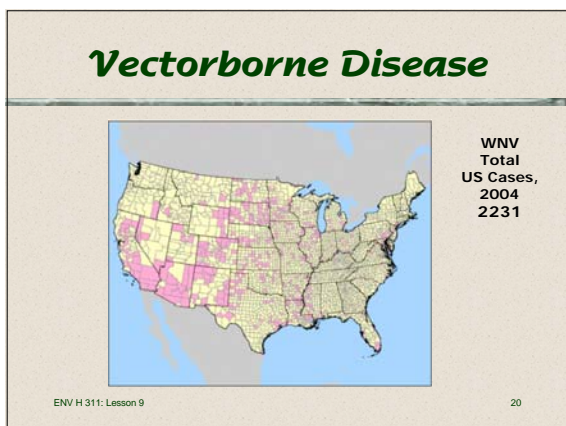
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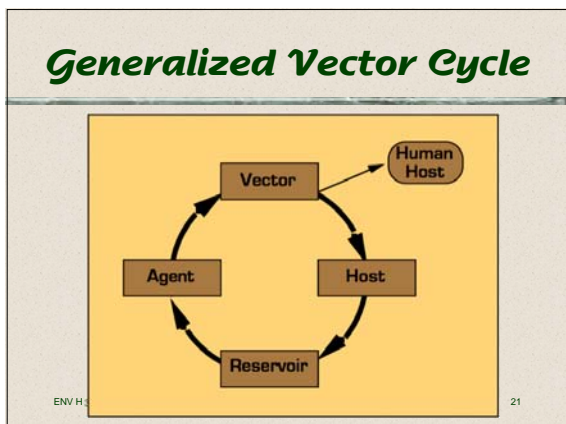
Important Zoonotic & Vectorborne Diseases

❖ Arboviral Encephalitides	❖ Rabies
❖ Dengue	❖ RMSF
❖ Hantavirus	❖ Tularemia
❖ Lyme Disease	❖ Typhus (Epidemic)
❖ Malaria	❖ Typhus (Murine)
❖ Plague	❖ Yellow Fever

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Vectorborne Disease Ecology

- ❖ The agent becomes established in an animal population
- ❖ The animal population comes into contact with man
 - (one or the other, or both, move)
- ❖ The vector must be able to transmit the agent to humans

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Disease Ecology *Continued*

- ❖ Epizootic conditions prevail
 - Sufficient numbers of infective vectors
- ❖ Appropriate climatic conditions exist
 - Temperature range
 - Humidity
 - Rainfall
- ❖ Confluence of all of these factors is necessary

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Important Vectors

<ul style="list-style-type: none">❖ Arthropods<ul style="list-style-type: none">➢ Mosquitoes➢ Other flies➢ Fleas➢ Ticks➢ Lice➢ Mites	<ul style="list-style-type: none">❖ Other Animals<ul style="list-style-type: none">➢ Rats➢ Mice➢ Bats➢ Birds
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Transmission

- ❖ Mechanical
- ❖ Biological

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Tickborne Diseases

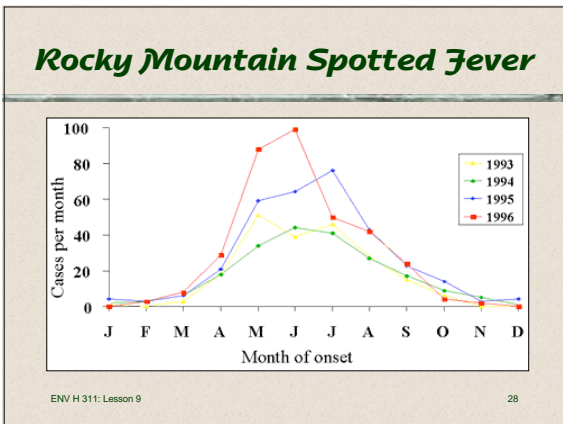
- ❖ Lyme disease
- ❖ Relapsing fever
- ❖ Tularemia
- ❖ Ehrlichiosis
- ❖ Babesiosis
- ❖ Rocky Mountain Spotted fever
- ❖ Tick paralysis (intoxication)

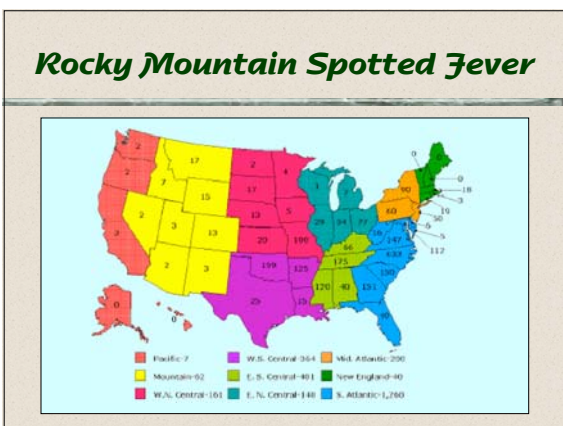
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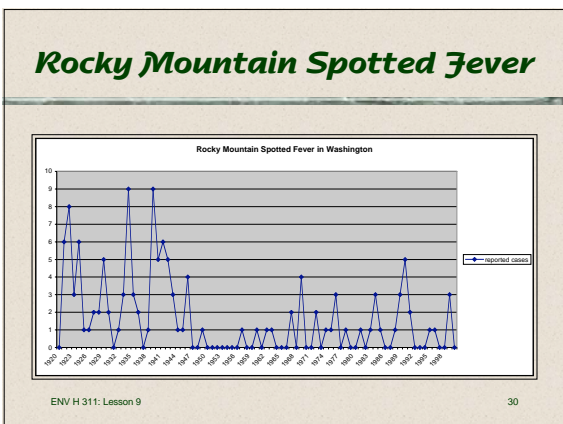
Rocky Mountain Spotted Fever

Year	Number of Cases
1942	500
1945	500
1948	600
1951	400
1954	300
1957	250
1960	250
1963	300
1966	400
1969	500
1972	800
1975	1100
1978	1150
1981	1100
1984	700
1987	600
1990	500
1993	450
1995	800

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Diseases Transmitted by Flies

- ❖ Tularemia - deer fly bites
- ❖ Mechanical transmission of enteric bacteria (Salmonella, Shigella, Campylobacter)

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Tularemia

FIGURE 1. Finger of patient infected with tularemia




Photo/CDC file

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Tularemia

FIGURE 2. Reported cases* of tularemia — United States, 1990-2000

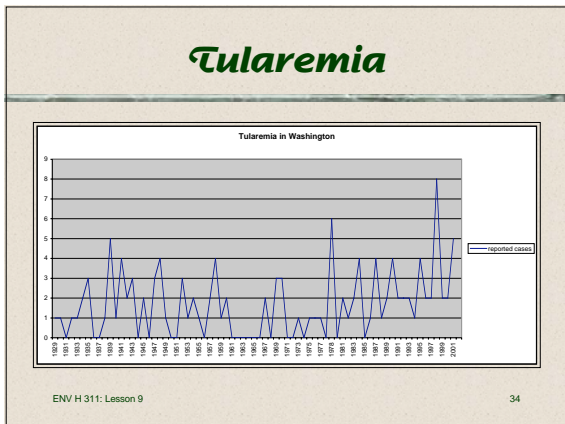


Number of Cases*
● 18
● 30

1990-2000

- 1,368 cases of
- from 44 states
- ~ 124 cases/year
- Range = 86-193

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- ### Fleaborne Diseases
- ❖ Bartonellosis - formerly cat scratch fever
 - ❖ Tapeworms
 - ❖ Plague - (1984) one human case in Washington
- ENV H 311: Lesson 9 35

Plague

- ❖ Early 1330s an outbreak of bubonic plague occurred in China
- ❖ Spread to western Asia and Europe
- ❖ Sicily, October of 1347

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Plague



- ❖ 1348: spread as far north as England
- ❖ 25 million people died in 5 years

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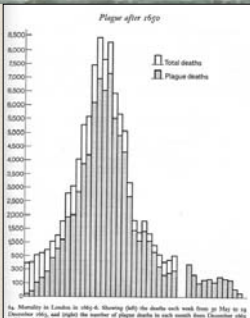
Plague



- ❖ Estimated population of Europe from 1000 to 1352:
 - > 1000 - 38 million
 - > 1100 - 48 million
 - > 1200 - 59 million
 - > 1300 - 70 million
 - > 1347 - 75 million
 - > 1352 - 50 million

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London, 1665-1666



- ❖ Disappeared after 1352
- ❖ Until the mid-17th century

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Plague in the U.S.



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So What?



Thousands flee as plague spreads death, panic in India

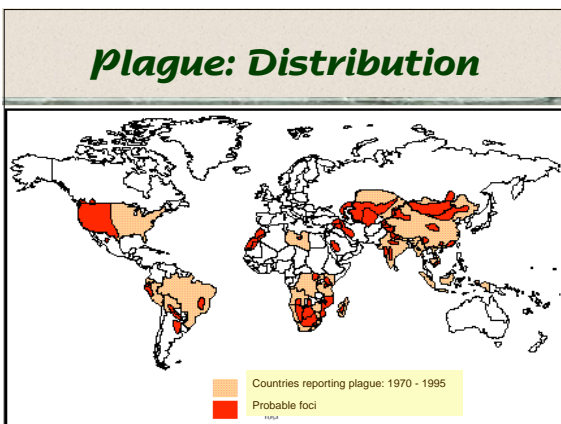
By Michael Levey
The outbreak in India
 BANGALORE — They have managed to stop the spread of the deadly disease, but the outbreak has not ended. In fact, it has spread to other parts of the country, and the death toll has risen to 100.

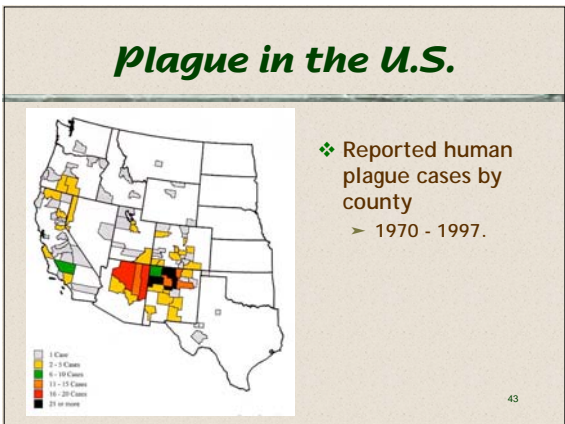
The 100,000 deaths have had a profound impact on the country. The World Health Organization (WHO) has declared it a global health emergency. The outbreak is the first of its kind in India since 1994.

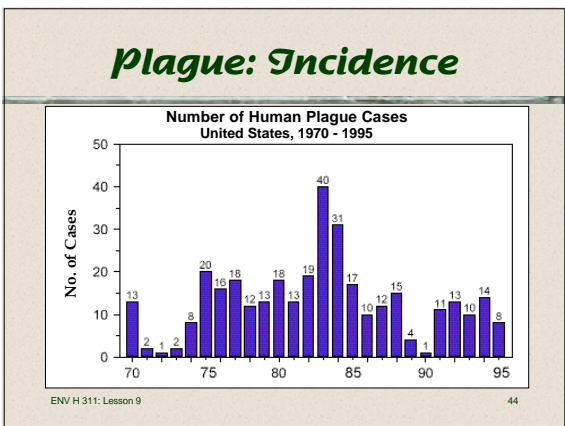
The WHO has urged the government to take immediate action to contain the disease. It has also urged the public to avoid contact with sick people and to seek medical attention if they become ill.

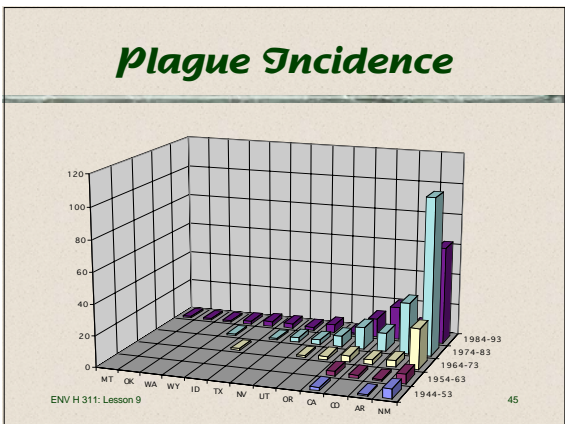
The WHO has also urged the government to improve its surveillance system for zoonotic diseases. It has also urged the public to avoid contact with sick people and to seek medical attention if they become ill.

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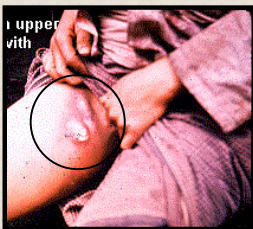
Plague

- ❖ **Agent:** *Yersinia pestis* (bacterium)
- ❖ **Vector:** *Xenopsylla cheopis* (Oriental Rat Flea)
- ❖ **Reservoir:** *Rattus Norvegicus* and *Rattus rattus* (Norway and Roof Rats)
- ❖ **Onset:** 2 -6 days after being bitten
- ❖ **Disease:** Bubonic, Pneumonic & Septicemic

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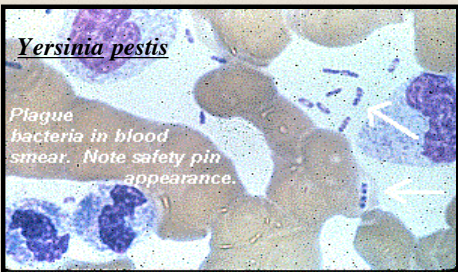
Bubonic Plague

- ❖ High Fever
- ❖ Toxemia
- ❖ Petechiae
- ❖ Shock
- ❖ Buboes



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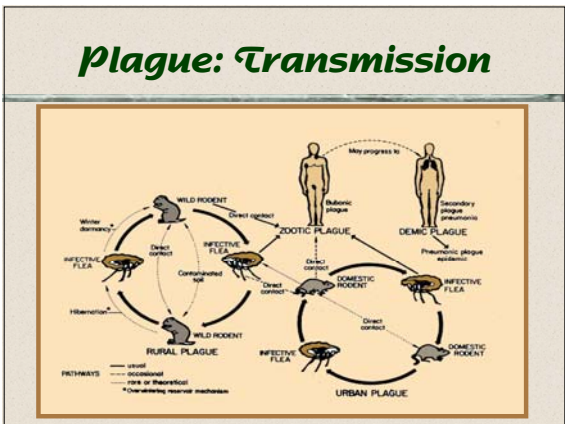
Plague: Agent

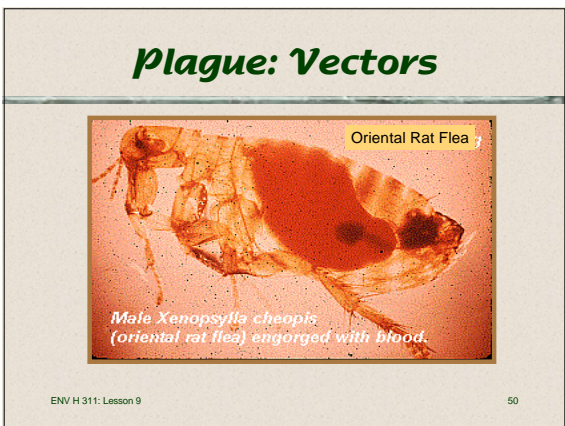


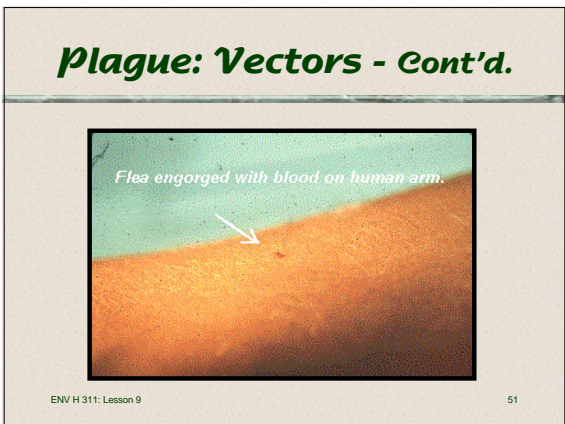
Yersinia pestis

Plague bacteria in blood smear. Note safety pin appearance.

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Plague: Vectors - Cont'd.

The diagram illustrates the life cycle of a flea. It starts with an **Egg**, which develops into a **Larva**, then a **Pupa**, and finally an **Adult** flea. The adult flea is shown with its legs and wings, ready to bite a host. The cycle is labeled "Life cycle of the flea".

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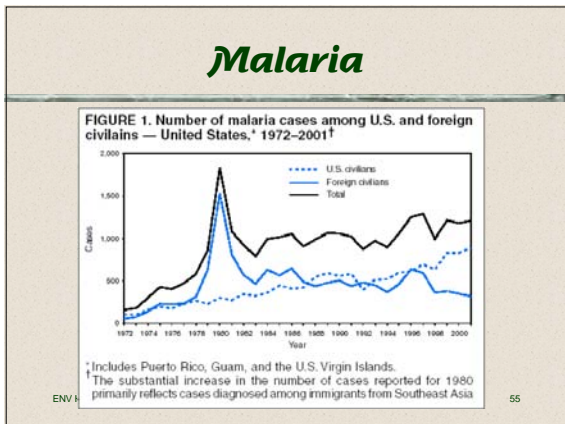
Reservoir

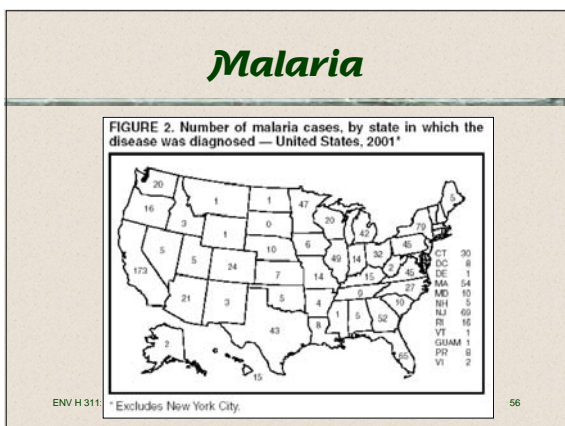
The image shows two types of reservoirs for plague. On the left, two mice are shown, labeled **Urban**. On the right, a prairie dog is shown, labeled **Rural**.

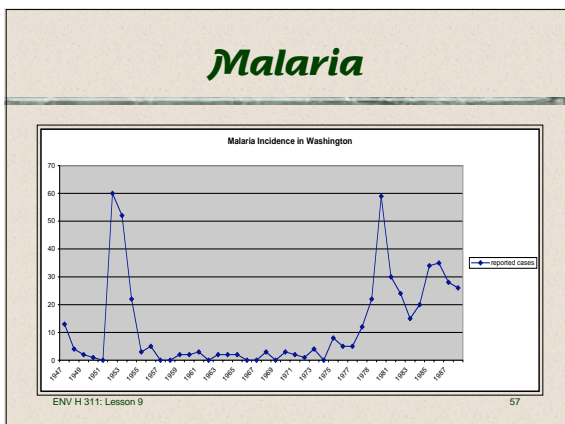
Mosquitoborne Diseases

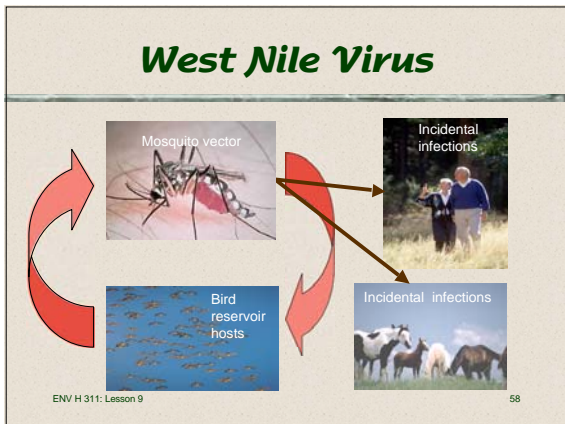
- ❖ Western equine encephalitis virus
- ❖ St. Louis encephalitis virus
- ❖ Both have occurred in Washington but no reported cases since early 1980's
- ❖ West Nile virus
 - > detected in 1999 in New York City
 - > human and horse deaths, dead birds
 - > progressing to other states in 2000
 - > Planned surveillance effort in Washington

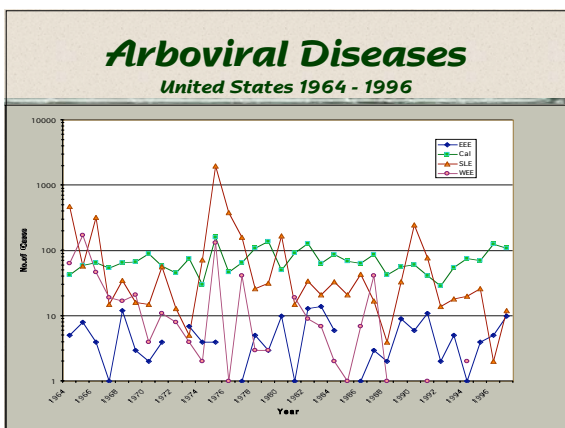
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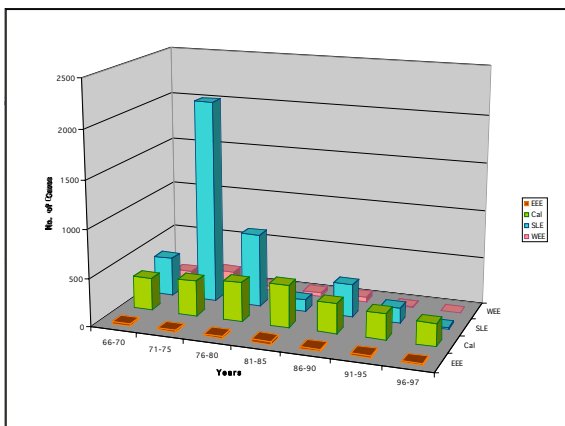


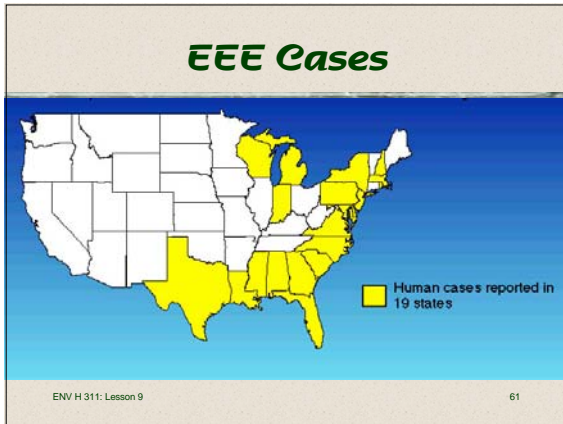


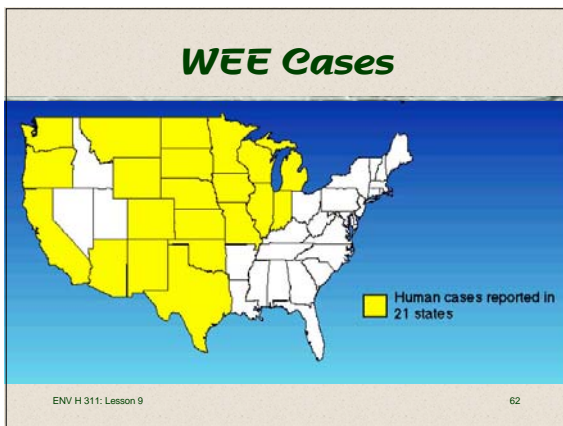


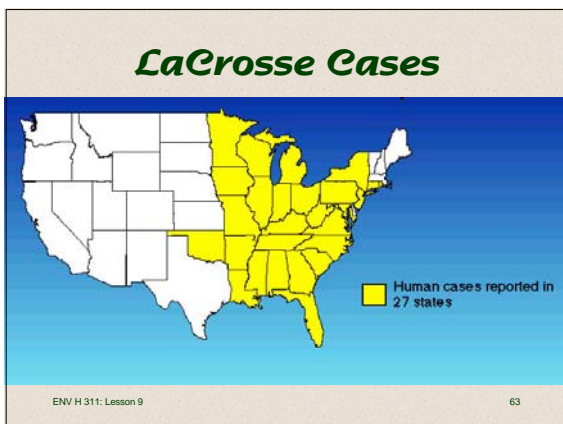


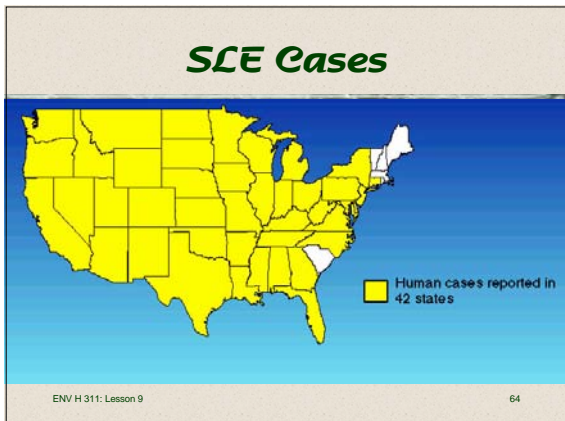


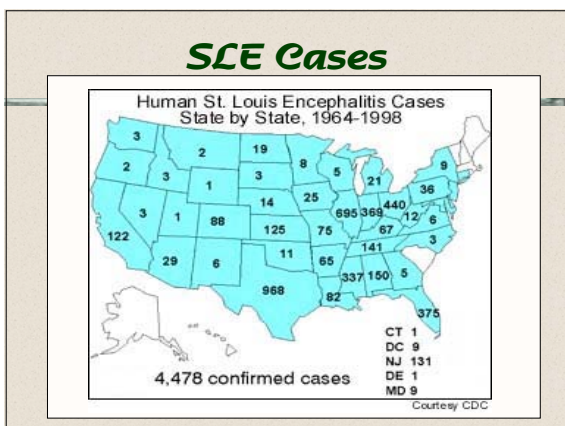


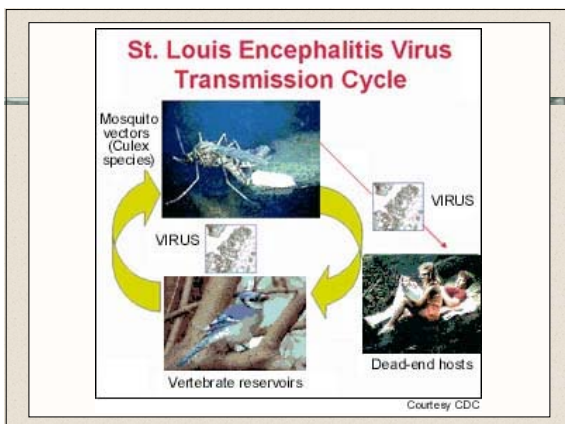


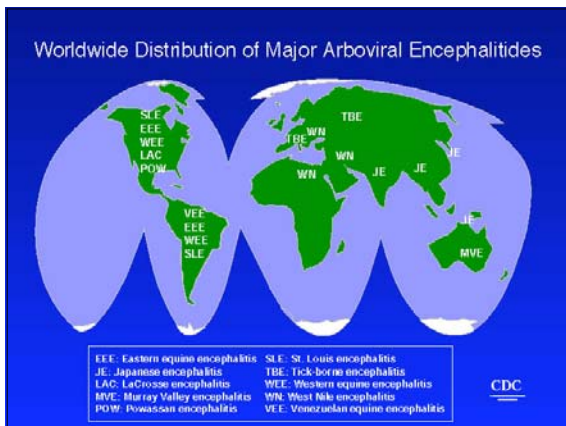








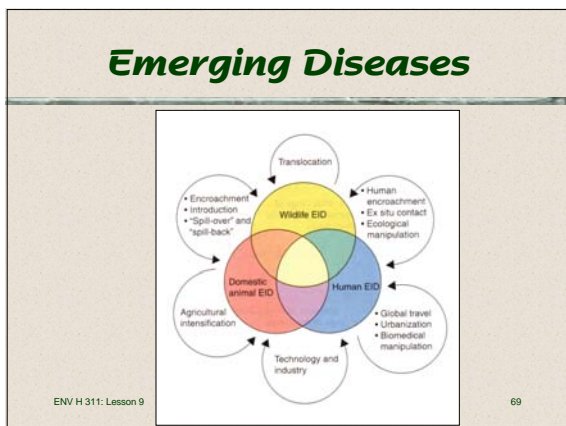




Causal Factors

- ❖ A "good" vector must:
 - > Be able to harbor the agent
 - > Be able to spread the agent
 - > Be mobile
 - > Survive long enough to:
 - Reproduce
 - Disseminate the agent
 - > Have wide zonal tolerances

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Protecting the Public's Health

- ❖ Surveillance
- ❖ Personal Protection and Education
- ❖ Vector Control

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Zoonotic Disease Program

- ❖ Education/technical assistance prevention information
- ❖ Case investigation (human and animal)
- ❖ Surveillance
 - Human and animal cases
 - Animal reservoir, arthropod vectors

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Personal Protection

- ❖ Wear long sleeves & pants in mosquito-infested areas
- ❖ Use repellent containing DEET (N,N-diethyl-3-methylbenzamide) and follow directions carefully
- ❖ Limit outdoor activities at dawn and early evening
- ❖ Repair holes in door & window screens

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Control

- ❖ Usually involves controlling the vector
 - Habitat reduction / modification
 - Sanitation
 - Larvaciding
 - Adulticiding
 - Integrated Pest Management (IPM)

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To Control Vectors

- ❖ Deny them:
 - Water
 - Food
 - Harborage
 - Warmth

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Surveillance

- ❖ What does it mean?
 - Human and animal cases
 - who, when, where, how
 - Prevalence studies
 - reservoir animals
 - arthropods (ticks, mosquitoes)
 - Population monitoring
 - Species distribution

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For Example

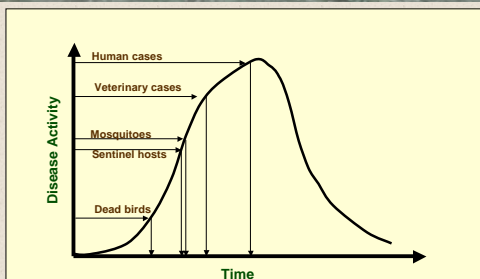
❖ WNV Surveillance:

- Dead birds
 - Especially crows, jays, magpies
- Mosquitoes
- Captive sentinels (e.g. chickens)
- Veterinary surveillance
- Human surveillance

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Estimated Sensitivity of WNV Surveillance Methods



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EVS Mosquito Traps


Packed with dry ice in preparation for trapping.



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EVS Mosquito Traps


Setting the trap in proper location.



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EVS Mosquito Traps

In operation.



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WNV Mosquitoes in Washington

Mosquito species	Counties (39)
<i>Aedes cinereus</i>	29
<i>Aedes vexans</i>	27
<i>Culex pipiens</i>	28
<i>Culex restuans</i>	1
<i>Culex tarsalis</i>	35
<i>Anopheles punctipennis</i>	26
<i>Coquilletidia perturbans</i>	10
<i>Ochlerotatus canadensis</i>	5
<i>Ochlerotatus japonicus</i>	1

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Tick Surveillance



Blanket-dragging for ticks.

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Rodent Surveillance



Rodent Droppings
Another sign of infestation, droppings can transmit hantaviruses and arenaviruses.

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Rodent Surveillance



Correct placement

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Control Measures

- ❖ Appropriate for pest
- ❖ Acceptable to community
- ❖ IPM approach
- ❖ Good records

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Control Measures *Continued*

- ❖ Arthropods
 - Sanitation
 - Environmental modifications
 - Pesticides
 - Larvicides
 - Adulticides
 - Repellants

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Control Measures *Continued*

- ❖ Rodents
 - Sanitation
 - Environmental modifications
 - Rodent proofing
 - Trapping
 - Rodenticides

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Integrated Pest Management (IPM)

- ❖ Physical Control
- ❖ Mechanical Control
- ❖ Biological Control
- ❖ Chemical Control

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IPM

- ❖ Physical Control
 - > Sanitation
 - > Environmental modification
- ❖ Mechanical Control
 - > Trapping

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Habitat Reduction

- ❖ Eliminate standing water (flower pots; tires; wheelbarrows; wading pools)
- ❖ Change the water in birdbaths at least weekly
- ❖ Aerate and chlorinate swimming pools and hot tubs; cover if possible
- ❖ Consider mosquito-eating fish for your pond
- ❖ Keep gutters clean to prevent standing water
- ❖ Spread the word: educate your friends and neighbors

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SPM *Continued*

- ❖ **Biological Control**
 - Use resistant species
 - Natural enemies
 - Sterile males
 - Biological insecticides
 - Insect Pheromone
 - Bacteria

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SPM *Continued*

- ❖ **Chemical Control**
 - By Application
 - Larvacides
 - Adulticides
 - By Mode of Action
 - Stomach poisons
 - Contact poisons

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SPM *Continued*

- ❖ **Chemical Control** *Continued*
 - By Chemistry
 - Inorganics
 - Organochlorine compounds
 - Organophosphate compounds
 - Carbamate compounds
 - Pyrethrins & Pyrethroids

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Cooperation / Coordination

- ❖ Federal
- ❖ State
- ❖ Local
- ❖ Private sector (PCOs)



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Questions



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Summary

- ❖ Historically vectorborne diseases have been a major threat
- ❖ Well controlled in industrialized world since WW/II
- ❖ Remains a problem in developing world
- ❖ Emerging problem for the entire world

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Next Lesson

Food Protection

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Resources

❖ Web Resources:

- <http://www.cdc.gov/ncidod/dvbid/index.htm>
 - Dengue Fever
 - Lyme Disease
 - Plagues
 - Arboviral Encephalitides
 - West Nile Virus
 - Japanese Encephalitis
 - Yellow Fever
 - Tularemia
- www.doh.wa.gov/WNV

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