# Mosquito-Borne Diseases

Vector Disease Control, Inc.

Mosquito Control Program

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# Mosquito-borne Diseases

Malaria

Lymphatic Filariasis

Eastern Equine Encephalitis

St. Louis Encephalitis

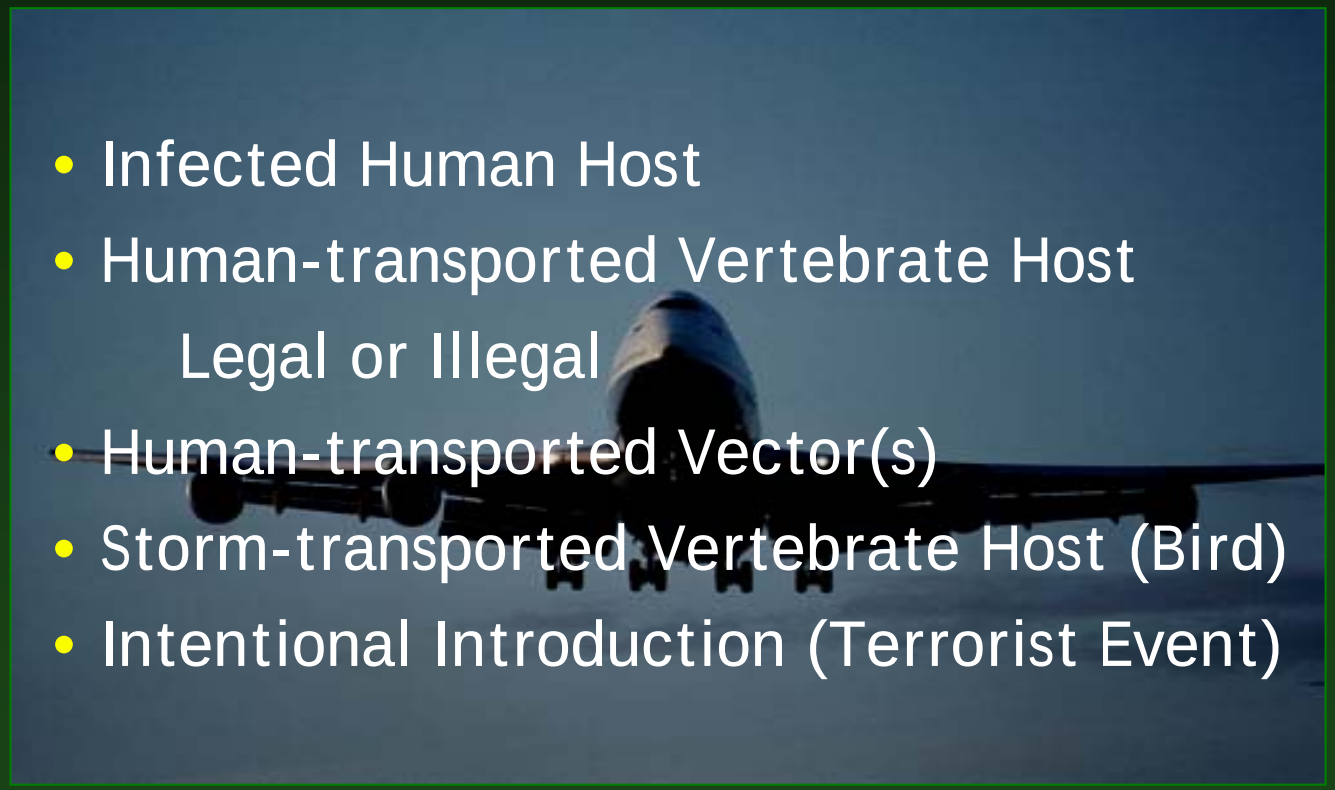
West Nile Virus

LaCrosse Virus

Yellow Fever Virus

Dengue Hemoragic Fever Virus

# Possible Routes of Introduction for New Disaeases



- Infected Human Host
- Human-transported Vertebrate Host
  - Legal or Illegal
- Human-transported Vector(s)
- Storm-transported Vertebrate Host (Bird)
- Intentional Introduction (Terrorist Event)

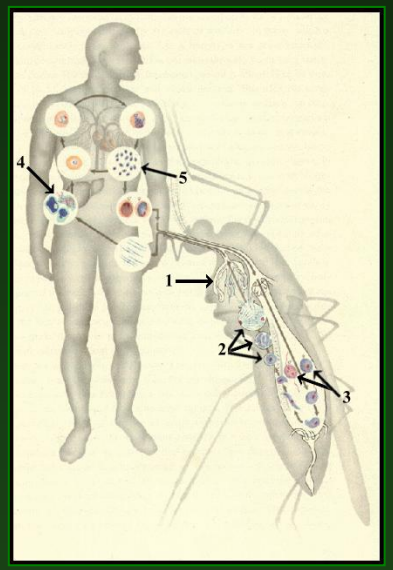
# Malaria Background

Causative Agent - Protozoan (*Plasmodium* spp.)

Primary Vector - *Anopheles* spp.

Primary Reservoir - Humans

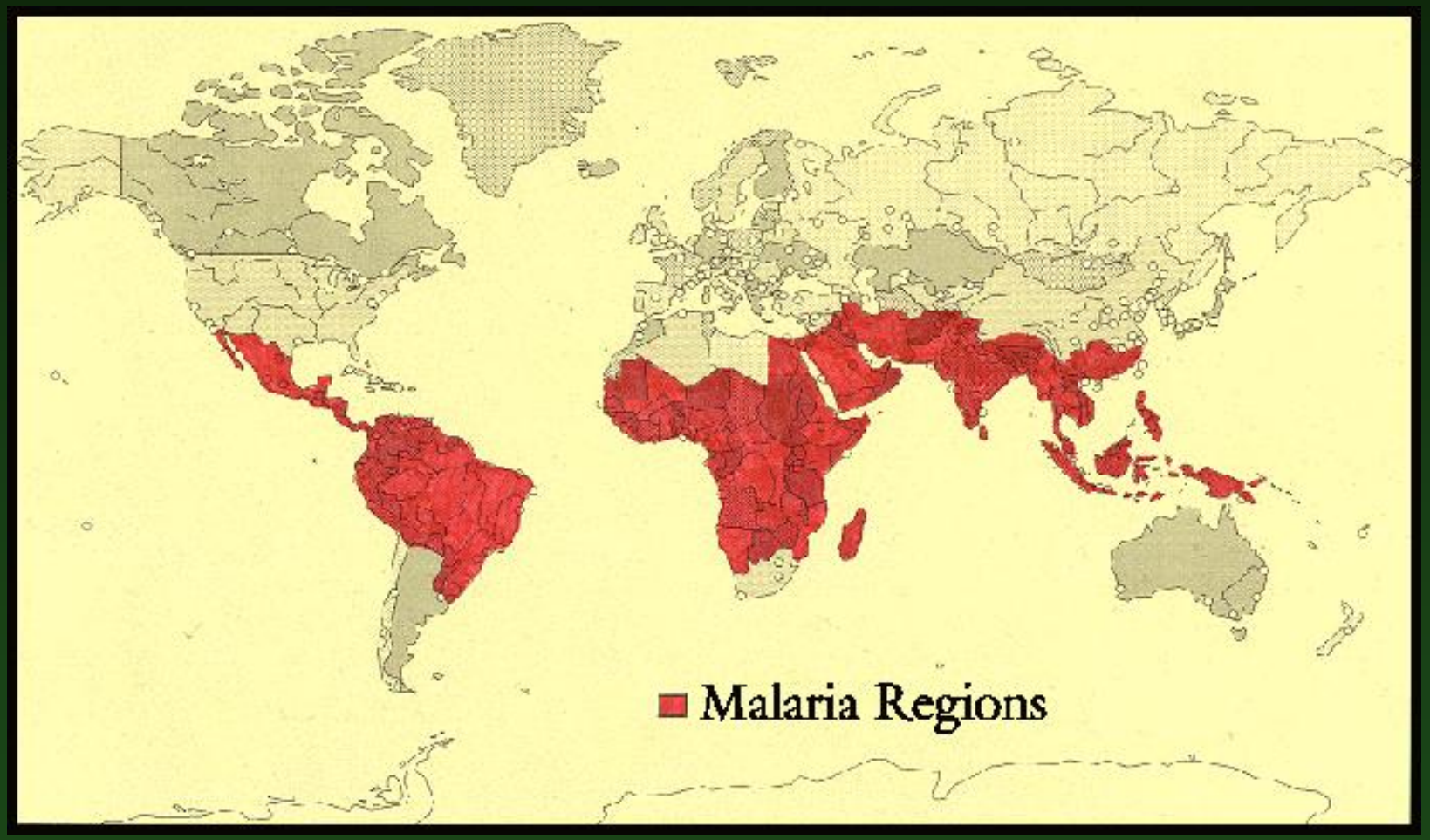
Habitat - Rural Environments




Impact - First Case, 400 BC
300 million cases worldwide each year

Distribution - Africa, Asia, Latin America

# Malaria Distribution



# Filariasis Background

Causative Agent - Nematode *(Wuchereria bancrofti)*

Primary Vector - *Culex* spp.*; Aedes* spp.; *Anopheles* spp.

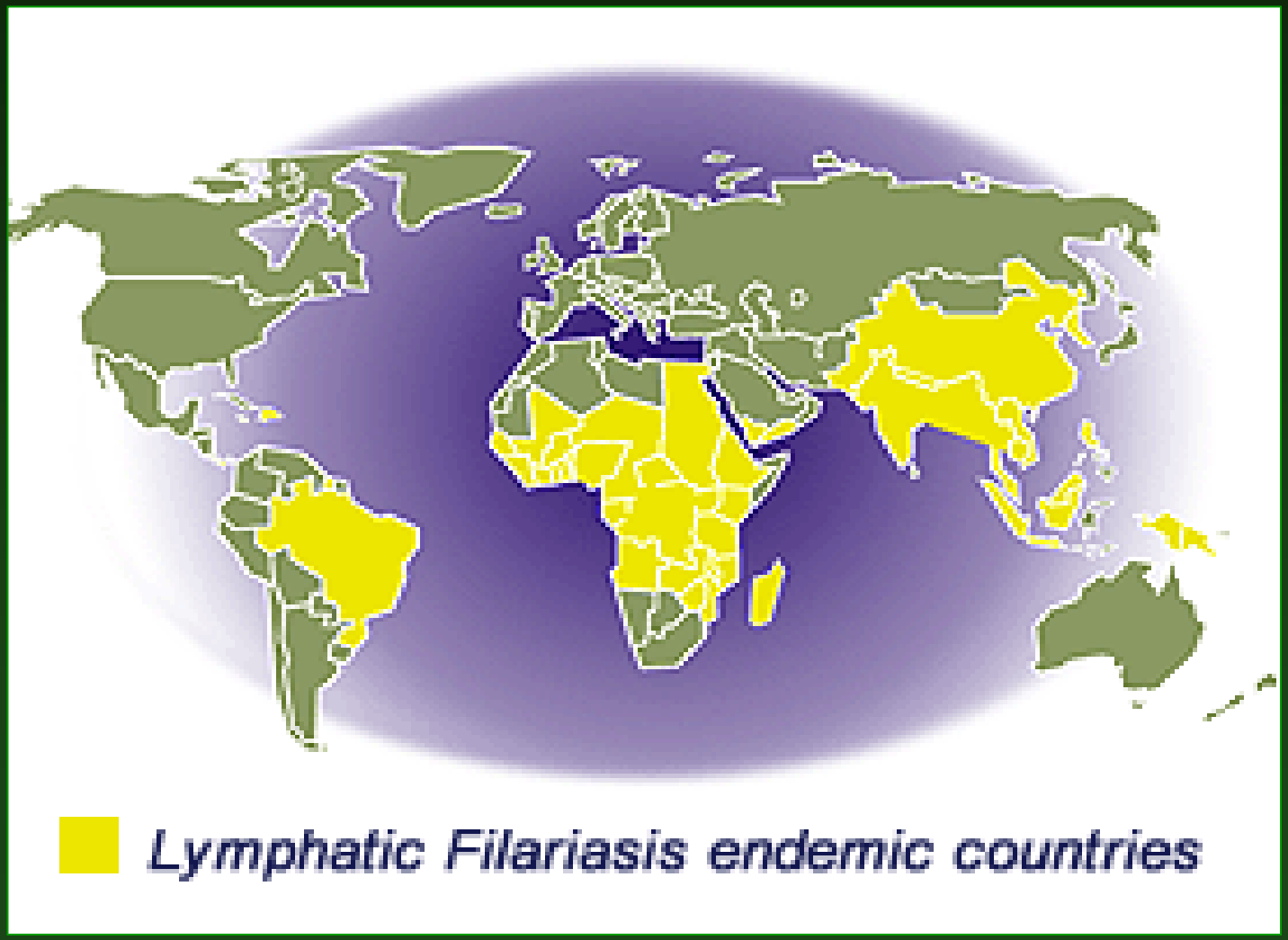
Primary Reservoir - Humans

Habitat - Urban and Rural Environments

Impact - First Case, ~4000BC
120 million people worldwide each year

Distribution - Tropical and Subtropical Africa, Asia, and South America

# Filariasis Distribution

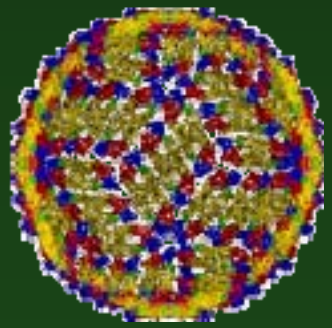


# Dengue Background

Causative Agent - Flavivirus (DEN-1; DEN-2; DEN-3; DEN-4)

Primary Vector - *Aedes aegypti; Ae. albopictus*

Primary Reservoir - Humans

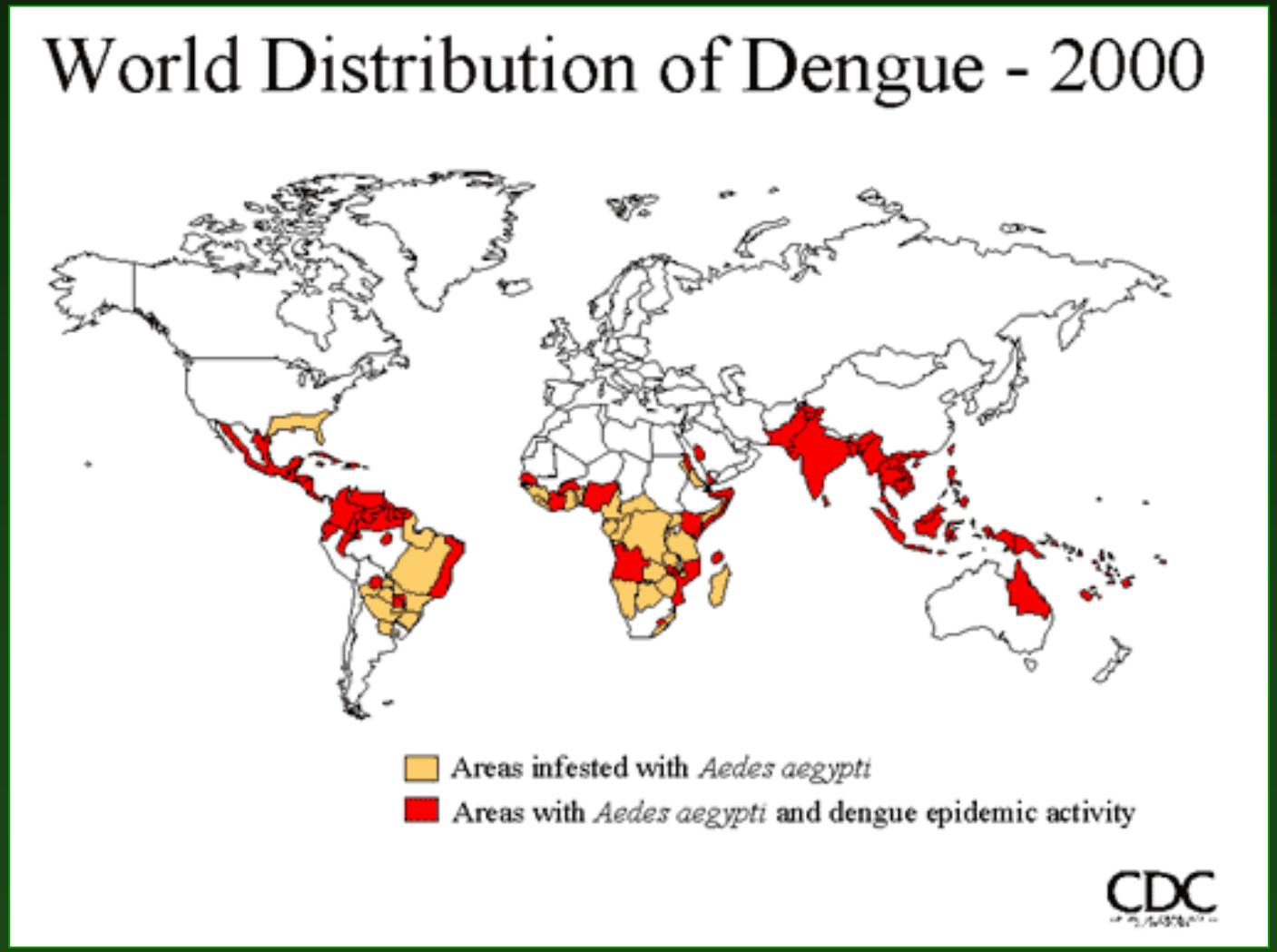


Habitat - Urban Environments

Impact - First Case, 1779; Asia, Africa, America
10-15 million cases each year worldwide

Distribution - Worldwide Tropics

# Dengue Distribution

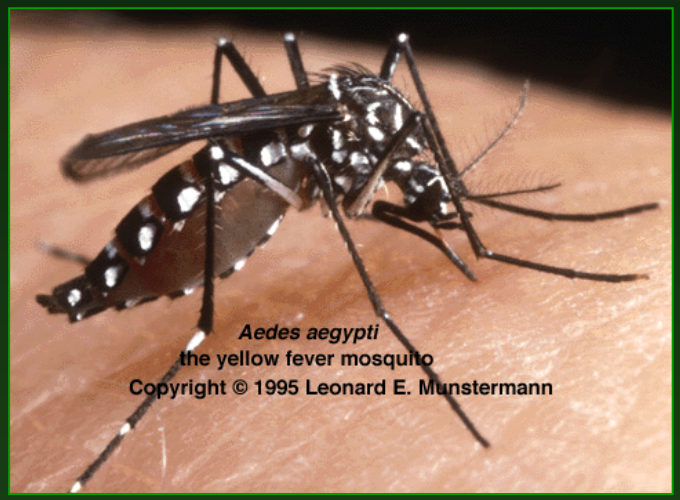


# Yellow Fever Virus Background

Causative Agent - Flavivirus

Primary Vector - *Aedes aegypti*

Primary Reservoir - Monkeys/Humans

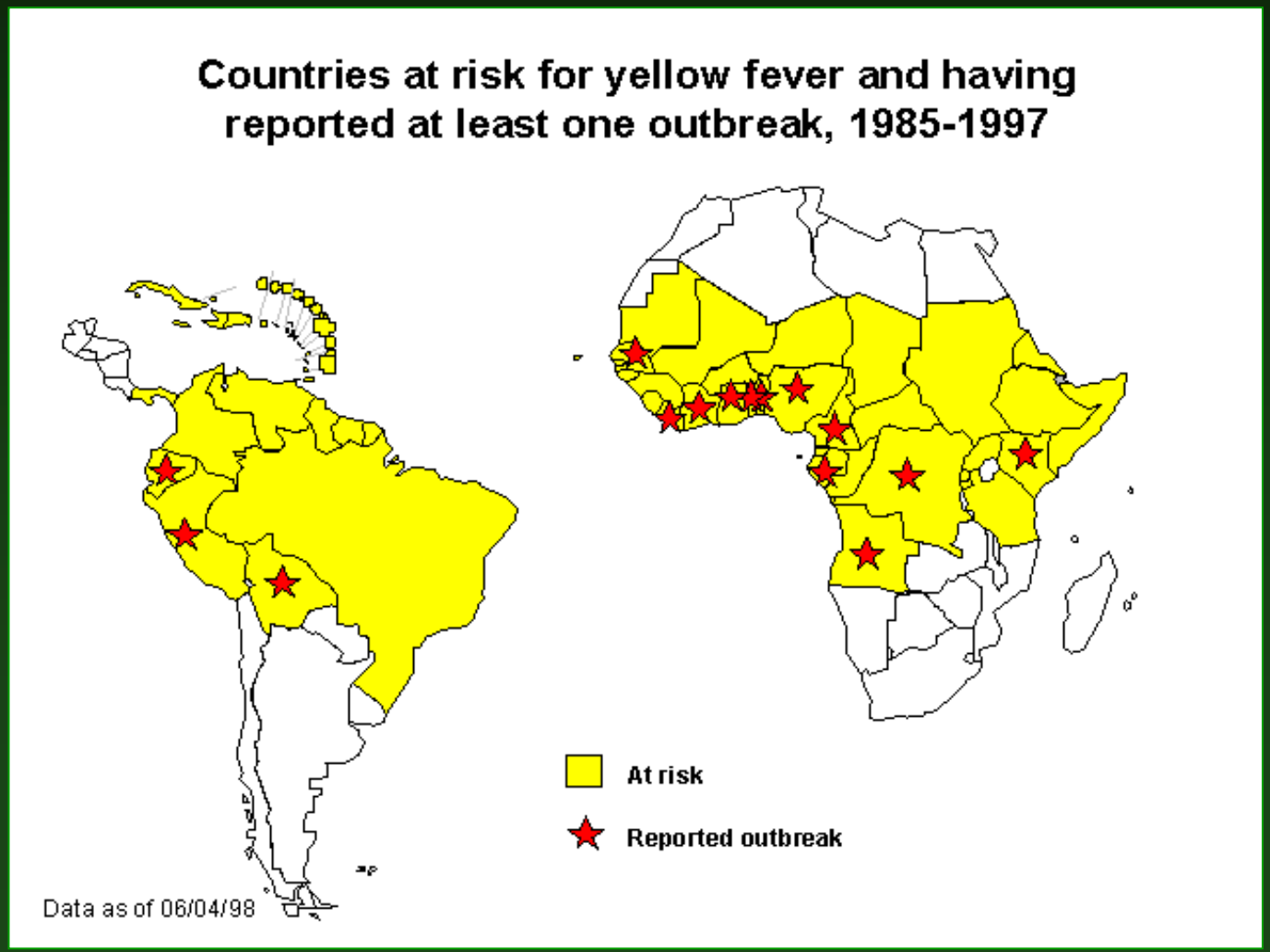



Habitat - Urban & Rural Environments

Impact - First Case, 1648; Guadeloupe and Yukatan
200,000 cases per year

Distribution - Tropical Africa and Americas

# Yellow Fever Distribution



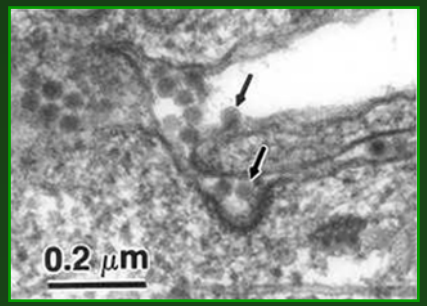
# West Nile Virus Background

Causative Agent - Flavivirus

Primary Vector - *Culex* spp. Mosquitoes

Primary Reservoir - Various Wild Bird Species

Habitat - Urban Environments

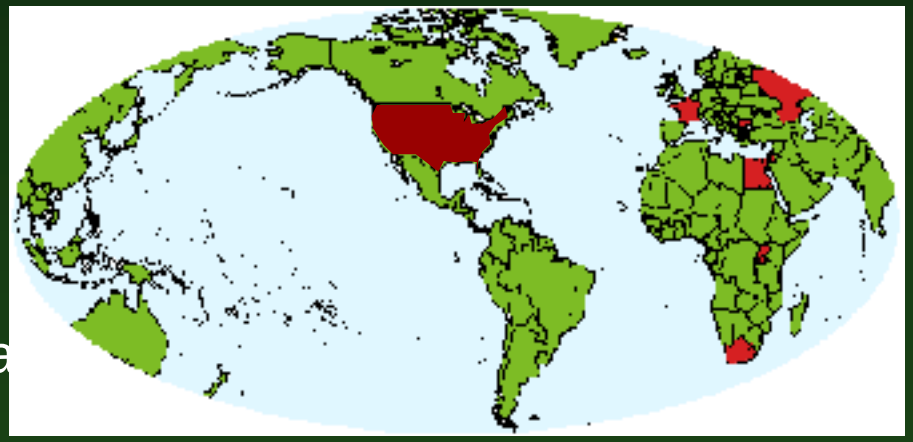



Impact - First Case, 1937; Sporadic Outbreaks Involving Hundreds to Thousands of People (Romania, 1996-1997, 500 Clinical Cases)

Distribution - Africa, Europe, Asia, North America

# Previous Major West Nile Virus Outbreaks

- 1937 - Uganda (West Nile First Discovered)
- 1951-1954 - Israel
- 1952-1954 - Egypt
- 1962 - France
- 1974 - South Africa
- 1996 - Romania
- 1999 - Russia
- 2002 - United States



# Arthropod Carriers of West Nile Virus

## Isolated from Over 40 Mosquito Species

- Mostly *Culex* species

  *Cx. univittatus, Cx. perixiguus, Cx. pipiens,*
  *Cx. modestus, Cx. quinquefasciatus,*
  *Cx. tritaeniorhynchus, and Cx. Vishnui*

- Other mosquito species in a variety of genera:

  *Aedes, Aedeomyia, Anopheles, Coquillettidia,*
  *Mansonia, Mimomyia, Ochlerotatus*

## Isolated from Ticks

- Soft tick genera: *Argas, Ornithodoros*
- Hard tick genera: *Amblyomma, Dermacentor,*
  *Hyalomma, Rhipicephalus*

# Reservoir Hosts of West Nile

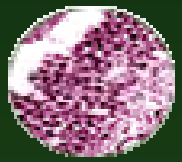
- Isolated from Numerous Wild Birds
  - Wetland and Terrestrial Species
- Birds are Considered Primary Amplifier Hosts
  - Reservoir Status Known for Some Species

- Migratory Birds Have a Role in Distribution and Re-introduction of Virus
- Role of Other Vertebrates (Mammals) is Not Known

# West Nile Transmission Cycle

Mosquito Vector
(*Culex* species)

Incidental Hosts



West Nile Virus

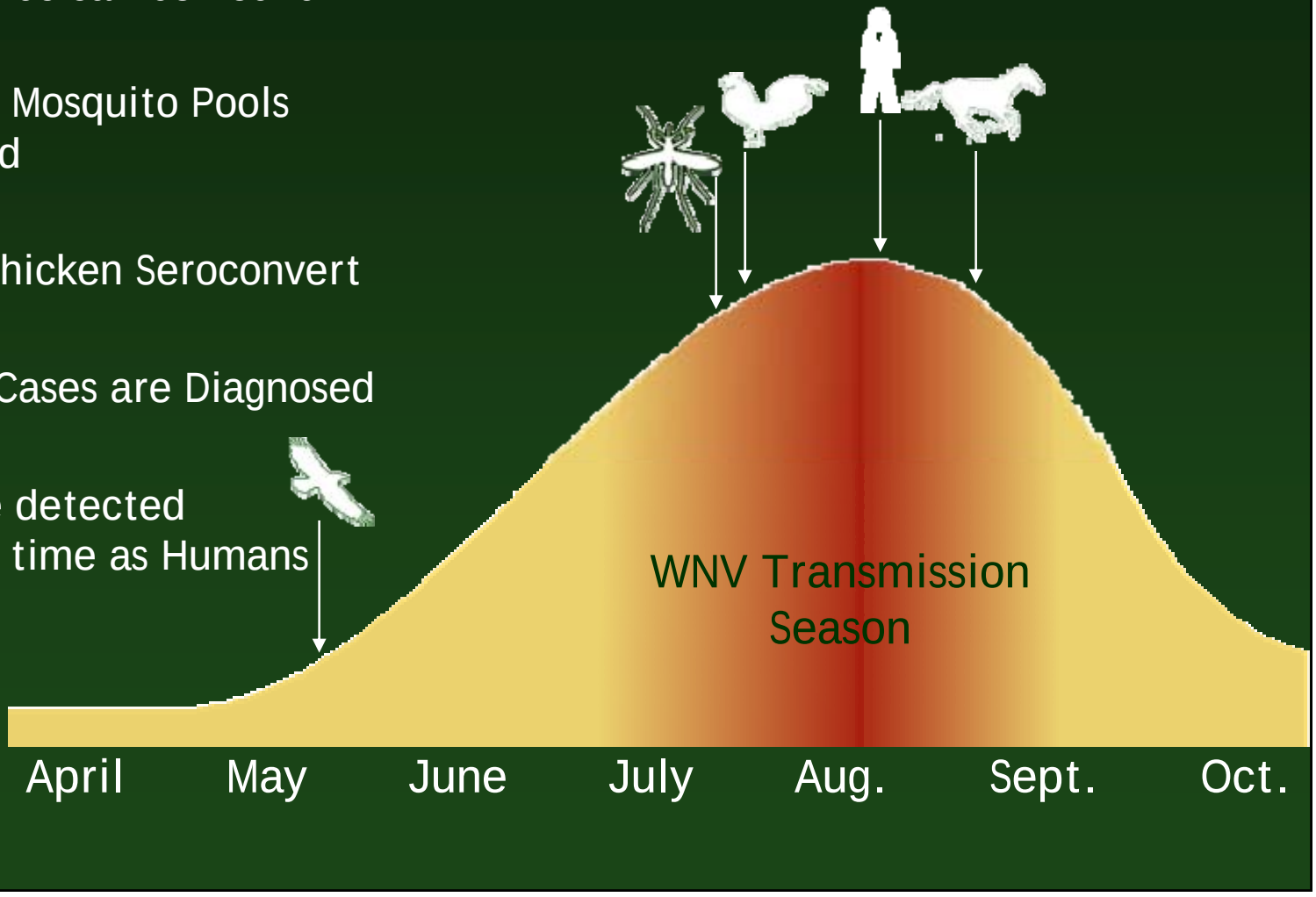
Mammal-biting
species

Reservoir Hosts
(Various Bird Species)

Incidental Hosts

# Most Mosquito-borne Diseases in Ohio are more common in Late Summer

- First Infected Birds can be Found
- Second Infected Mosquito Pools can be Collected
- Third Sentinel Chicken Seroconvert
- Finally, Human Cases are Diagnosed
- Equine Cases are detected about the same time as Humans



# Surveillance Techniques for Mosquito-borne Diseases

# Mosquito-borne Disease Surveillance Options

Surveillance Operations Can Include:

- Mosquitoes
- Sentinel Chickens
- Wild Crows/Birds
- Non-Human Mammals
- Humans

# Mosquito Surveillance

*Advantages:*

- May provide the earliest and most definitive evidence of transmission in an area
- Provides information on potential mosquito vector species
- Provides an estimate of vector species abundance
- Provides information on relative risk to humans and animals
- Provides baseline data that can be used to guide emergency control operations
- Allows evaluation of control methods

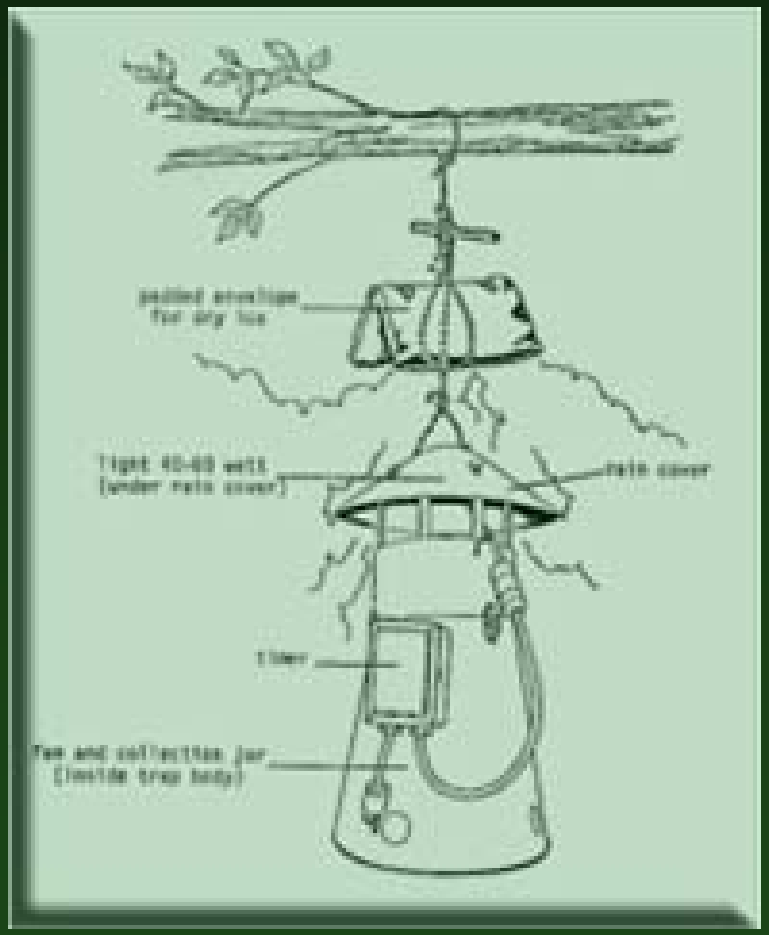
*Disadvantages:*

- Labor-intensive and expensive
- Substantial expertise is required

# Oviposition Traps

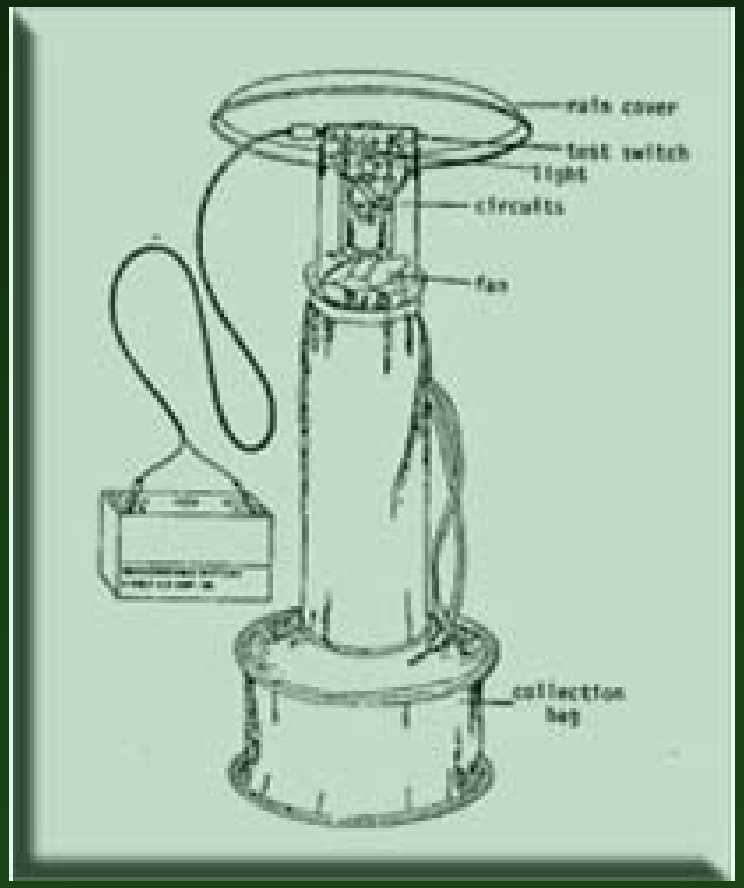
- Uses oviposition site as attractant
- Simple design is cost effective
- Collects eggs
- Samples floodwater and container-breeding mosquitoes

# NJ Light Trap



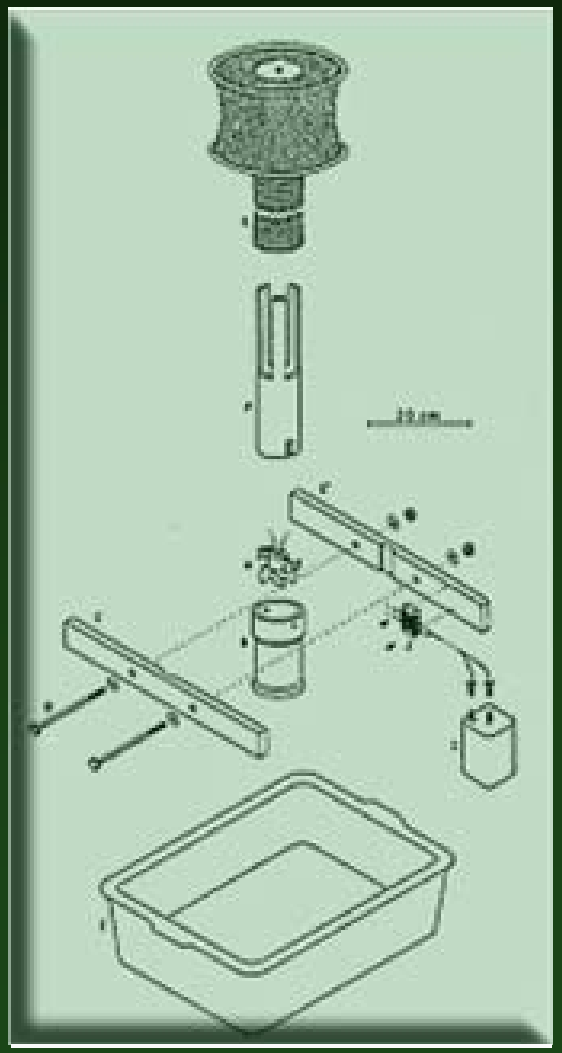
- Uses light as attractant; Dry ice can be added
- Electricity required - less portable
- Collects host-seeking mosquitoes
- Collects a wide variety of mosquitoes

# CDC Miniature Light Trap




- Baited with dry ice
- Battery powered and easily moved
- Collects host-seeking mosquitoes
- Collects a wide variety of mosquitoes

# Gravid Traps



- Uses putrid water as attractant
- Battery powered and easily moved
- Collects ovipositing mosquitoes
- Collects primarily *Culex* mosquitoes

# Landing Rate Counts

- Uses human as an attractant
- Little equipment required
- Collects human-seeking mosquitoes

# Diagnostic Procedures for Mosquito Pools

*Laboratory-probable infection*

- RAMP Test
- Vec Test

# Diagnostic Procedures for Mosquito Pools

*Laboratory-confirmed infection*

- Viral isolation (virus identity confirmed with IFA, cross-neutalization, RT-PCR, or gene sequencing
- Positive RT-PCR with validation by repeated RT-PCR, using another PCR system, or viral isolation

# Sentinel Chicken Surveillance

*Advantages:*

- There is a long history of successful use in flavivirus surveillance
- Chickens may have a high seroprevalence of antibodies
- Chickens are relatively easy to bleed
- No necropsies are needed

*Disadvantages:*

- Sentinel flocks detect only focal transmission
- Flocks are subject to vanadlism and theft
- Set-up and flock maintenance are expensive

# Diagnostic Procedures for Sentinel Chickens

*Laboratory-probable infection*

- Detection of IgM antibody to antigen by ELISA
- Seroconversion in serially collected samples by hemagglutination inhibition

# Diagnostic Procedures for Sentinel Chickens

*Laboratory-confirmed infection*

- Viral isolation (virus identity confirmed with IFA, cross-neutalization, RT-PCR, or gene sequencing
- Seroconversion in serially collected samples by plaque-reduction neutralization
- Detection of IgM antibody to antigen by ELISA validated by demonstration of neutralizing antibody to antigen

# Wild Crow Surveillance

*Advantages:*

- American crows are very susceptible to WNV infection
- Crows occur in a wide variety of habitats and occur in large numbers in nature
- Public can be used to locate and report dead crows
- Crows can be relatively easily necropsied and tested

*Disadvantages:*

- Crow dispersal makes it difficult to know where the dead crows acquired infection with the virus
- Collection, handling, shipping, and processing of birds can cumbersome and problematic
- Long-term usefulness of this system is uncertain

# Diagnostic Procedures for Wild Crows

*Laboratory-probable infection*

- Positive RT-PCR test for WNV RNA in a single test
- Detection of flaviviral antigen in tissues by immunohistochemistry

# Diagnostic Procedures for Wild Crows

*Laboratory-confirmed infection*

- WNV isolation (virus identity confirmed with IFA, cross-neutalization, RT-PCR, or gene sequencing
- Positive RT-PCR with validation by repeated RT-PCR, using another PCR system, or viral isolation
- Detection of flaviviral antigen in tissues by immunohistochemistry

# Non-Human Mammal Surveillance

*Advantages:*

- Horses are highly conspicuous, numerous and widely distributed
- Some horses are routinely bled and tested for other pathogens
- Brain specimens that test negative for rabies are readily available and can be used for disease surveillance
- Samples from pet dogs and cats with neurologic disease can be taken during veterinary visits

*Disadvantages:*

- WNV infection may occur simultaneously with human cases
- Necropsies are expensive and logistically difficult
- Long-term usefulness of this system is uncertain

# Diagnostic Procedures for Non-Human Mammals

*Laboratory-probable infection*

- Demonstration of serum IgM antbody against antigens by ELISA
- Demonstration of an elevated titer of specific IgG antibodies in convalescent-phase serum

# Diagnostic Procedures for Non-Human Mammals

*Laboratory-confirmed infection*

- Isolation of virus from, or demonstration of antigen or genomic sequences in, tissue, blood, CSF, or other body fluid
- Demonstration of IgM antibody in CSF by IgM- capture EIA
- A >4-fold serial change in plaque-reduction neutralizing (PRNT) antibody titer to antigen in paired, CSF samples
- Demonstration of both antigen-specific IgM (by EIA) and IgG (screened by EIA or HI, confirmed by PRNT) in a single serum sample.

# Protect Yourself from Mosquito-borne Diseases

## *Mosquito Reduction*

- All standing water should be eliminated
- Empty containers holding water; drill holes in garbage and recycling containers
- Clean gutters
- Cover or turn over boats and canoes
- Properly grade property and smooth out tire ruts
- Empty or cover wading pools

## *Personal Protection*

- Repair or replace window screens
- Use insect repellent (DEET, 20-30%, adults)
- Treat clothing with repellent
- Limit activity at dawn and dusk

*Thank You*