Lesson 10. Vector Control

Zoonotic Diseases

February 3, 2005

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Lesson Overview

- Definitions
- The Problem
- Causal Factors
- Control Measures

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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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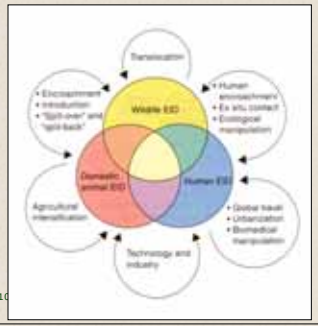
Emerging Diseases



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Zoonotic Disease Transmission

- **Direct Contact**
- **Transmission by Vectors**

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

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On the web…

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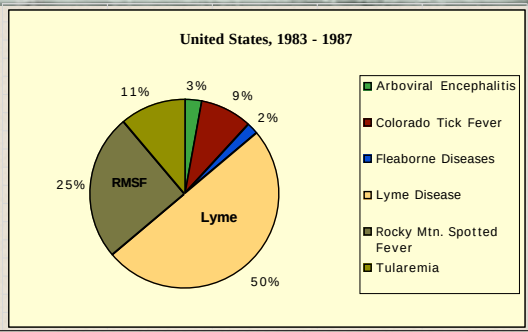
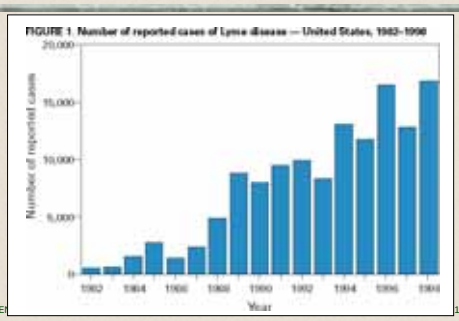
Vectorborne Disease



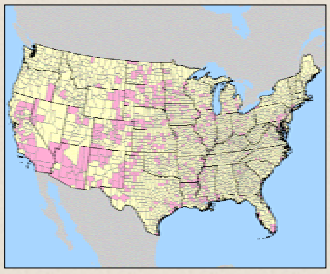
Vectorborne Disease



Vectorborne Disease

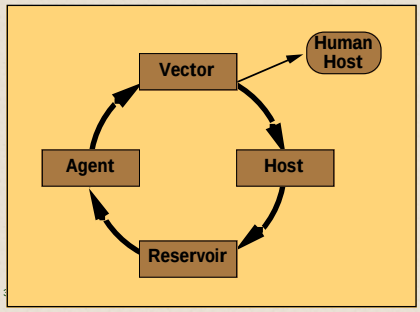
Total US Cases, 2003 9,862

Vectorborne Disease



Total US Cases, 2004 2231

Generalized Vector Cycle



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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

- Arthropods
  - Mosquitoes
  - Other flies
  - Fleas
  - Ticks
  - Lice
  - Mites
- Other Animals
  - 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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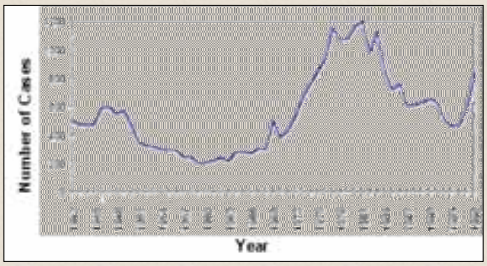
Rocky Mountain Spotted Fever



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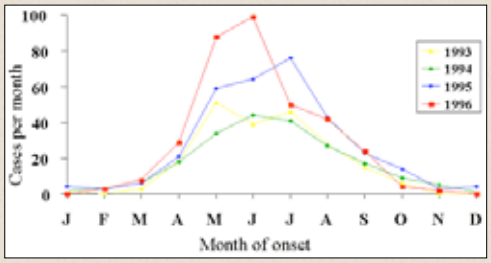
Rocky Mountain Spotted Fever



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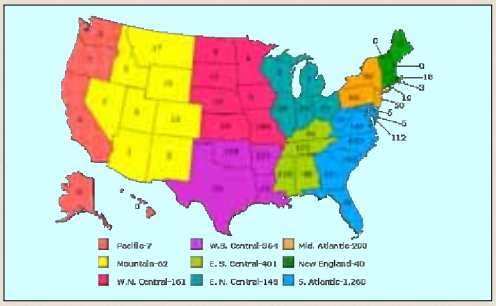
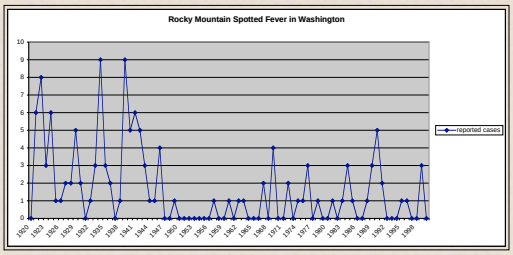
Rocky Mountain Spotted Fever



Rocky Mountain Spotted Fever



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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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Malaria

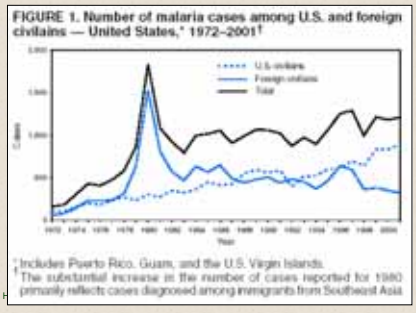
FIGURE 1. Number of malaria cases among U.S. and foreign civilains — United States,* 1972–2001†

* Includes Puerto Rico, Guam, and the U.S. Virgin Islands.
† The substantial increase in the number of cases reported for 1980 primarily reflects cases diagnosed among immigrants from Southeast Asia

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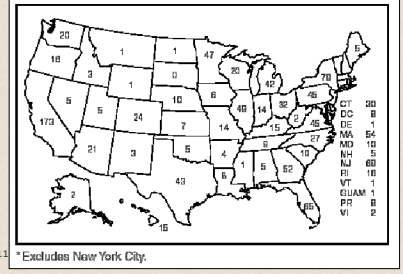
Malaria

FIGURE 2. Number of malaria cases, by state in which the disease was diagnosed — United States, 2001*



* Excludes New York City.

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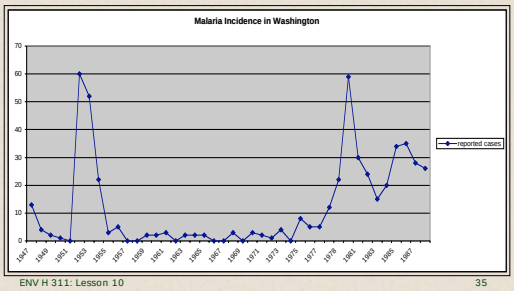
Malaria



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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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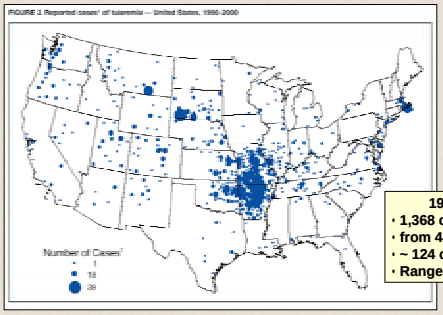
Tularemia



1990-2000
- 1,368 cases of
- from 44 states
- ~ 124 cases/year
- Range = 86-193

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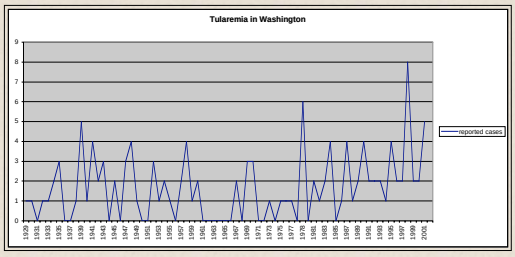
Tularemia



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Fleaborne Diseases

- Bartonellosis - formerly cat scratch fever
- Tapeworms
- Plague - (1984) one human case in Washington

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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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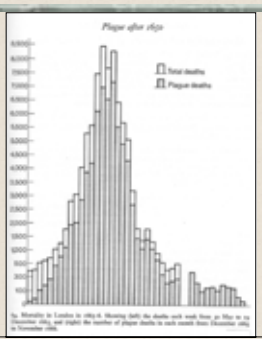
London, 1665-1666



- 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

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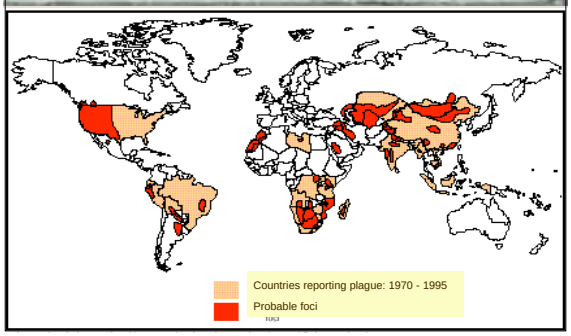
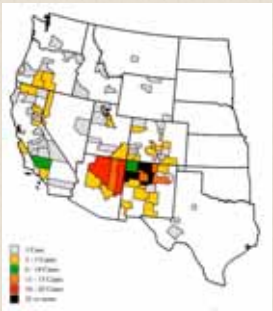
Plague: Distribution



Plague in the U.S.



- Reported human plague cases by county
  - 1970 - 1997.

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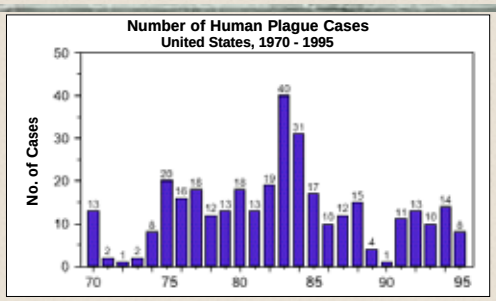
Plague: Incidence



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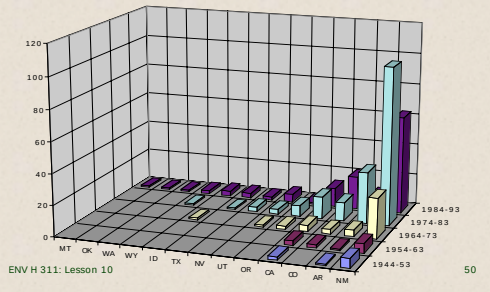
Plague Incidence



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Plague

- **Agent:** *Yersinina 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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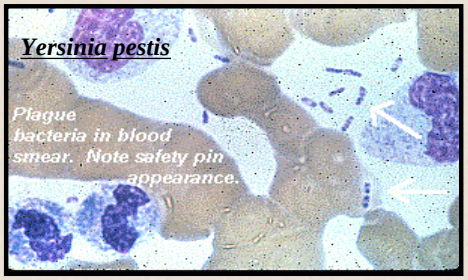
Plague: Agent



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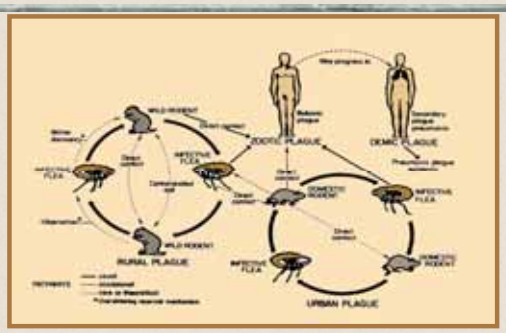
Plague: Transmission



Plague: Vectors

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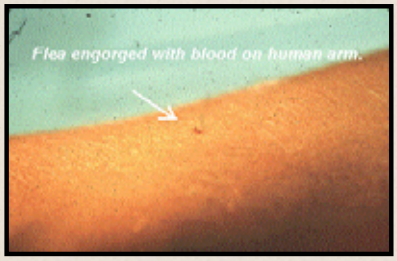
Plague: Vectors - Continued



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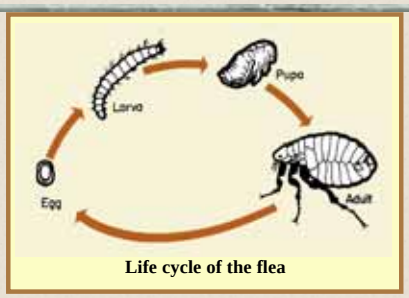
Plague: Vectors - Continued



Life cycle of the flea

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Reservoir

Protecting the Public's Health

- Surveillance
- Personal Protection and Education
- Vector Control

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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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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 repellant 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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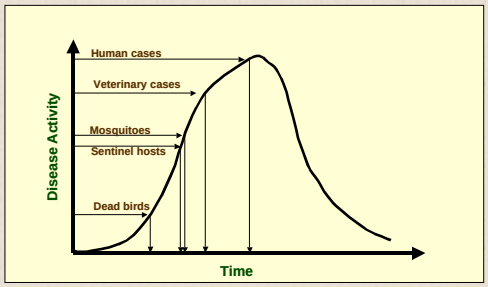
Estimated Sensitivity of WNV Surveillance Methods



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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)
Aedes cinereus	29
Aedes vexans	27
Culex pipiens	28
Culex restuans	1
Culex tarsalis	35
Anopheles punctipennis	26
Coquilletidia perturbans	10
Ochlerotatus canadensis	5
Ochlerotatus japonicus	1

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Tick Surveillance

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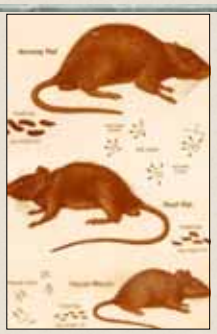
Rodent Surveillance



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

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Rodent Surveillance

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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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IPM Continued

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

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IPM Continued

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

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IPM Continued

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

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Cooperation / Coordination

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

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Questions

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

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

Next Lesson

Mid-term Exam

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WNV in the U.S.

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WNV Background

- First isolated from in the West Nile District of Uganda, 1937
- Recognized as a cause of inflammation of the spinal cord and brain with outbreak in elderly patients, Israel, 1957
- Equine disease noted in Egypt and France in the early 1960s
- 1999 "Old World" virus arrives in the "New World"

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WNV Outbreaks

- Israel - 1951-1954, 1957, 2000-2002
- France – 1962, 2000
- South Africa - 1974
- Romania – 1996
- Italy 1997
- Russia - 1999
- United States –1999-2003

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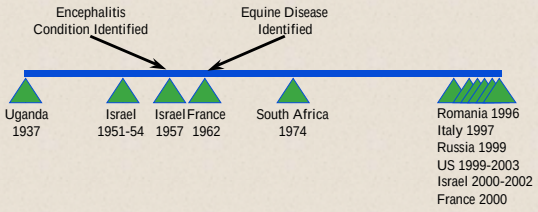
Timeline



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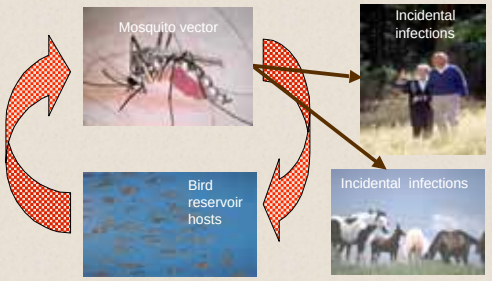
Transmission Cycle



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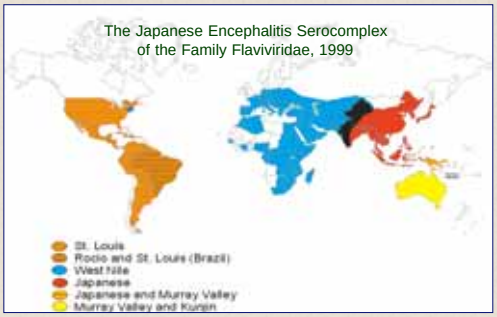
Related Viruses



WNV in the U.S.

- Some Speculated Pathways of Introduction
  - Human-transported bird
    - Illegal (Black market "exotics")
    - Legal (zoos & legitimate breeders)
  - Human-transported mosquitoes
  - Storm-transported bird
  - Intentional introduction (terrorist event) - not likely
  - Infected human traveler - not likely

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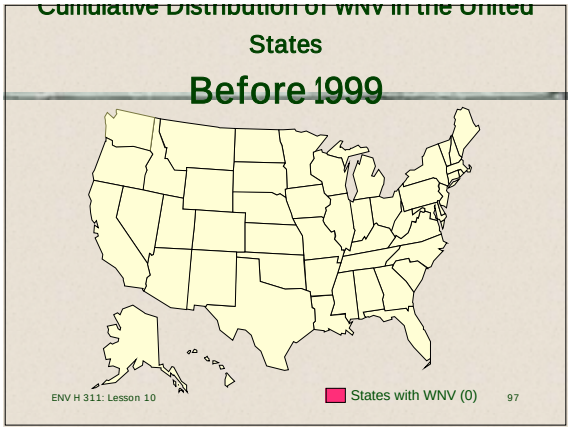
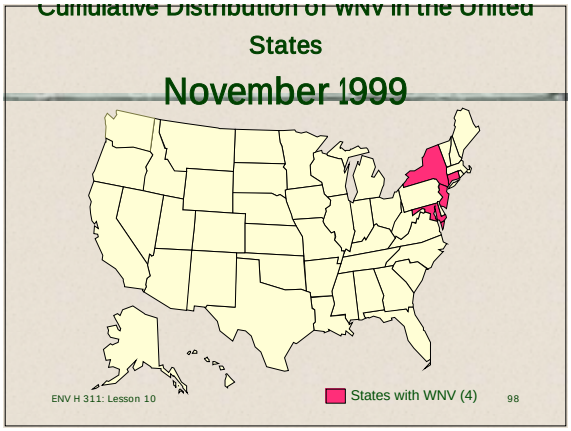
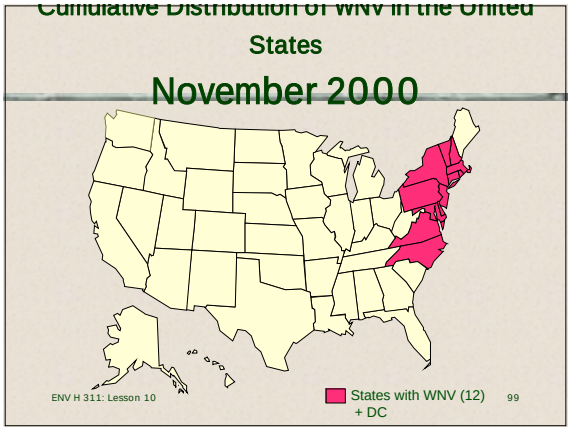
The Disease

- Symptoms:
  - High Fever
  - Headache and body aches
  - Skin rash
  - Swollen lymph glands
  - Neck stiffness
  - Disorientation
  - Convulsions
- Incubation period:
  - Generally 3-14 days (following a bite from an infected female mosquito)

ENV H 311: Lesson 10 96

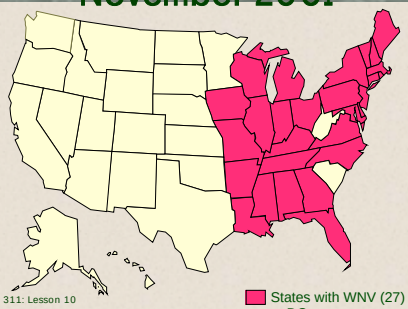

Cumulative Distribution of WNV in the United States
Before 1999
ENV H 311: Lesson 10
States with WNV (0)
97


Cumulative Distribution of WNV in the United States
November 1999
ENV H 311: Lesson 10
States with WNV (4)
98


Cumulative Distribution of WNV in the United States
November 2000
ENV H 311: Lesson 10
States with WNV (12) + DC
99

Cumulative Distribution of WNV in the United States

November 2001



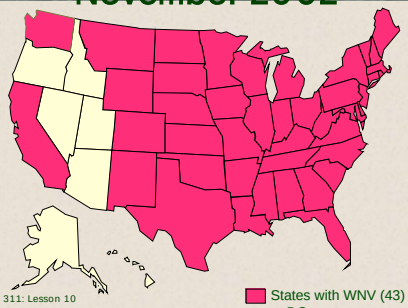
ENV H 311: Lesson 10

States with WNV (27) + DC

100

Cumulative Distribution of WNV in the United States

November 2002



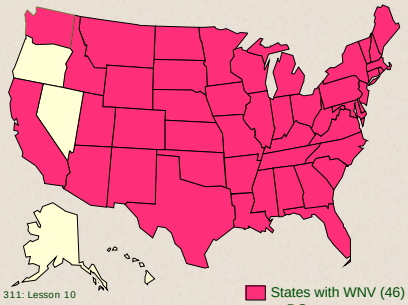
ENV H 311: Lesson 10

States with WNV (43) + DC

101

Distribution of WNV in the United States

October 2003



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States with WNV (46) + DC

102

2003 WNV Activity

Case Summary

Year	Humans (deaths)	Horses (deaths)
2003*	7,021 (152)	2,912
2002	4,156 (284)	14,717 (~5,150)
2001	66 (9)	733 (156/470)
2000	21 (2)	60 (23)
1999	62 (7)	25 (8)

* As of October 17, 2003

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Demographics & Mortality United States, 1999-2002

	1999-2000	2001	2002
No. of Cases	83	66	2,661
Median Age	65	68	55
Age Range (in years)	5 - 90	19 - 90	1 mo. - 99
Males	54%	65%	54%
Fatality Rate	11%	14%	9%
Mean Fatality Age			78 (24-99)

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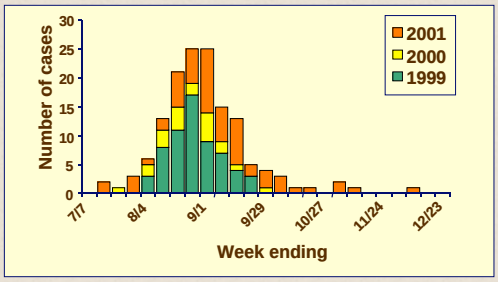
Date of Symptom Onset

West Nile Virus — United States, 1999-2001



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Mosquito-borne Disease Response Plan

Washington State

Washington State Department of Health response to threats of arbovirus, such as West Nile virus transmitted to humans by mosquitoes.

September 2002

Washington's Response

- Statewide mosquito-borne disease response plan
  - guidance for state/local agencies and organizations
  - response protocols for disease-related events
  - tiered response based on severity
  - recommendations on public information and education, surveillance and control
- Re-establish, develop new partnerships
- Conduct ongoing training

ENV H 311: Lesson 10 108