Mosquito Biology and Disease Transmission: A Brief Overview

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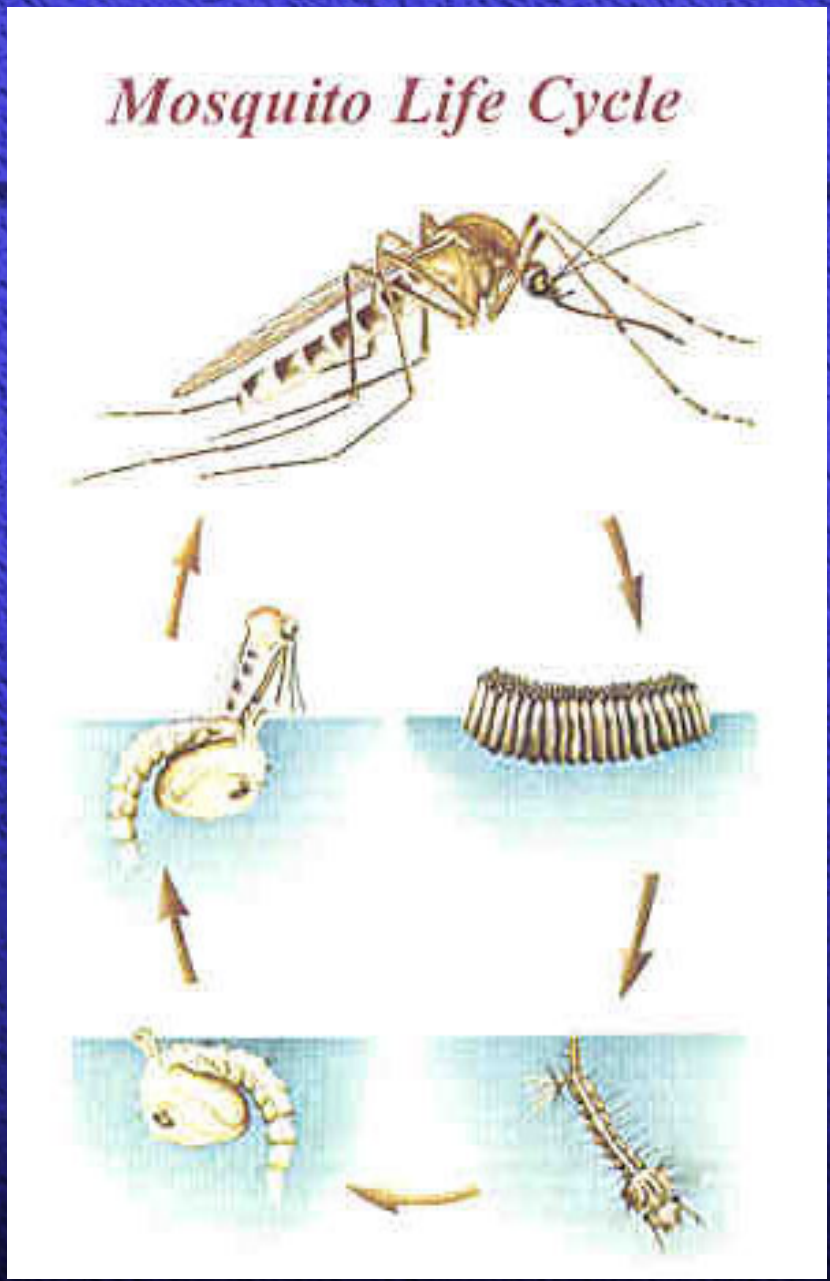
Purpose of this Presentation

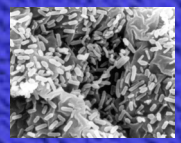
- Review biology of mosquitoes in Michigan
- Discuss features of mosquito-borne viral encephalitis transmission relevant to Michigan conditions
- Review generally the outbreak of West Nile virus in Michigan and in the U.S.


Mosquito Life Cycle
Adult female
Emergence
Eggs
Pupa
Larva

Expanded Mosquito Life Cycle

Eggs

Hatching cues



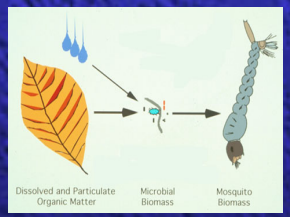
Bacteria on egg surface

Oviposition = egg laying

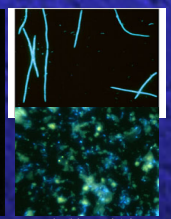
Larvae and Pupae

Adults

Food resources:
Larvae eat bacteria, protozoans, fungi, and algae

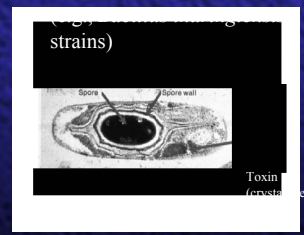


Ciliate (protozoan)

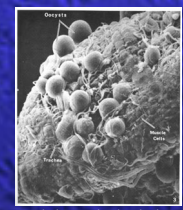


Bacteria (blue stain) in larval habitats

Pathogens:
Some microorganisms can kill mosquito larvae and are used in control measures.



Disease transmission:
Mosquitoes transmit viruses, protozoans, and roundworms to humans and animals.



Malaria parasite developing on mosquito midgut

Host location and blood feeding mosquitoes also feed on sugar, usually nectar

Bacteria on leaf surface grazed by mosquito larvae

Fungal spores on leaf surface

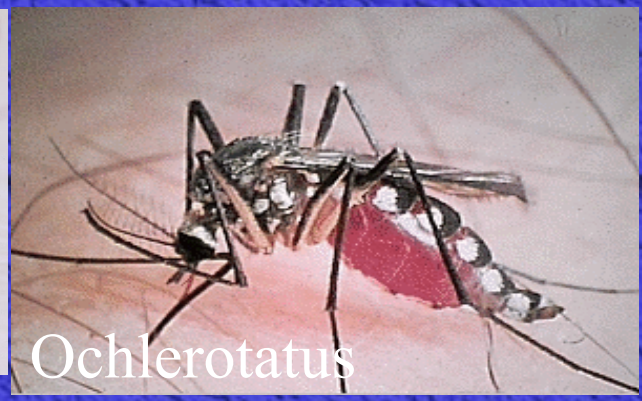
Algae in larval habitats

Michigan Mosquitoes

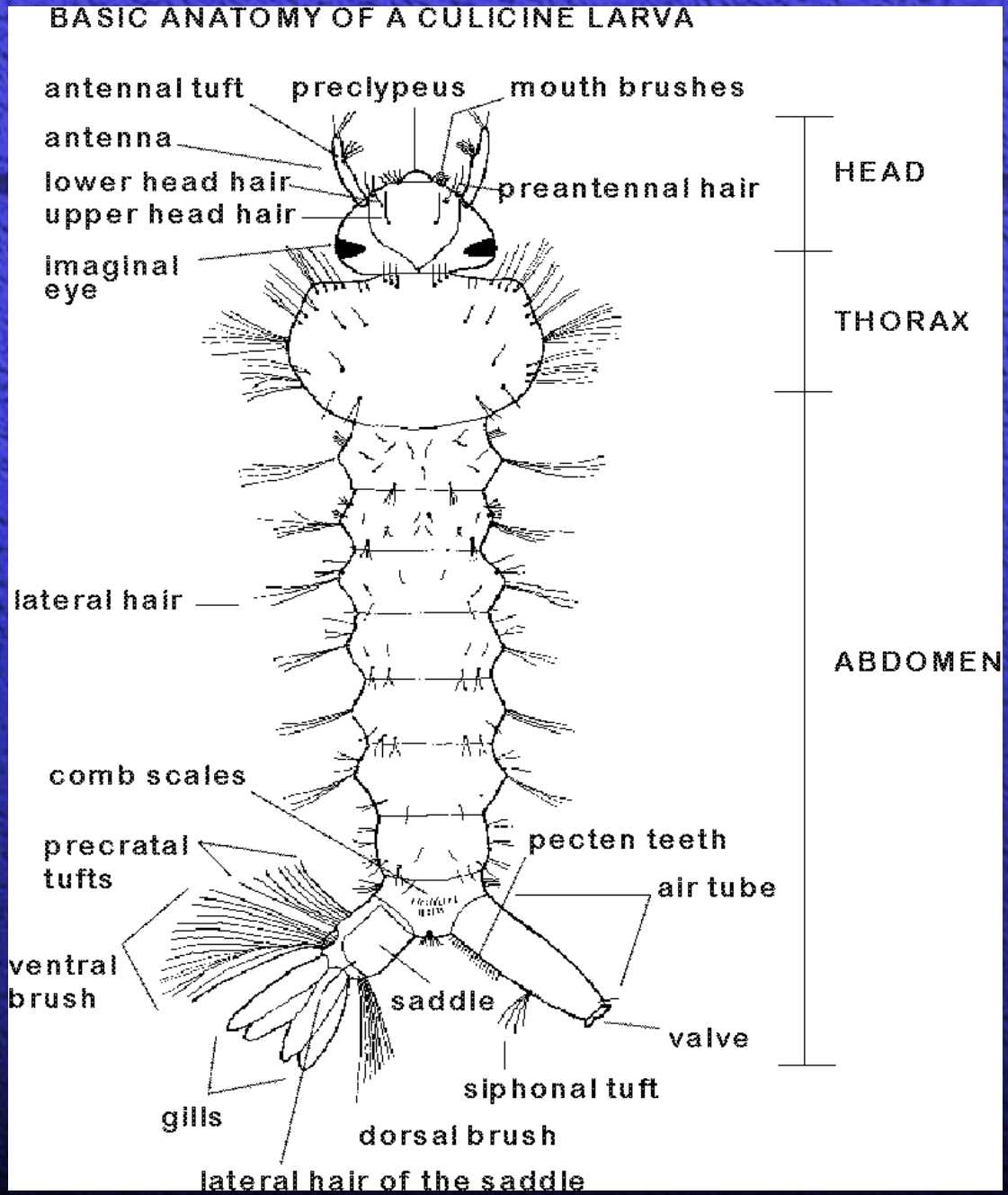
- About 60 species in the state
- Only the females bite, and not all of our species need blood, or bite people
- The overwintering stage is species specific; eggs, larvae, or adult females may overwinter
- Mosquitoes are classified by their shape and anatomy

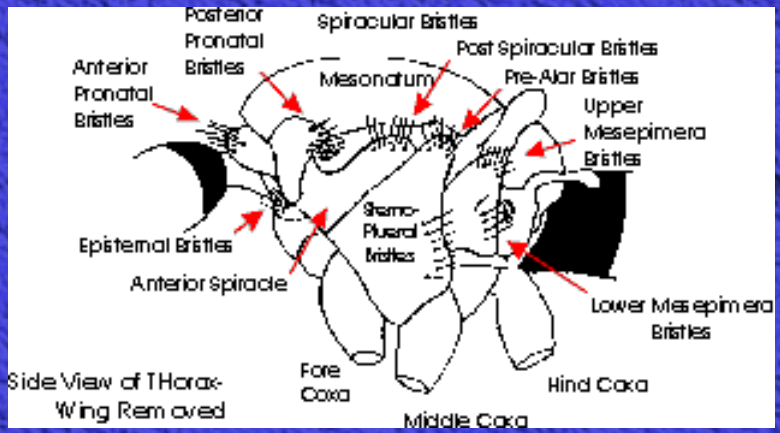
Two major groupings:

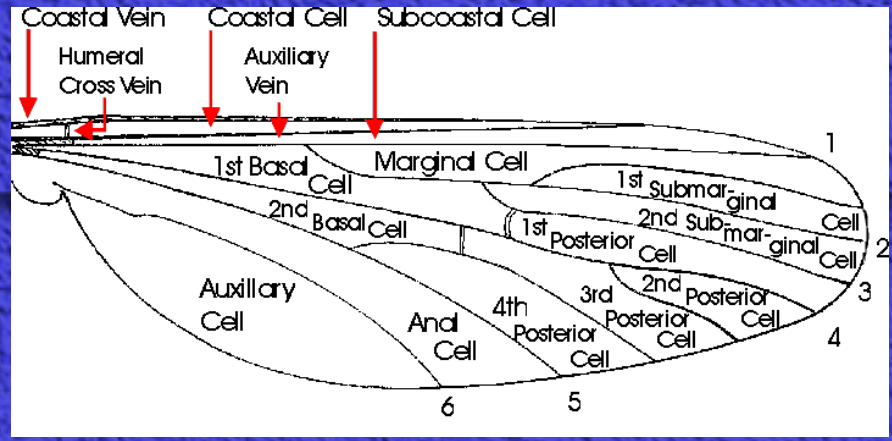
Culicinae

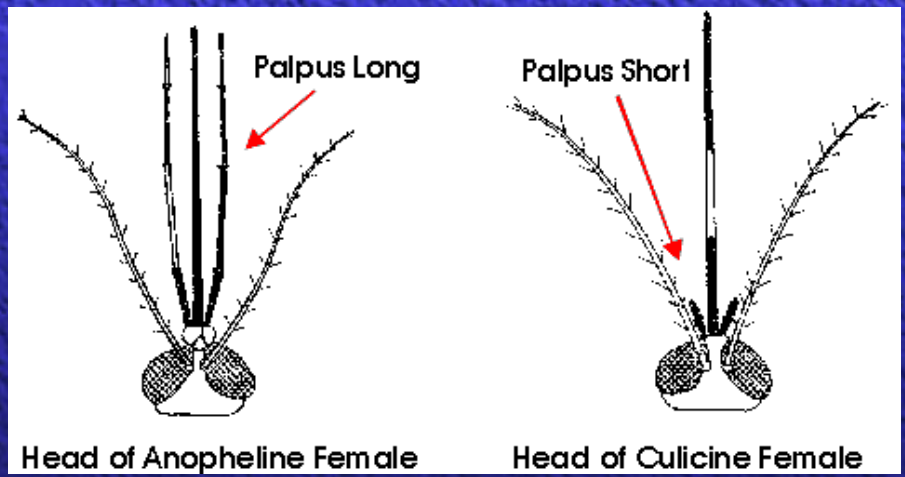


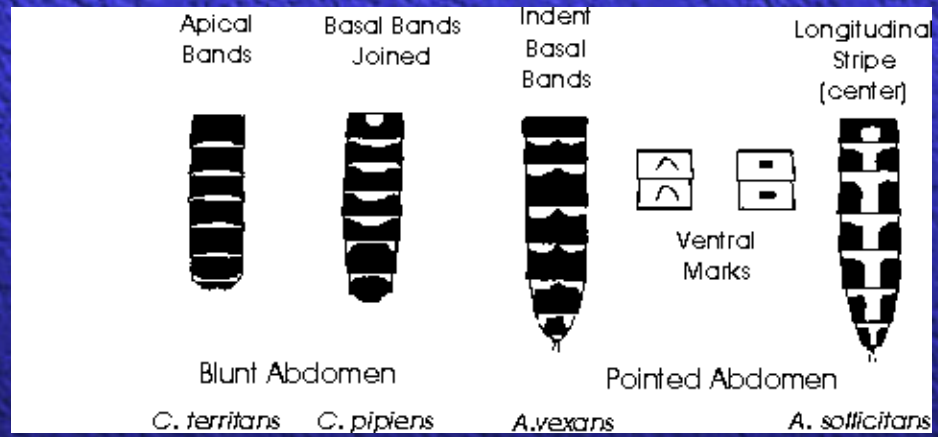
Anophelinae


BASIC ANATOMY OF A CULICINE LARVA
antennal tuft
preclypeus
mouth brushes
antenna
lower head hair
preantennal hair
upper head hair
imaginal eye
HEAD
THORAX
ABDOMEN
lateral hair
comb scales
precratal tufts
pecten teeth
air tube
ventral brush
saddle
valve
siphonal tuft
gills
dorsal brush
lateral hair of the saddle


Posterior Pronotal Bristles
Spiracular Bristles
Post Spiracular Bristles
Anterior Pronotal Bristles
Mesonotum
Pre-Alar Bristles
Upper Mesepimera Bristles
Episternal Bristles
Anterior Spiracle
Sterno-Pleural Bristles
Lower Mesepimera Bristles
Side View of Thorax-Wing Removed
Fore Coxa
Middle Coxa
Hind Coxa


Coastal Vein
Coastal Cell
Subcoastal Cell
Humeral Cross Vein
Auxiliary Vein
1st Basal Cell
Marginal Cell
1st Submar-ginal Cell
2nd Basal Cell
2nd Sub-mar-ginal Cell
1st Posterior Cell
2nd Posterior Cell
3rd Posterior Cell
4th Posterior Cell
Auxillary Cell
Anal Cell
1
2
3
4
5
6


Palpus Long
Palpus Short
Head of Anopheline Female
Head of Culicine Female


Apical Bands
Basal Bands Joined
Indent Basal Bands
Longitudinal Stripe (center)
Ventral Marks
Blunt Abdomen
Pointed Abdomen
C. territans
C. pipiens
A.vexans
A. sollicitans

Generalized Classification Scheme for Michigan Mosquitoes

- Spring woodland pool mosquitoes
- Summer floodwater mosquitoes
- Open water mosquitoes
- Container mosquitoes
- There are important exceptions to this classification

- One generation per year; eggs overwinter
- >1 generations in summer; eggs overwinter
- *Anopheles*, *Culex*: females overwinter, >1 generation per summer
- Adapted to small bodies of water held in plants or made by people; overwinter as eggs or larvae
- Examples: waste water and underground mosquitoes


Spring woodland pool


Summer floodwater in ditch


Cattail marsh


Extensively flooded freshwater marsh extending into swamp


Larval habitat of Culiseta
beneath tree hummock

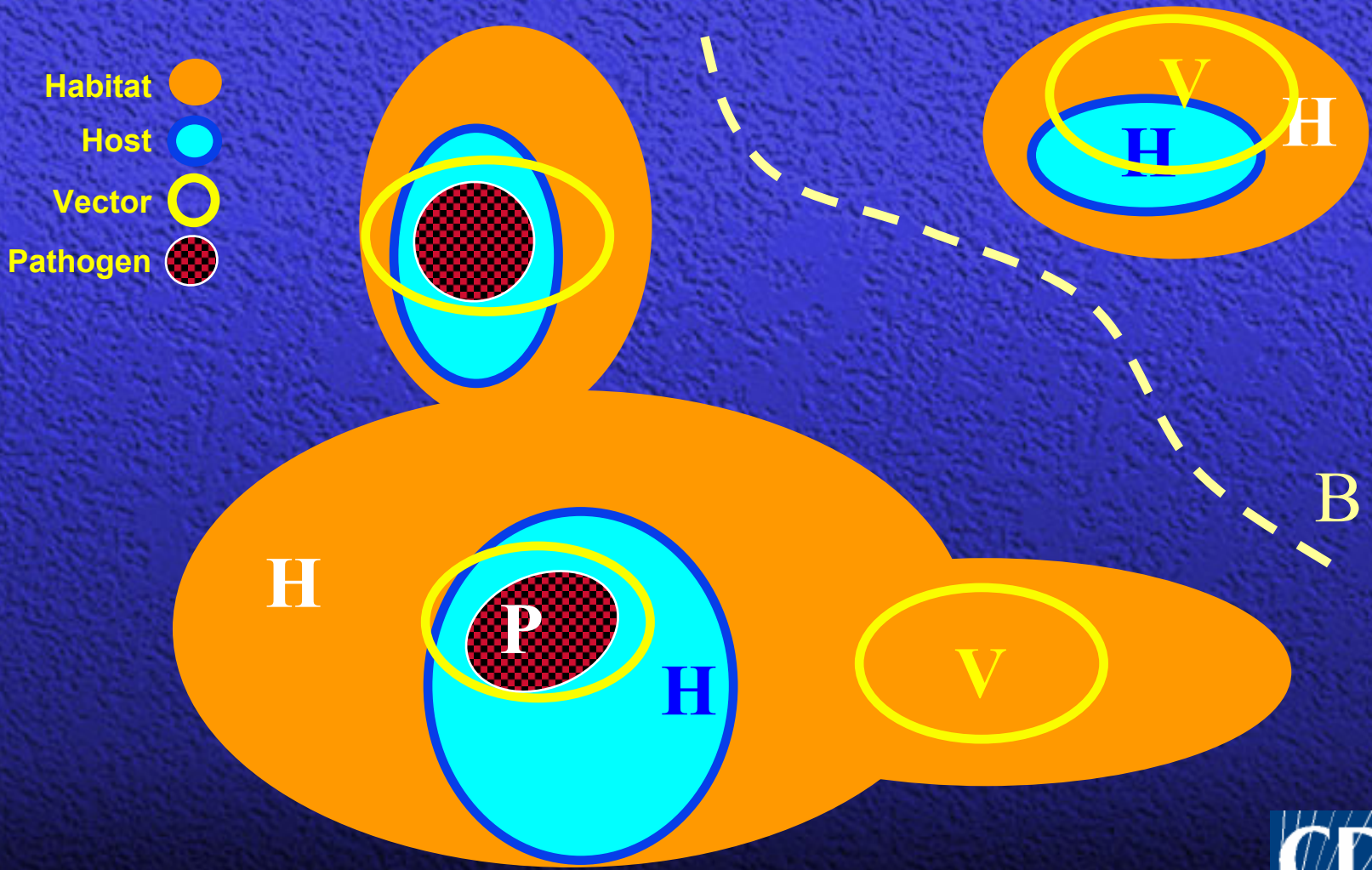

Treehole


Tires

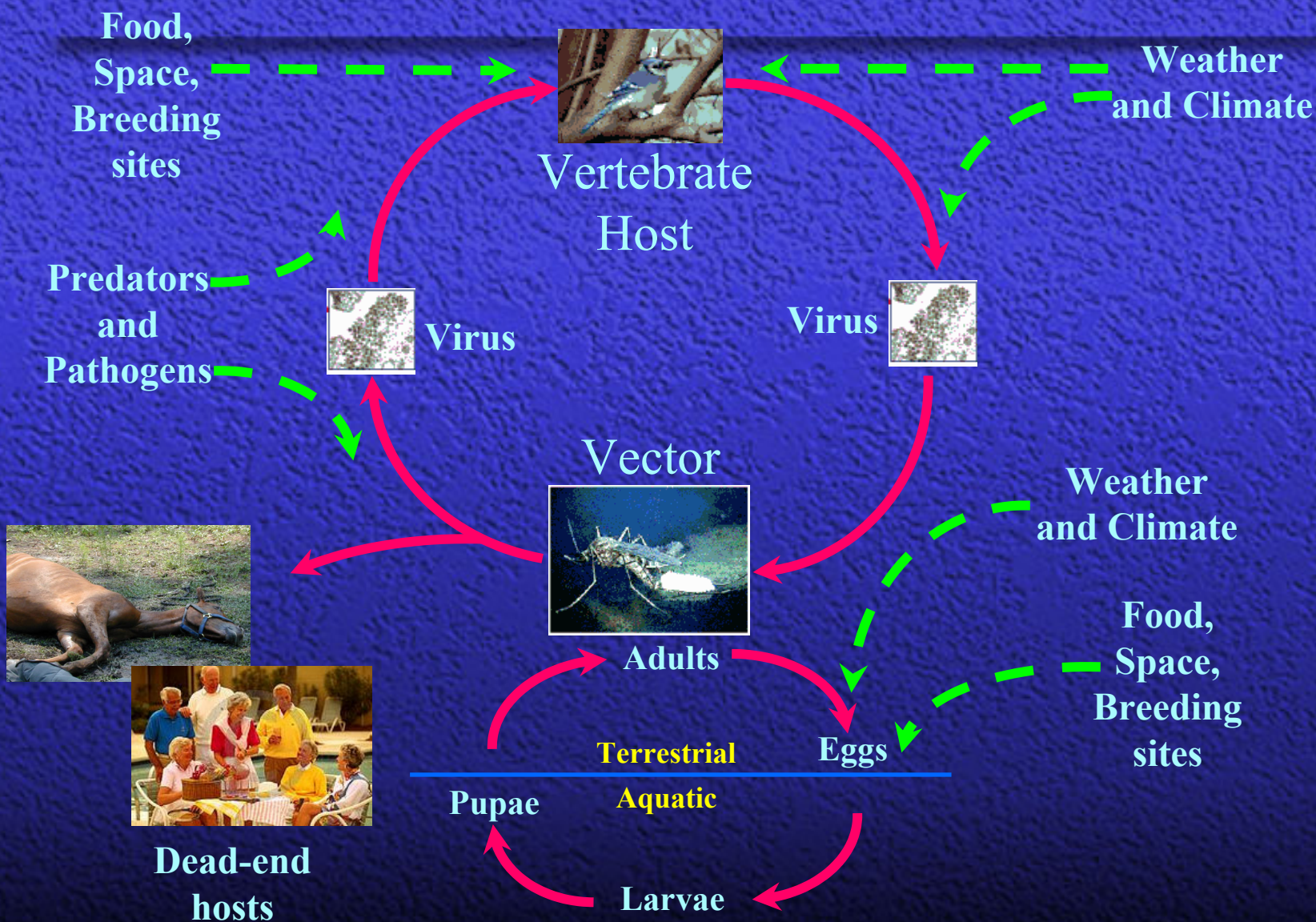

Urban street catchbasin


Pitcher

A Vector-borne Disease System



Arbovirus Transmission Cycles are Complex



Arbovirus

[Contraction]

Arthropod-borne virus

Mosquito and tick transmitted viruses that cause disease in humans and animals

Vector

An arthropod (such as a species of mosquito or tick that is capable of transmitting viruses that cause disease in humans and animals

Mosquito-borne Arboviruses

Arboviruses: Not a taxonomic term. Refers to viruses transmitted biologically by blood-feeding arthropods "**Ar**thropod-**Bo**rne **viruses**"

Major groupings of arboviruses:

Flaviviruses (Flaviviridae): yellow fever, dengue; Japanese encephalitis complex (incl. **WNV**)

Alphaviruses (Togaviridae): EEE, WEE, VEE; chikungunya, o'nyong nyong, Ross River

Bunyaviruses (Bunyaviridae): California serogroup (e.g., LaCrosse virus)

Phleboviruses (Bunyaviridae): Rift Valley fever

Principal Arboviral Diseases, United States

LaCrosse (LAC) encephalitis

St. Louis encephalitis (SLE)

Eastern equine encephalomyelitis (EEE)

Western equine encephalomyelitis (WEE)

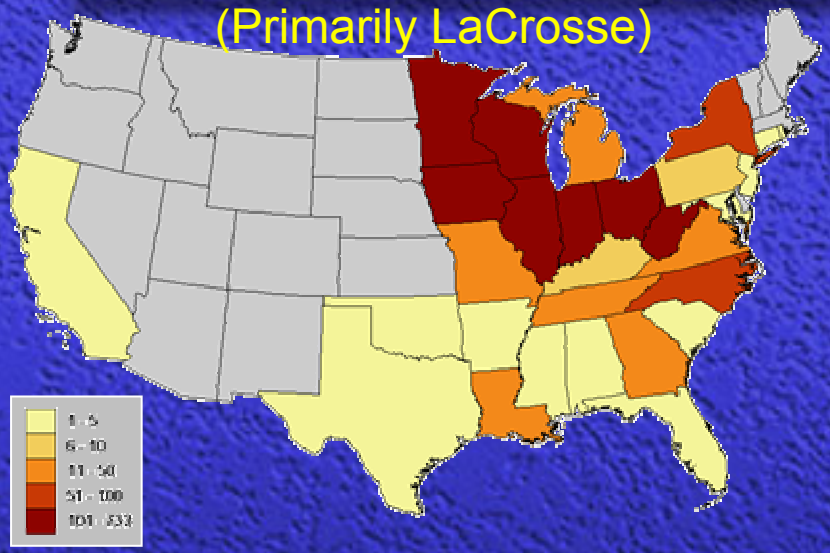
West Nile encephalitis

Dengue

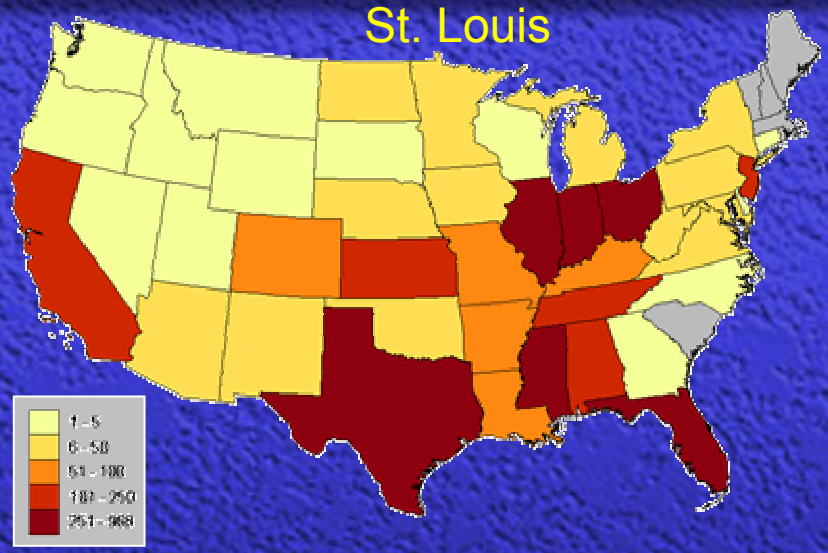
Common Arboviruses in the United States

California Serogroup

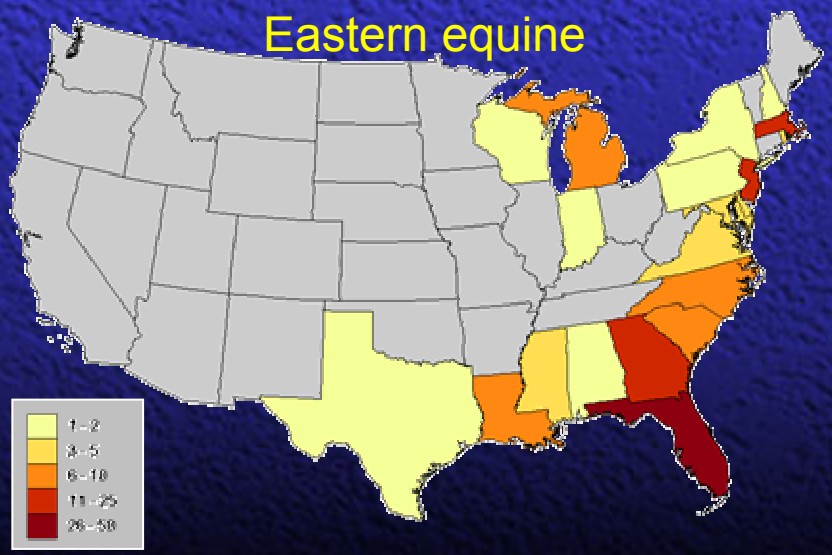
(Primarily LaCrosse)



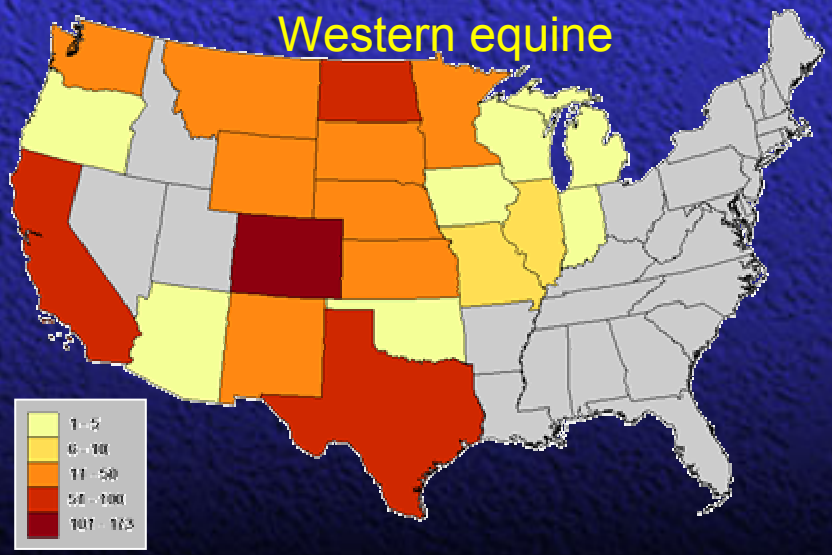
St. Louis



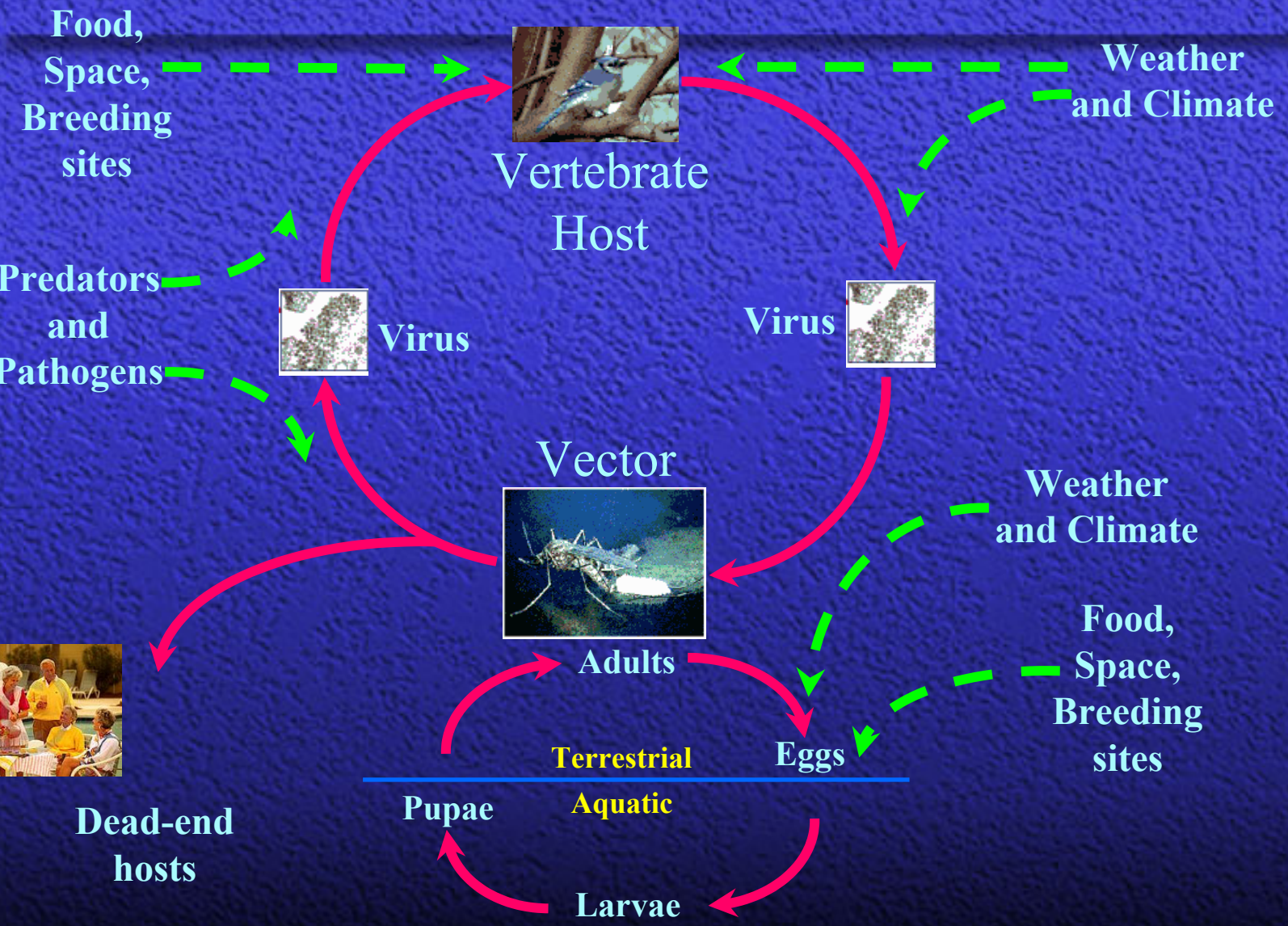
Eastern equine



Western equine



St Louis Encephalitis and WNV have distinct cycles amenable to urban and suburban transmission



Urban Flavor of SLE and WNV Transmission Cycles

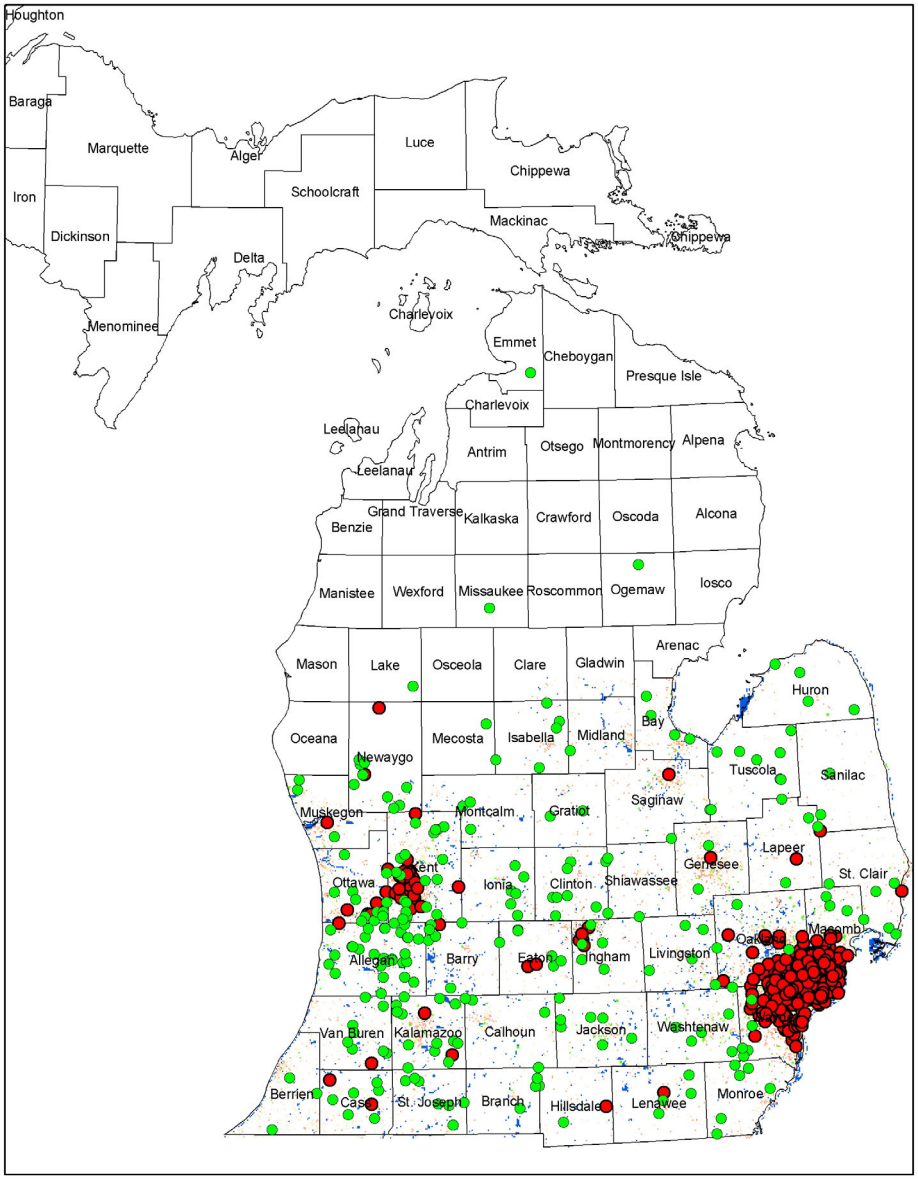
- Culex mosquito vectors: larvae associated with waste- and storm-water retention and channeling systems (street catchbasins and stormwater retention catchments are key)
- Culex mosquitoes quest for urban bird (crow, other) hosts in the urban green space tree canopy: setting for urban amplification
- Crows have become urbanized
- Culex spp. rarely but stealthly feed on humans (late at night; indoors and outdoors; at low densities of exposure)
- Urban virus overwintering in hibernating female Culex in refugia (under streets etc)

Cryptic habitats of larval and adult Culex in urban environments

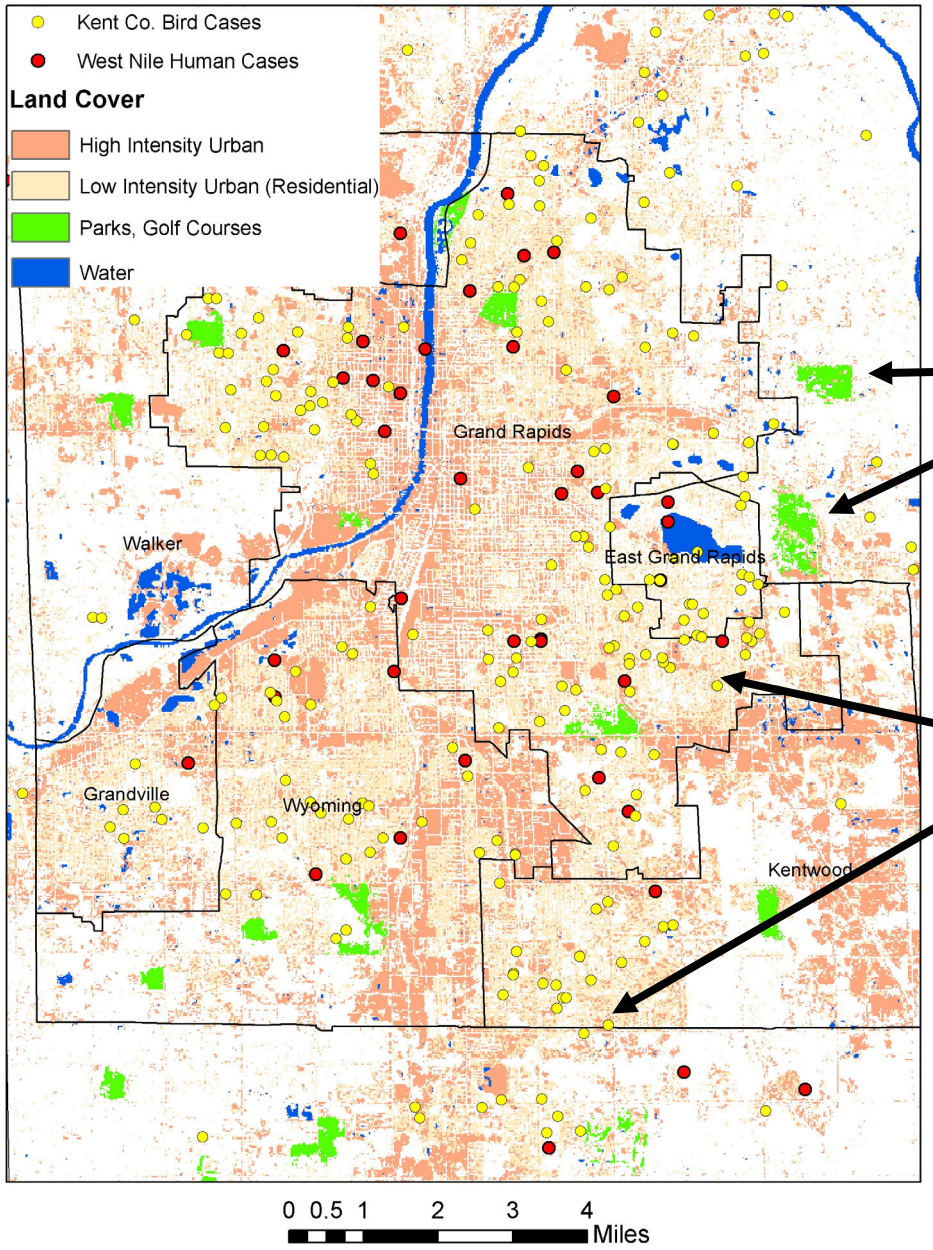
Urban trees provide roost for crows

Manholes leading to utility workspaces

Catchbasin



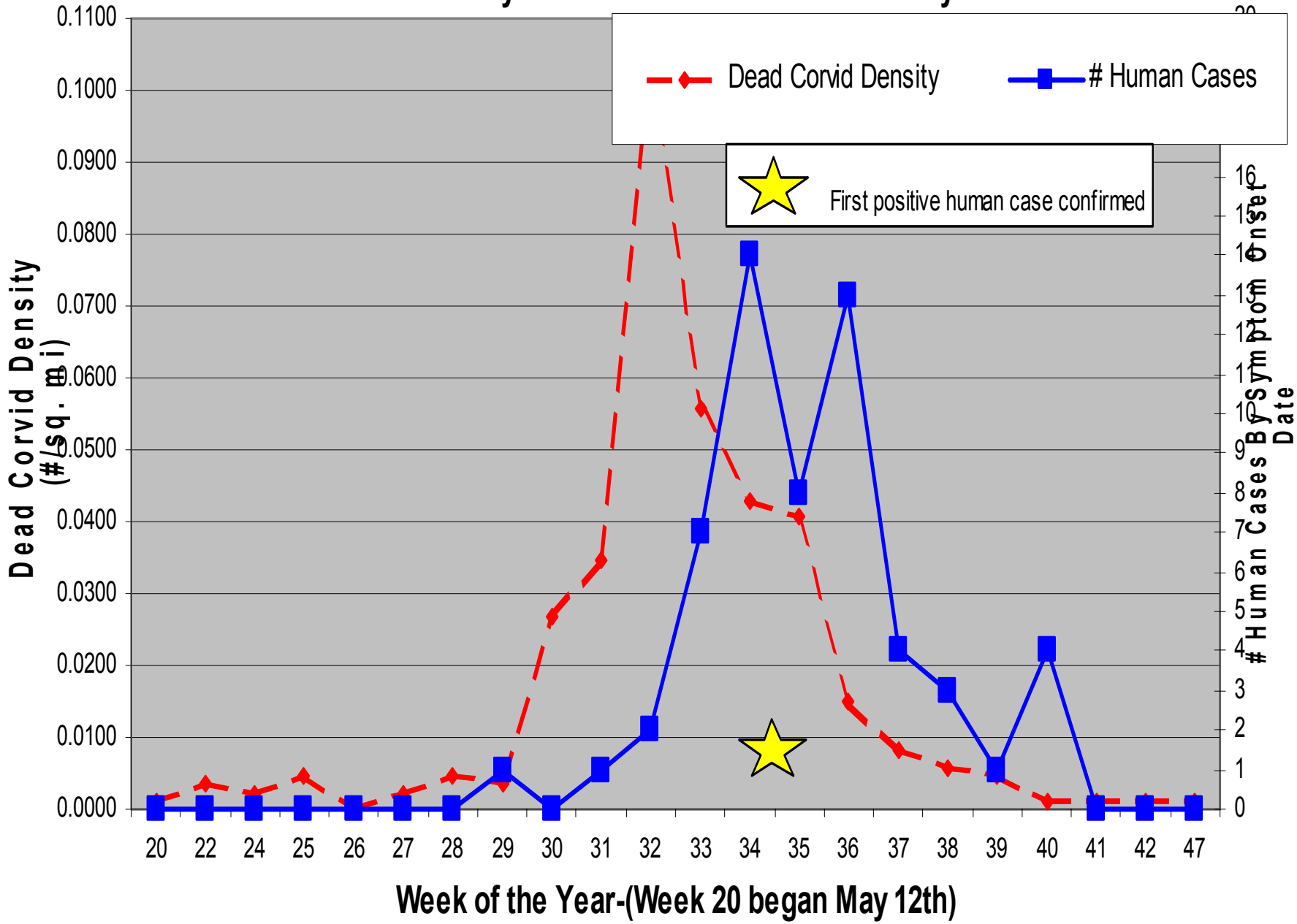
- WNV horse cases -329
- WNV human cases -644



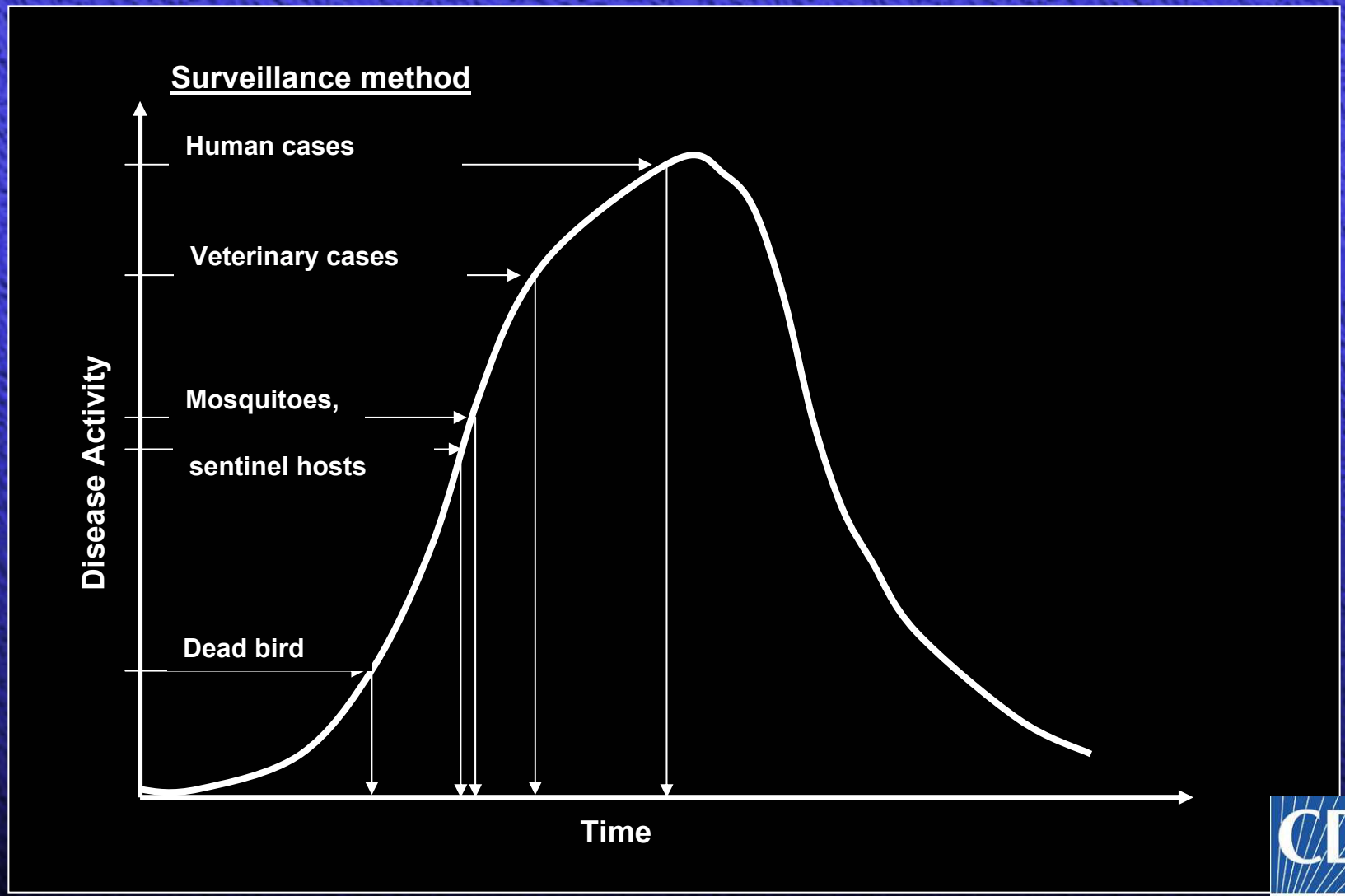
Metro Grand Rapids WNV human and bird cases

Golf courses and parks

Sites of dead bird reports


Dead Corvid Density vs. Human Cases for Kent County in 2002
Dead Corvid Density
Human Cases
First positive human case confirmed
Dead Corvid Density (#/sq. mi)
Human Cases By Symptom Onset Date
Week of the Year-(Week 20 began May 12th)
0.1100
0.1000
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
20 22 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 47

Estimated Sensitivity of West Nile Virus Surveillance Methods

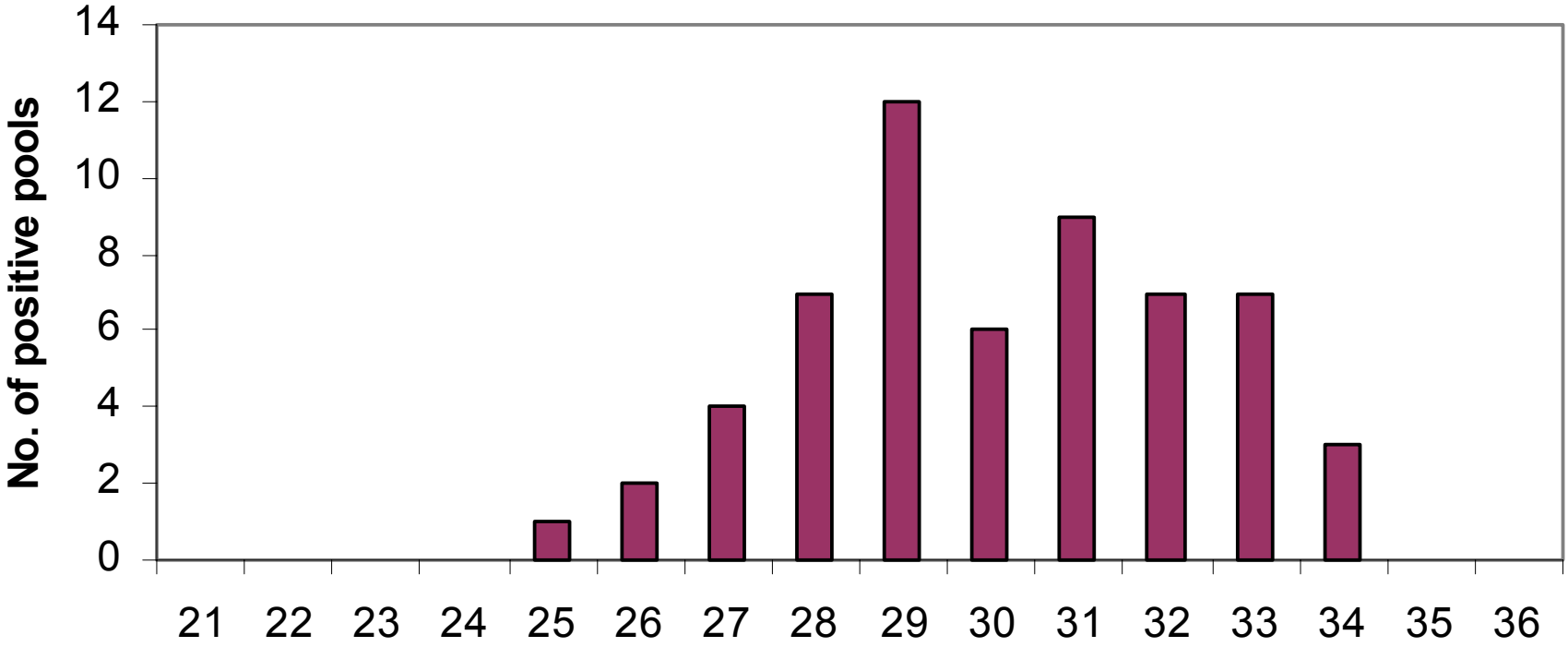


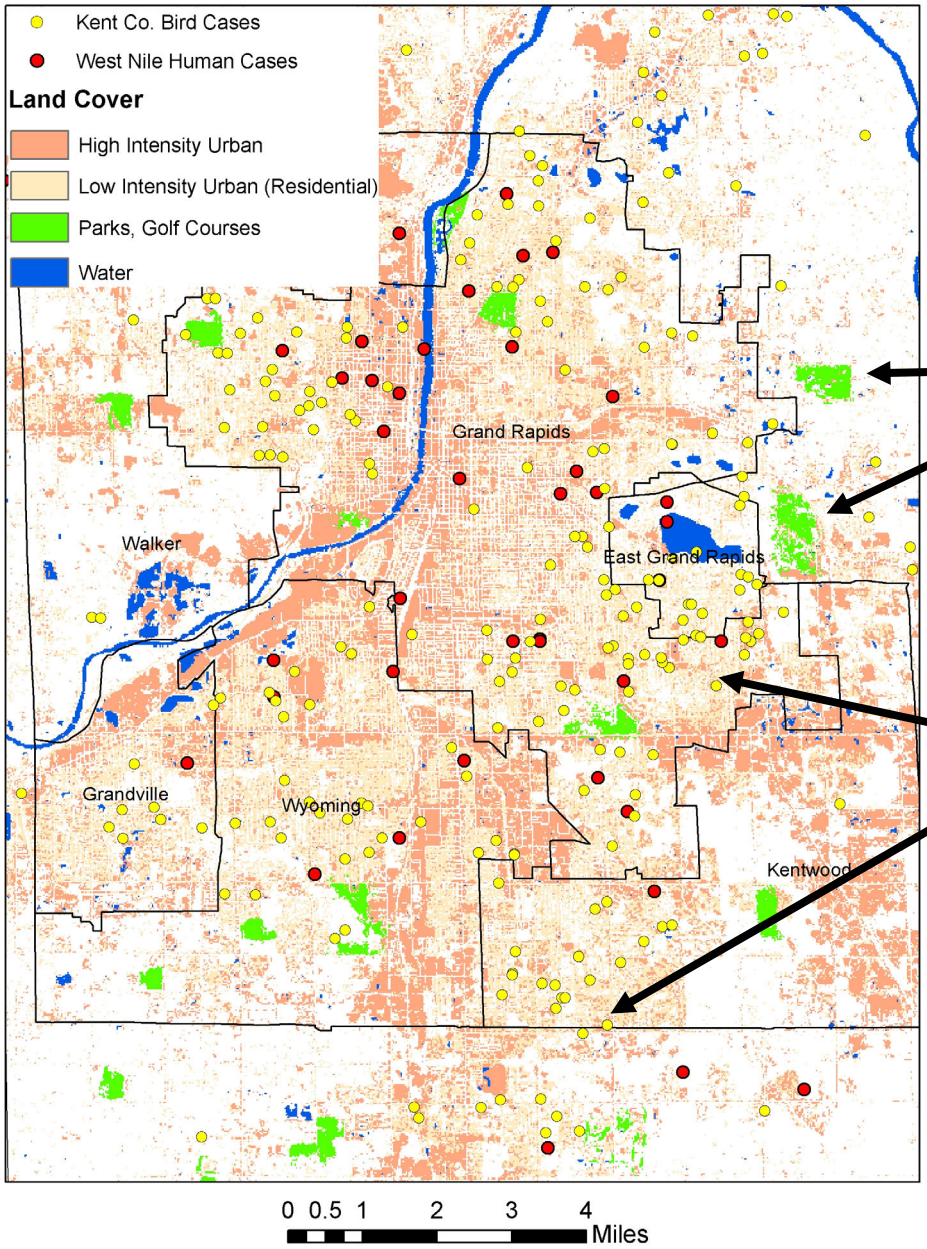
CDC
Centers for Disease Control and Prevention

West Nile virus, PCR positive mosquitoes, Michigan, 2002

Species	No. tested	No. pools	No. positives	estim. MFIR*
Culex spp	5768	431	27	4.7
Cx. pipiens	1182	121	23	19.5
Cx. restuans	58	25	3	51.7
Cx. salinarius	318	30	2	6.3
Cx. territans	2	2	0	0.0
Cq. perturbans	2000	201	1	0.5
Culiseta spp.	188	28	0	0.0
Ochl. triseriatus	76	30	0	0.0
Ochl. trivittatus	569	31	1	1.8
Or.signifera	7	6	0	0.0
Ochl. canadensis	32	7	0	0.0
Ae. vexans	2003	188	1	0.5
An. punctipennis	270	83	0	0.0
An. quadrimaculatus	337	74	0	0.0
Ur. sapphirina	14	8	0	0.0
TOTAL	12824	1265	58	4.3

Positive Mosquito Pools by Week of Year, Michigan, 2002





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